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The Performance in Mathematics 8 Using Geoboard in Cabasan National High School

JERRIE MAE SAMBAJON BATALLA *

Graduate Studies, Daniel B. Peña Memorial College Foundation, Inc., Ziga Avenue, San Juan, Tabaco City, Philippines.

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Abstract

This study determined the performance in Mathematics 8 using a geoboard in Cabasan National High School. Specifically, it answered the following questions: 1. What is the performance of the control and experimental groups in the pre-test along with illustrating triangle congruence; illustrating the SAS, ASA, and SSS congruence postulates; solving corresponding parts of congruent triangles; proving that two triangles are congruent; proving statements on triangle congruence; and applying triangle congruence to construct perpendicular lines and angle bisectors? 2. What is the performance of the control and experimental groups in the post-test? 3. Is there a significant difference in the performance of the control and experimental groups in the pre-test and post-test? 4. What are the least mastered skills in the post-test of the experimental group? and 5. What activity sheets using a geoboard may be proposed to address the least mastered skills?

This study applied the quasi-experimental method to determine the effectiveness of geoboards in the performance of Mathematics 8 students. The researcher employed the pre- and post-test in the control and experimental groups.

The main tool used by the researcher to gather the data is a teacher-made pre- and post-test. The performance of the students in each group was determined by computing the mean score in each skill and the corresponding performance level. To test the hypothesis if there is a significant difference in the performance of the control and experimental groups in the pre- and post-tests, a t-test for independent samples was utilized.

Keywords: Geoboard; Academic Performance; Triangle Congruence; Activity Sheets; Quasi-Experimental Method

1. Introduction

Academic performance in Mathematics varies significantly across the globe, influenced by multiple factors such as education systems, teaching methods, cultural attitudes, and socioeconomic conditions. Poor academic performance in Mathematics is a concern shared by many countries, for it affects not only individual student success but also national development and competitiveness.

The goal of Mathematics in the basic education levels is to promote critical thinking and problem-solving skills of the students. The Department of Education in the Philippines recognizes that the use of appropriate tools is necessary in teaching mathematics. These include manipulative objects, measuring devices, calculators, and computers. From the experiences and reflections, the students had, the knowledge is constructed and connects them to new ideas by the learner. In addition, realizing these theories can be done through the use of manipulatives like geoboards. A geoboard is a physical manipulative used to teach basic geometrical concepts. Conventionally, a geoboard is a block of plywood with nails/pegs uniformly pounded onto it. Another element that goes along with a geoboard is rubber bands. Students can use rubber bands to make practically any shape on the board by simply stretching them between nails/pegs. Geoboards help develop spatial reasoning skills, which involve understanding relationships, orientations, and

* Corresponding author: JERRIE MAE SAMBAJON BATALLA

transformations of objects in space. By manipulating rubber bands on the geoboard, students can explore symmetry, rotations, translations, and reflections. This promotes the development of mental spatial manipulation skills and enhances geometric reasoning abilities.

With the existence of the K-12 curriculum in the Philippines, the use of manipulatives, like geoboard is highly suggested to realize the goals of education. The discovery learning and experiential learning support the idea that students learn when they make use of personal experiences to discover facts, relationships, and concepts. Hence, using geoboards in teaching and learning Mathematics is being seen as an effective manipulative method in engaging the students in the teaching-learning process.

Students' active participation in class requires various interventions and strategies. It lies in the hands of the teachers on how to handle and deliver lessons effectively and how to create a conducive learning environment that promotes equality and enhancement of students' capabilities and interests. Geoboard is one of the materials that can be used in promoting critical thinking skills and the development of students' ability to solve and analyze mathematical problems.

1.1. Statement of the Problem

This study determined the performance of students in Mathematics 8 using geoboard in Cabasan National High School, SY 2024-2025. Specifically, it answered the following sub-problems:

- What is the performance of the control and experimental groups in the pre-test along
  - illustrating triangle congruence;
  - illustrating the side-angle-side (SAS), angle-side-angle (ASA) and side-side-side (SSS) congruence postulates congruence postulates;
  - solving corresponding parts of congruent triangles;
  - proving two triangles are congruent;
  - proving statements on triangle congruence;
  - applying triangle congruence to construct perpendicular lines and angle bisectors?

- What is the performance of the control and experimental groups in the post-test in the above-mentioned skills?
- Is there a significant difference in the performance of the control and experimental groups in the pre-test and post-test?
- What are the least mastered skills of the experimental group in the posttest?
- What activity sheets using a geoboard may be proposed to address the least mastered skills?

1.2. Assumption of the Study

This study was based on the following assumptions

- The control and experimental groups have an equal performance in the pre-test along with illustrating triangle congruence, illustrating the side-angle-side (SAS), angle-side-angle (ASA), and side-side-side (SSS) congruence postulates, solving corresponding parts of congruent triangles, proving two triangles are congruent, proving statements on triangle congruence, and applying triangle congruence to construct perpendicular lines and angle bisectors.
- The performance of the control and experimental groups in the post-test using geoboards differs.
- Geoboard enhances the students' performance in the least mastered skills in Grade 8 Mathematics.
- Activity sheets can be developed to address the least mastered skills of grade 8 students.

1.3. Scope and Delimitation

The researcher focused on the following topics: illustrating triangle congruence; illustrating the side-angle-side (SAS), angle-side-angle (ASA), and side-side-side (SSS) congruence postulates; solving corresponding parts of 10 congruent triangles; proving two triangles are congruent; proving statements on triangle congruence; and applying triangle congruence to construct perpendicular lines and angle bisectors. These are based on the K to 12 Mathematics 8 Most Essential Learning Competencies. The other topics in Mathematics 8 and other grade levels were not included in the study. The subjects of the study were the Grade 8 students of Cabasan National High School in Bacacay South District, Division of Albay. Two (2) groups were utilized in this study and were labelled as the control group and the experimental group. Each group consisted of thirty-three (33) students. Grades of students in the second quarter were utilized to determine their mathematical ability. Each group was composed of an equal number of students with above-average, average, and below-average performance.

2. Material and methods

2.1. Research Method

This study utilized the experimental method to measure the performance of students in Mathematics 8 using geoboards in Cabasan National High School. The experimental research design was done with Grade 8 students. The researcher used the one group pre-test post-test design, which usually involves three steps: (1) administering a pre-test, measuring the dependent variable; (2) applying the experimental treatment to the subjects; and (3) administering a post-test, again measuring the dependent variable. Differences attributed to the application of the experimental treatment were then evaluated by comparing the pre-test and post test scores.

2.2. Subjects of the Study

The subjects of the study were the selected two (2) Grade 8 students of Cabasan National High School, Bacacay, Albay, in the Division of Albay. The subjects were divided into two (2) groups. These groups were the control group and the experimental group. Each of this group has thirty-three (33) students. The researcher made sure that the performance level of each group was equal. The final second (2nd) quarter grades in mathematics of students were utilized to determine their mathematical ability. Each group consisted of an equal number of students. Above-average students were those with grades 93-100, average students attained the grades from 84-92, and below-average performance students achieved the grades from 75-83.

2.3. Research Instrument

In this research, the main instrument used was the lesson plans on illustrating triangle congruence, illustrating the SAS, ASA, and SSS congruence postulates, solving corresponding parts of congruent triangles, proving that two triangles are congruent, proving statements on triangle congruence, and applying triangle congruence to construct perpendicular lines and angle bisectors that the researcher prepared, integrating the material/tool, which is the geoboard. To measure the performance level of the control group and the experimental group on the said topics, the researcher prepared a test that served as the pre-test and post-test. A table of specifications was prepared to identify the weight and proper placement of the items. The said test was composed of fifty (50) items.

2.4. Validation of the Research Instrument

The research instrument was subjected to two phases of validation. This was the face and content validation and the dry run. The validation was done by the thesis committee during the proposal defense to determine if the instrument is appropriate to the research problem of this study. For content validation, the researcher solicits the help of external validators for suggestions and recommendations for the improvement of the items in the instrument. Two master teachers from Camalig National High School and the JHS Mathematics Department Chairman of Cabasan National High School. Each validator brought a unique perspective that greatly contributed to the refinement of the study materials. The feedback helped the researcher identify areas for improvement to the research instrument.

The second phase was the dry run for the trial group, which was also conducted in Cabasan National High School. After the dry run, the researcher conducted an item analysis that determined the difficulty index and determined which items needed to be retained, discarded, or revised.

3. Results and discussion

3.1. The Performance of the Control and Experimental Groups in the Pre-Test

Proving triangle congruence is a critical skill that requires students to apply logical reasoning, spatial visualization, and analytical thinking. The study of triangle congruence provides a foundation for advanced mathematical concepts, such as similarity, trigonometry, and analytic geometry. Effective teaching and learning strategies for triangle congruence and proof are necessary for students to develop a deep understanding of geometry and its applications.

The pre-test for the control group is a 50-item test administered to measure the current performance of the control group before the delivery of the instruction without using a geoboard in the teaching and learning process.

Table 1 Performance of the Control Group in the Pre-Test

Skill	No. of Items	Total Score	Mean	PL (%)	Description
Illustrating triangle congruence	9	80	2.42	27	Low Mastery
Illustrating the SAS, ASA and SSS congruence postulates	8	79	2.39	30	Low Mastery
Solving corresponding parts of congruent triangles	9	94	2.85	32	Low Mastery
Proving that two triangles are congruent	8	57	1.73	22	No Mastery
Proving statements on triangle congruence	8	82	2.48	31	Low Mastery
Applying triangle congruence to construct perpendicular lines and angle bisectors	8	71	2.15	27	Low Mastery
Overall	50	463	14.03	28	Low Mastery

Table 1 implies that before the actual implementation of the study, Grade 8 students in the control group did not have enough understanding of illustrating triangle congruence, illustrating the SAS, ASA, and SSS congruence postulates, solving corresponding parts of congruent triangles, proving statements on triangle congruence, and applying triangle congruence to construct perpendicular lines and angle bisectors, and they had no mastery in proving that two triangles are congruent. The result of the pretest is proof that many of the students are still struggling with the said topics. It is due to poor understanding of the prerequisite topics of the lesson. With this, the students find it difficult to comprehend the next lesson, and it affects the mastery of the most essential learning competencies. Based on researchers' personal experiences, students find it difficult to grasp the new lessons if they lack fundamental/basic skills in learning. When the students lack a solid foundation in basic skills, they find it challenging to understand and comprehend more advanced concepts.

This highlights the importance of strengthening foundational knowledge before introducing more complex mathematical concepts. Teachers should ensure that students have a clear understanding of prerequisite topics such as basic geometric terms, properties of triangles, and fundamental reasoning skills. Addressing these learning gaps through targeted interventions, scaffolded instruction, and the use of visual or hands-on learning tools—such as geoboards—can support better comprehension. When students are equipped with the necessary foundational skills, they are more likely to engage with the lesson, participate actively in discussions, and demonstrate mastery of higher-order learning competencies.

In the study conducted by Gafoor and Kurukkan (2015)[1], the authors stated that mathematics serves as the framework for community development. It is believed that the development of mathematics and civilizations go together. The first step to learn mathematics thoroughly is to know the basic skills in mathematics. Being able to master the previous and prerequisite lessons, they will show good performance during the delivery of the lessons.

Developing materials and interventions is essential in the process of learning. According to Hawthorne (2024)[2], interventions in education allow teachers and teaching assistants to address any gaps in a child's progress or attainment. Once a need has been identified, effective interventions can then be used to overcome any barriers in the child's learning. Developed materials ensures that interventions are engaging and accessible, catering to the individual needs of each learner. Additionally, consistent monitoring and evaluation of these interventions help educators adjust strategies to maximize student progress and outcomes.

Table 2 The Performance of the Experimental Group in the Pre-Test

Skill	No. of Items	Total Score	Mean	PL (%)	Description
Illustrating triangle congruence	9	72	2.18	24	No Mastery
Illustrating the SAS, ASA and SSS congruence postulates	8	67	2.03	25	Low Mastery
Solving corresponding parts of congruent triangles	9	98	2.97	33	Low Mastery
Proving that two triangles are congruent	8	77	2.33	29	Low Mastery
Proving statements on triangle congruence	8	92	2.79	35	Low Mastery
Applying triangle congruence to construct perpendicular lines and angle bisectors	8	65	1.97	25	Low Mastery
Overall	50	471	14.27	29	Low Mastery

The results mean that the students in the experimental group demonstrated low performance in illustrating the SAS, ASA, and SSS congruence postulates; solving corresponding parts of congruent triangles; proving that two triangles are congruent; proving statements on triangle congruence; and applying triangle congruence to construct perpendicular lines and angle bisectors, and no mastery in illustrating triangle congruence. Teachers really need to develop strategies that will address the foundations of each learner in terms of learning mathematics. Addressing students' needs and interests is very important in planning a lesson. As a mathematics teacher, being able to understand the students' strengths and weaknesses is essential in planning and delivering the lessons.

According to Serin (2023)[3], effective instruction in the mathematics classroom assists students in fostering a strong conceptual understanding of concepts. Teachers can facilitate students' comprehension of mathematics through well-planned lessons. Participation in discussions and problem-solving activities enables students to connect abstract mathematical concepts with concrete experiences. Simply put, students improve deeper understanding while exploring real-world applications.

Using hands-on materials is common in most math lessons today in schools around the world. Concrete manipulatives are critical for students to develop an understanding of math concepts. Furner (2024)[4] found that math manipulatives help better connect the math ideas for better understanding. Using math manipulatives had a positive impact on student achievement in learning mathematics.

3.2. The Performance of the Control and Experimental Groups in the Post-Test

After the implementation, a post-test was administered to test if there were improvements in the performance of the two groups using different approaches. The post-test was the same as the pre-test.

Table 3 The Performance of the Control Group in the Post-Test

Skill	No. of Items	Total Score	Mean	PL (%)	Description
Illustrating triangle congruence	9	238	7.21	80	Mastery
Illustrating the SAS, ASA and SSS congruence postulates	8	187	5.67	71	Near Mastery
Solving corresponding parts of congruent triangles	9	181	5.48	61	Near Mastery
Proving that two triangles are congruent	8	115	3.48	44	Low Mastery
Proving statements on triangle congruence	8	98	2.97	37	Low Mastery
Applying triangle congruence to construct perpendicular lines and angle bisectors	8	107	3.24	41	Low Mastery

Overall	50	926	28.06	56	Near Mastery

Table 3 denotes that while traditional teaching methods positively impacted students' performance in areas like illustrating triangle congruence, illustrating the SAS, ASA, and SSS congruence postulates, and solving corresponding parts of congruent triangles, there remain areas that need to be improved, especially in fostering deeper understanding and critical thinking skills. Although the students showed improvement in all the skills discussed, the development of diverse teaching approaches that will address the least mastered skills must be developed. Based on researchers' personal experience, students find it easy to understand illustrating triangle congruence. However, they find it difficult to apply it in constructing perpendicular lines and angle bisectors.

According to Gagić et al., (2019)[5], effective learning occurs when meaningful connections are established throughout the entire curriculum. Often, students struggle to engage with subjects they deem challenging. While certain disciplines may possess greater complexity and abstraction, employing suitable teaching approaches can positively influence students' attitudes toward mastering these complex topics. This means that when lessons are connected to prior knowledge and real-life applications, students are more likely to retain and understand new concepts. Therefore, educators must adopt strategies that promote active learning and make abstract topics more accessible and engaging for learners.

Padillo et al., (2021)[6] explained that learning difficulties in mathematics must be quickly recognized and treated as early as possible because in mathematics, every new learning skill is built on previous learning and is related to one another. Therefore, if students have difficulty with one of the materials, it can be difficult for them to understand the next material. This may ultimately affect the ability of students to learn and understand the material.

Table 4 The Performance of the Experimental Group in the Post-Test

Skill	**No. of Items**	**Total Score**	**Mean**	**PL (%)**	**Description**
Illustrating triangle congruence	9	268	8.12	90	Near Full Mastery
Illustrating the SAS, ASA and SSS congruence postulates	8	240	7.27	91	Near Full Mastery
Solving corresponding parts of congruent triangles	9	268	8.12	90	Near Full Mastery
Proving that two triangles are congruent	8	213	6.45	81	Mastery
Proving statements on triangle congruence	8	201	6.09	76	Mastery
Applying triangle congruence to construct perpendicular lines and angle bisectors	8	164	4.97	62	Near Mastery
Overall	50	1354	41.03	82	Mastery

Table 4 shows that there is a significant improvement in the students' performance within the experimental group, highlighting the positive impact of using a geoboard in teaching mathematics. The material fostered the development of the students' critical thinking skills. The students were encouraged to develop their spatial reasoning and their ability to visualize different situations related to the topics. The lesson plans developed promote deeper understanding and engagement in the teaching and learning process. Based on the conduct of the experimentation, students actively participate in the classroom activities with the use of hands-on materials. They were eagerly motivated to use hands-on materials in the learning process. They were able to express their ideas by manipulating objects on their own, and they were able to visualize the lessons easily.

Hurts & Linsell (2011)[7] elucidated that concrete models can facilitate the development of number sense as well as develop the meaning of written symbols and help students develop a sense of place value. By using this method, teachers can get a better understanding of what students know, as well as identify misconceptions, so they can design interventions accordingly. Understanding the interconnections of mathematical ideas can be improved by utilizing manipulatives. Using manipulatives to solve a problem can assist students in keeping track of what they did and explaining their ideas.

According to Hudson et al., (2010)[8], many children are influenced and motivated using manipulatives. Incorporating manipulatives during instruction can increase academic achievement in math. Hands-on activities engage students in creative thinking as they work to discover mathematical principles. It is a process where students can develop meaning by doing something.

3.3. Test of Significance on the Difference in the Performance of the Control and Experimental Groups in the Pre and Post-test

To determine if there is a significant difference between the performance of control and experimental groups in the pre-test, a test of significance was conducted. The data collected from both groups were analyzed using a t-test for independent samples, comparing their mean scores and variances. The goal of this analysis was to assess if any observed differences in the pre-test performances could be attributed to random chance or if they were statistically significant.

Table 5 Test of Difference on the Performance of the Control and Experimental Groups in the Pre-Test

Group	Mean	Mean Difference	Variance	t-value		Remark
				Computed	Critical	
Control	14.03	-0.24	24.66	-0.18	±1.67	Not Significant
Experimental	14.27		32.77			

The control group computed a mean score of 14.03, and the experimental group computed a mean score of 14.27, having a mean difference of -0.24. The variances of the scores are 24.66 and 32.77 for the control and experimental groups, respectively. The data gives a t-computed value of -0.18, which is within the t-critical value of ±1.67 at a 0.05 level of significance with 64 degrees of freedom. The null hypothesis is accepted that there is no significant difference in the performance of the control and experimental groups in the pre-test.

This implies that both the control and experimental groups performed similarly on the pre-test, proving that they had equal levels of knowledge and skills before the intervention. This equivalence in performance is essential for the validity of the experiment, as it ensures that any differences observed in the post-test can be reliably attributed to the teaching methods or intervention applied. It establishes a fair baseline for comparison, eliminating potential biases that could arise from unequal starting points.

Table 6 Test of Difference on the Performance of the Control and Experimental Groups in the Post-Test

Group	Mean	Mean Difference	Variance	t-value		Remark
				Computed	Critical	
Control	28.06	-12.97	31.99	-9.52	±1.67	Significant
Experimental	41.03		29.28			

The mean of the scores of the control group is 28.06, while the experimental group has 41.03, generating a mean difference of -12.97. The variance of the control group is 31.99, while the experimental group has 29.28. The t-computed value is -9.52. This value is beyond the t-critical value of ±1.67 at the 0.05 level of significance with 64 degrees of freedom; the null hypothesis is rejected. This means that there is a significant difference in the performance of the control and experimental groups in the post-test.

This implies that a significant difference in performance suggests that the intervention used on the experimental group had a positive and substantial impact on student learning outcomes. The control group, which did not receive the same intervention, scored much lower. It indicates that traditional methods (or the methods used in this group) were less effective in improving students' performance. The results validate the effectiveness of the intervention in addressing learning gaps and enhancing students' understanding of the topic. It also highlights the need to re-evaluate conventional teaching strategies that may no longer meet the diverse needs of learners. Implementing innovative and student-centered approaches can significantly improve engagement, retention, and overall academic performance.

3.4. Least Mastered Skill of the Experimental Group in the Post-test

The researcher identified the least mastered skills in the experimental group along with triangle congruence and proving. Table 7 presents the least mastered skill of the experimental group in the post-test.

Table 7 Least Mastered Skill

Skill	Mean	Performance Level (%)	Description
Applying triangle congruence to construct perpendicular lines and angle bisectors	4.97	62	Near Mastery

After the intervention, a post-test is given, and the result shows that among the six (6) competencies tested, one (1) skill is considered the least mastered. This skill is applying triangle congruence to construct perpendicular lines and angle bisectors, which obtained a mean score of 4.97, or a performance level of 62 percent only. This connotes that among the topics covered, the experimental group struggled the most in applying triangle congruence to construct perpendicular lines and angle bisectors. Based on the researcher's observations, students found it challenging to apply their learnings about triangle congruence in constructing perpendicular lines and angle bisectors.

3.5. Activity Sheets Using Geoboard to Address the Least Mastered Skills

To address this concern, researchers have been exploring innovative and engaging strategies to enhance students' mathematical understanding and skills. One such approach is the use of geoboards, a manipulative tool that allows students to explore and visualize geometric shapes, patterns, and relationships. By the interactive and hands-on nature of geoboards, activity sheets can be designed to provide students with a structured and guided learning experience. Geoboards are used in addressing the skills in mathematics. By exploring the impact of this innovative approach on students' mathematical understanding and skills, this research seeks to contribute to the existing body of knowledge on mathematics education and provide educators with a practical and evidence-based strategy to support their students' learning needs.

Incorporating geoboards into activity sheets also promotes active participation and collaborative learning among students. As learners manipulate the tool to explore geometric relationships, they engage in meaningful discussions, share strategies, and learn from one another's perspectives. This interactive learning environment not only deepens conceptual understanding but also fosters confidence and motivation to tackle more complex mathematical tasks.

Activity sheets that incorporate the use of a geoboard present a promising approach to enhancing students' understanding of geometric concepts and spatial reasoning. By offering a structured and guided learning experience, these materials support the development of problem-solving skills, critical thinking, and analytical abilities. Moreover, the hands-on and visual nature of geoboard activities makes abstract mathematical ideas more accessible and engaging for learners.

In applying triangle congruence to construct perpendicular lines and angle bisectors, the writer developed activity sheets that promotes real-life applications wherein the students represent each situations using Geoboards. Students will be able to apply triangle congruence in real-life situations that involves perpendicular and angle bisectors. It enhances students' ability to create, analyze and evaluate given situations using hands on material.

4. Conclusion

The following conclusions were drawn

- The performance of the control group, along with illustrating triangle congruence; illustrating the SAS, ASA, and SSS congruence postulates; solving corresponding parts of congruent triangles; proving statements on triangle congruence; and applying triangle congruence to construct perpendicular lines and angle bisectors, is described as low mastery. However, in the area of proving that two triangles are congruent, the group's performance was classified as no mastery.
- The performance level of the experimental group is interpreted as low mastery along with illustrating the SAS, ASA, and SSS congruence postulates; solving corresponding parts of congruent triangles; proving that two triangles are congruent; proving statements on triangle congruence; and applying triangle congruence to

construct perpendicular lines and angle bisectors. In addition, the group's performance in illustrating triangle congruence was described as no mastery.

- The performance level of the control group, along with illustrating triangle congruence, is interpreted as under mastery. However, on illustrating the SAS, ASA, and SSS congruence postulates and solving corresponding parts of congruent triangles, the performance is described as near mastery. On the other hand, on the skills of proving that two triangles are congruent, proving statements on triangle congruence, and applying triangle congruence to construct perpendicular lines and angle bisectors, the group's performance is considered low mastery.
- The experimental group's performance level on illustrating triangle congruence; illustrating the SAS, ASA, and SSS congruence postulates; and solving corresponding parts of congruent triangles is considered near full mastery. However, the performance in proving that two triangles are congruent and in proving statements on triangle congruence was classified as under mastery. Meanwhile, the performance in applying triangle congruence to construct perpendicular lines and angle bisectors is interpreted as near mastery.
- There was no significant difference in the performance of the control and experimental groups across the various skills assessed in the pre-test; however, a significant difference was observed in the post-test results.
- In the post-test, the experimental group's least mastered skill was applying triangle congruence to construct perpendicular lines and angle bisectors, with a performance level interpreted as near mastery.
- To address the least mastered skills, the researcher developed activity sheets specifically designed to target those areas.

Compliance with ethical standards

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Disclosure of conflict of interest

I declare that I have no conflicts of interest related to this research. I have no personal or financial relationships that could influence my work.

Statement of ethical approval

The present study does not contain any studies performed on animals/human's subject by any the author.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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