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(Research Article)

The effects of algorithm approach to students' understanding of functions

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Abstract

This research study explored the effectiveness of the Algorithm Approach as a teaching strategy in enhancing the understanding and performance of Grade 11 Academic Track students at Naga National High School. The topics covered in this study are: evaluating functions; performing addition, subtraction, multiplication, division and composition of functions; solving problems involving functions; distinguishing rational functions, rational equation, and rational inequality; solving rational equations and inequalities; and finding the domain and range of a rational function. The researcher utilized a quasi-experimental design involving two groups of students: a control group, which received conventional instruction, and an experimental group, which was taught using the algorithm approach. Both groups were administered pre-tests and post-tests, and their scores were subjected to statistical analysis to determine any significant differences in performance.

The results showed a notable improvement in the post-test scores of the experimental group compared to the control group. The mean difference and a computed t-value that exceeded the critical value of ±2 confirmed that the algorithm approach had a statistically significant effect on students' academic performance. Learners in the experimental group demonstrated stronger mastery of key mathematical skills, indicating that the structured nature of the algorithm approach contributed to better learning outcomes. Based on these findings, the study concludes that the algorithm approach is an effective instructional strategy for teaching functions in senior high school.

Keywords: Algorithm Approach; Functions; Quasi-experimental Design; Pre-test; Post-test; Academic Track students

1. Introduction

Functions allow students to model relationships in real-world contexts, including population growth, financial transactions, and physical processes. Mastery of functions is essential for higher-level topics such as algebra, calculus, and statistics. Functions also foster logical reasoning, analytical thinking, and problem-solving abilities. Despite their significance, many students find functions abstract and challenging, often relying on rote memorization rather than deep understanding. Traditional teaching methods may emphasize procedural skills without adequately developing conceptual comprehension, leaving students unable to apply mathematics effectively.

One approach that addresses these challenges is the algorithmic approach in Mathematics. This method involves structured, step-by-step procedures for solving problems, performing calculations, and processing data according to clear rules. Algorithmic strategies make abstract concepts, such as functions, more accessible by linking them to practical, real-life applications. Through systematic problem-solving, students develop computational skills, critical thinking, and decision-making abilities. Moreover, algorithmic approaches promote active learning, reduce mathematics anxiety, encourage collaboration, and foster motivation. By guiding students through logical sequences of steps, this approach bridges the gap between procedural proficiency and conceptual understanding.

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1.1. Statement of the Problem

This study determined the effects of the algorithm approach on the students' understanding of functions of Grade 11 students of Naga National High School, SY 2025-2026. Specifically, it answered the following sub- problems:

- What is the performance of the control and experimental groups in the pre- test along:
  - Evaluating functions;
  - Performing addition, subtraction, multiplication, division and composition of functions;
  - Solving problems involving functions;
  - Distinguishing rational functions, rational equation, and rational inequality;
  - Solving rational equations and inequalities; and
  - Finding the domain and range of a rational function?
- What is the performance of the control and experimental group in the post-test?
- Is there a significant difference in the performance of the control and experimental group in the pre-test and post-test?
- What are the least mastered skills of the experimental group in the post-test?
- What enhanced lesson plans using the algorithm approach may be proposed to address the least mastered skills?

1.2. Assumption of the Study

This study was based on the following assumptions:

- The performance level of the control and experimental groups varies in the post-test using the algorithm approach.
- There are identified least mastered skills after the conduct of the post-test of the experimental group.
- Enhanced lesson plans applying algorithm approach are developed to address the least mastered skills in functions.

1.2.1. Hypothesis

There is no significant difference in the performance of the control and experimental groups in the pre-test and post-test.

1.3. Scope and Delimitation

This study examined the effects of the algorithmic approach on the understanding of selected Grade 11 Academic Track students at Naga National High School during the School Year 2025–2026. Two groups were utilized in the study: an experimental group and a control group. Each group consists of thirty (33) students. The students in each group were on equal footing in terms of performance in Mathematics which is based on their final grade in Mathematics 10.

The researcher focused on the following topics: evaluates a function; performs addition, subtraction, multiplication, division and composition of functions; solves problems involving functions; distinguishes rational functions, rational equation, and rational inequality; solves rational equations and inequalities; finds the domain and range of a rational function. These are based on the K to 12 Most Essential Learning Competencies from week one (1) to week six (6) in General Mathematics. The other topics in General Mathematics from week seven (7) in K to 12 Most Essential learning Competencies onwards and other subjects are not included in the study because they are not part of the focused skills in the present study. To determine the effects, this research used the pre-test and post-test as instruments to measure the performance of the experimental and control groups.

2. Materials and Methods

2.1. Research Method

This study applied an experimental method specifically the quasi-experimental design wherein the experimental and control groups were utilized to determine the effectiveness of the algorithm approach in enhancing the understanding of functions among senior high school grade 11 students of Naga National High School for school year 2025–2026, aimed at improving their academic performance in General Mathematics. To gauge the performance level of the control group and the experimental group on the said topics, the researcher prepared a test that was administered to the subjects of the study and served as both the pre-test and post-test. A Table of Specifications was also prepared to identify the weight and appropriate placement of the items. The said test was composed of a forty (40)-item multiple-choice test.

2.2. Subjects of the Study

The subjects of the study were from the two (2) sections of Grade 11 Senior High School – academic track students of Naga National High School for school year 2025–2026. The subjects were divided into two groups: the control group and the experimental group. Each group consisted of thirty-three (33) students, totaling sixty-six (66) Grade 11 students.

The students' grades in Mathematics 10 were utilized to determine their mathematical ability. Each group was composed of an equal number of students. "Above-average" students were those with grades from 93 to 100, "average" students' attained grades from 84 to 92, and "below-average" students achieved grades from 75 to 83. To ensure that no other underlying factors interfered with the results of the study aside from the variables presented in the conceptual paradigm, both groups were handled by the same teacher, their classrooms were located within the same area, and their class schedules were comparable in terms of time intervals.

2.3. Research Instrument

The researcher used 40-item multiple choice test that match the topic about functions in pre-test and post-test as the research instruments of this study in gathering data from the participants, which sought to measure the performance level of the students. The said test materials underwent a dry run to ensure their validity, reliability, usability, and measurability. This study also utilized lesson plans, which served as guides for teaching both groups. Lessons were incorporated with various models as teaching materials in integrating the algorithm approach.

2.4. Validation of the Research Instrument

The research instruments underwent two phases of validation: content validation and a dry run. These validation procedures were conducted after the research proposal had been approved. Prior to the implementation of the experimental method, the researcher ensured thorough preparation to guarantee the accuracy, validity, and usability of the research tools and lesson plans. The validators consisted of three (3) master teachers: two master teachers from the Mathematics Department of Naga National High School and one mathematics teacher from Tiwi Agro-Industrial School–Junior High School.

3. Results and Discussion

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

This study focused on the six core competencies identified in Weeks 1 to 6 of the Most Essential Learning Competencies (MELCs) for General Mathematics—a foundational component of the Senior High School curriculum. These competencies are carefully crafted to develop not only procedural fluency but also critical thinking, logical reasoning, and mathematical maturity among learners. However, despite their importance, many Senior High School students find these competencies challenging to grasp. A multitude of factors contribute to this struggle. Chief among them are persistent gaps in foundational knowledge, which hinder the students' ability to connect new concepts with prior **learning.**

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

Skills	**No. Of Items**	**Total Score**	**Mean**	**Performance Level (%)**	**Description**
Evaluating functions	7	444	13.45	84	Low Mastery
Performing operations such as addition, subtraction, multiplication, division, and composition of functions	13	820	24.85	78	Low Mastery
Solving real-life problems involving functions	7	408	12.36	77	Low Mastery

Distinguishing between rational functions, rational equations, and rational inequalities	3	175	5.30	77	Low Mastery
Solving rational equations and inequalities	5	160	4.85	67	No Mastery
Identifying the domain and range of rational functions	5	175	4.70	64	No Mastery
Overall	40	2,162	65.52	82	Low Mastery

Table 1 reveals that the data from the control group shows significant implications regarding the current instructional approach to teaching functions and rational expressions. With an overall performance level classified as low mastery at 82%, it is evident that while students demonstrate some procedural understanding—particularly in evaluating functions and performing basic operations—they still struggle with more complex concepts such as solving rational equations and inequalities and determining the domain and range of rational functions. The performance dipped into the no mastery category.

The performance trends exhibited by the control group in this study strongly echo the challenges documented by Dubinsky and Harel (1992)[1], who conducted extensive research into students' conceptual understanding of functions. Their work highlights a common difficulty among learners in transitioning from procedural mastery—such as straightforward evaluation or computation—to a more sophisticated, structural comprehension of functions, including operations like composition and inversion. Dubinsky and Harel argued that many students perceive functions merely as computational tools rather than as objects with intrinsic properties, which limits their ability to engage meaningfully with abstract mathematical ideas. This phenomenon is reflected in the control group's low mastery scores in performing operations on functions and solving problems involving functions, suggesting that students have yet to develop the necessary higher-order thinking skills to fully internalize these concepts.

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

Skills	No. Of Items	Total Score	Mean	Performance Level (%)	Description
Evaluating functions	7	430	13.00	82	Low Mastery
Performing operations such as addition, subtraction, multiplication, division, and composition of functions	13	860	26.30	81	Low Mastery
Solving real-life problems involving functions	7	400	11.80	76	Low Mastery
Distinguishing between rational functions, rational equations, and rational inequalities	3	170	5.67	79	Low Mastery
Solving rational equations and inequalities	5	155	4.55	61	No Mastery
Identifying the domain and range of rational functions	5	165	4.90	65	No Mastery
Overall	40	2,180	65.22	75	Low Mastery

Table 2 shows that students demonstrate a generally low mastery of skills related to functions and rational expressions, with an overall performance level of 78%. While students performed relatively better in foundational competencies such as evaluating functions (82%) and performing basic operations on functions (81%), their understanding remains insufficient for mastery. More complex skills, including solving real-life problems involving functions (76%) and distinguishing between rational functions, equations, and inequalities (79%), showed slightly lower performance, indicating challenges in applying and conceptualizing mathematical ideas.

According to Yazon et al. (2019)[2], students often struggle with rational functions due to limited conceptual understanding and procedural fluency, particularly when identifying domain and range, which was also evident in the present study where students demonstrated no mastery in this competency (PL = 65%). This aligns with Pantaleon et al. (2023)[3], who found that explicit teaching strategies significantly improved student performance in understanding domain restrictions and interpreting function behavior. Furthermore, Japitana and Cajandig (2025)[4] emphasized that many senior high school students exhibit poor performance in solving rational equations and inequalities due to a lack of deep reasoning and problem-solving strategies, which reflects the current study's findings of no mastery in that area (PL = 61%).

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

In the conduct of the study, both the control and experimental groups were exposed to instruction covering the same competencies in functions. These competencies included evaluating functions, performing operations on functions, solving real-life problems, distinguishing rational expressions, solving rational equations and inequalities, and identifying domain and range. However, the primary distinction between the two groups lay in the teaching methodologies employed. The control group received instruction through the traditional method, which typically relies on teacher-centered strategies such as direct instruction, chalk-and-talk lectures, and textbook-based exercises. In contrast, the experimental group was taught using the algorithm approach, a method designed to enhance students' problem-solving efficiency through step-by-step procedures and structured strategies tailored to each mathematical task.

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

Skills	No. Of Items	Total Score	Mean	Performance Level (%)	Description
Evaluating functions	7	480	14.55	90	Near Mastery
Performing operations such as addition, subtraction, multiplication, division, and composition of functions	13	845	25.61	88	Near Mastery
Solving real-life problems involving functions	7	460	13.94	88	Near Mastery
Distinguishing between rational functions, rational equations, and rational inequalities	3	215	6.52	87	Near Mastery
Solving rational equations and inequalities	5	290	8.79	76	Low Mastery
Identifying the domain and range of rational functions	5	270	8.18	82	Low Mastery
Overall	40	2,560	77.59	86	Near Mastery

Table 3 implies that several implications emerge regarding the effectiveness of the traditional approach to instruction. The data showed that students reached a near mastery level in most foundational competencies, such as evaluating functions (PL = 90%), performing operations on functions (PL = 88%), solving real-life problems (PL = 88%), and distinguishing among rational expressions (PL = 87%). These results imply that the traditional method, which relies heavily on direct instruction and a teacher-centered "chalk-and-talk" delivery, is effective in supporting students' acquisition of procedural knowledge and basic conceptual distinctions. It is likely that repeated demonstrations and structured examples helped reinforce mechanical skills and familiarity with standard problem types.

In a study conducted by Bayocot (2014)[5], it was found that students exposed to conventional teaching strategies in mathematics—characterized by lectures, demonstrations, and board work—performed adequately in tasks involving basic operations but struggled significantly when faced with more complex or application-based problems. This aligns with the present study's findings, where the control group demonstrated near mastery in skills such as evaluating functions and performing operations, yet exhibited low mastery in solving rational equations and identifying domain and range. Similarly, Freeman et al. (2014)[6], through a meta-analysis of 225 STEM-related studies, concluded that students in traditional lecture-based classes were 1.5 times more likely to fail than those engaged in active learning environments

In this present study, the researcher acknowledges that the traditional teaching approach has had a considerable impact on students' performance in the topic of functions. Based on years of teaching experience, it has been consistently observed that the instructional strategy used to deliver mathematical content significantly influences students' learning outcomes. A key factor affecting students' comprehension and mastery of functional concepts is the method of instruction. In settings where the traditional approach predominates—characterized by teacher-led discussions, repetitive lectures, and the use of chalkboard or whiteboard demonstrations—students tend to adopt a passive role in the learning process. These lessons generally follow a sequential and procedural format, where students are led through examples and exercises without ample opportunities for independent inquiry or collaborative engagement.

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

Skills	No. Of Items	Total Score	Mean	Performace Level (%)	Description
Evaluating functions	7	217	6.58	94	Mastery
Performing operations such as addition, subtraction, multiplication, division, and composition of functions	13	395	11.97	92	Mastery
Solving real-life problems involving functions	7	205	6.21	89	Near Mastery
Distinguishing between rational functions, rational equations, and rational inequalities	3	86	2.61	87	Near Mastery
Solving rational equations and inequalities	5	142	4.30	86	Near Mastery
Identifying the domain and range of rational functions	5	140	4.24	85	Near Mastery
Overall	40	1185	35.91	90	Mastery

Table 4 indicates that the use of the algorithmic teaching approach has a significantly positive effect on the experimental group's comprehension of functions. The students achieved mastery in essential skills such as evaluating functions and performing various operations, as evidenced by their high mean scores and performance levels surpassing 90%. This suggests that the algorithm approach provides learners with clear, stepwise procedures that foster strong procedural fluency and boost their confidence in managing function-related problems. The results imply that the algorithmic approach serves as an effective teaching strategy that not only enhances students' accuracy and mastery of computational skills but also promotes the growth of analytical and critical thinking abilities essential for grasping more abstract mathematical ideas.

Sembiring and Silalahi (2019)[7] revealed that students taught using algorithm-based instruction exhibited higher accuracy and procedural fluency when solving function-related problems compared to those taught through traditional methods. Their research emphasized that breaking down complex mathematical processes into clear, manageable steps reduces cognitive overload, allowing learners to develop confidence and a deeper understanding of problem-solving techniques. This supports the present findings, where the experimental group showed mastery in foundational skills through the algorithm approach, highlighting its potential to foster systematic and effective learning.

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

Group	Mean	Mean Difference	Variance	t- value		Remarks
				Computed	Critical	
Control	65.52	0.30	9.04	0.60	±1.67	Not Significant
Experimental	65.22		9.07			

Table 5 reveals that the control group obtained a mean score of 65.52, while the experimental group recorded a mean score of 65.22, resulting in a mean difference of 0.30. The computed t-value was 0.60, which was lower than the critical t-value of 1.67 at the 0.05 level of significance. This indicated that there was no statistically significant difference between the two groups in terms of their performance in general mathematics before the intervention was implemented.

Since the result showed no significant difference, it confirmed that the two groups were statistically equivalent at the outset. This established a valid basis for implementing the experimental intervention, as any changes in the post-test performance could be confidently attributed to the use of the algorithm approach in the experimental group. Therefore, the findings validated the appropriateness of using a quasi-experimental design, which requires initial group comparability to measure the effectiveness of the independent variable—namely, the teaching method used.

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		Remarks
				Computed	Critical	
Control	27.59	41.68	6.59	-24.66	±1.67	Significant
Experimental	35.91		9.21			

Table 6 presents a comparison of the academic performance of the control and experimental groups. The mean score of the experimental group (35.91) was higher than that of the control group (27.59), indicating an improvement in performance following the intervention using the algorithm approach. The mean difference of 6.59 points reflects the relative gain of the experimental group over the control group.

The computed t-value of -24.66 exceeds the critical value, suggesting that the difference in performance between the two groups is statistically significant. This indicates that the algorithm-based teaching strategy had a positive effect on students' understanding of the mathematical concepts, particularly in areas related to functions, rational equations, and inequalities. The higher variance in the control group (41.68) compared to the experimental group (9.21) further implies that the experimental group's scores were more consistent, likely due to the structured, step-by-step guidance provided by the algorithm approach. Overall, these findings demonstrate the effectiveness of the algorithm approach in enhancing both student performance and consistency in learning outcomes.

Table 7 Least Mastered Skill of the Experimental Group in the Post-test

Skills	No. Of Items	Total Score	Mean	Performace Level (%)	Description
Solving rational equations and inequalities	5	155	4.55	61	Low Mastery
Identifying the domain and range of rational functions	5	165	4.90	65	Low Mastery

The table clearly identifies the two skills in which the experimental group demonstrated the lowest performance in the post-test: "Solving rational equations and inequalities" and "Identifying the domain and range of rational functions." For *solving rational equations and inequalities*, the group achieved a performance level of 61%, which is classified as low mastery. This low score suggests that students faced significant challenges with the procedures and concepts required for this skill. Mastery of rational equations and inequalities demands an understanding of algebraic manipulation, the ability to simplify expressions, find common denominators, recognize restrictions on variable values, and correctly solve inequalities while considering extraneous solutions. The poor performance indicates that students likely struggled with these complex steps, possibly due to gaps in foundational knowledge or ineffective instructional strategies that failed to scaffold these concepts adequately.

Similarly, the skill of *identifying the domain and range of rational functions* showed only a slightly better performance level of 65%, but still remained within the low mastery range. This skill requires students to analyze rational functions both graphically and algebraically to determine the set of possible input values (domain) and output values (range). It involves understanding the behavior of functions, such as identifying asymptotes, discontinuities, and points where the function is undefined. The difficulty in this area suggests that learners had trouble conceptualizing these abstract ideas and applying them to specific problems, which might be due to a lack of visual aids, limited practice opportunities, or insufficient explanations during instruction.

These findings imply that the instructional intervention used with the experimental group did not effectively address the complexity of these mathematical concepts. The low mastery in these critical areas may hinder students' ability to progress to more advanced topics involving rational functions and algebraic reasoning. To improve learning outcomes, it is recommended that future instruction incorporate more targeted and differentiated teaching strategies. These could include breaking down problems into smaller, manageable steps, using graphical representations and interactive tools to visualize domain and range, and providing ample guided practice with immediate feedback. Additionally, reinforcing prerequisite algebra skills and conducting formative assessments to identify and address specific misconceptions early can help bridge learning gaps. Ultimately, these approaches would better support students in developing a deeper understanding and mastery of solving rational equations and inequalities, as well as identifying the domain and range of rational functions.

3.3. Enhanced Lesson Plans Applying Mathematical Modeling Approach to Address the Least Mastered Skills

Mathematics concepts such as rational equations and inequalities require students to navigate multiple procedural steps, often involving complex algebraic manipulations and careful consideration of domain restrictions. Similarly, understanding the domain and range of rational functions demands both algebraic insight and graphical interpretation skills, which students commonly find abstract and difficult to visualize. The enhanced lesson plans can address these challenges head-on by introducing structured, step-by-step algorithms that guide students through the problem-solving process in a clear and systematic manner.

This algorithmic approach serves multiple pedagogical purposes. First, it scaffolds student thinking by breaking down complex problems into smaller, more manageable parts. By providing explicit procedures to follow, students are less likely to become overwhelmed or confused by the intricacies of the problems. This scaffolding supports students in developing procedural fluency while simultaneously reinforcing conceptual understanding, as they learn not just how to solve the problems but why each step is necessary.

Second, the lesson plans integrated modeling and guided practice, which are essential for effective skill acquisition. The teacher's role in demonstrating the algorithm through think-aloud strategies allows students to observe expert problem-solving in action, making invisible cognitive processes visible. Guided practice then provides a collaborative learning environment where students can apply these strategies with the support of peers and the teacher, facilitating immediate feedback and correction of errors. This approach fosters confidence and deepens understanding.

Furthermore, the plan incorporates the use of technology and visual tools—such as graphing calculators and software—to enhance comprehension of domain and range concepts. Visualizing functions graphically complements algebraic techniques and caters to diverse learning preferences, enabling students to connect symbolic manipulations with graphical behaviors such as asymptotes and discontinuities. This dual representation is crucial in building a robust and flexible understanding of rational functions.

Another notable feature of the plan is the emphasis on reflection and metacognition. By encouraging students to articulate their understanding of the algorithm and the problem-solving process, the lesson promotes self-regulation and the ability to transfer learned strategies to new problems. This reflective practice helps students become more autonomous learners and critical thinkers. Finally, the inclusion of independent practice, through homework and exit tickets, ensures that learning extends beyond the classroom and provides ongoing opportunities to reinforce and assess mastery. This continuous engagement is vital for retention and the development of confidence in handling rational equations and functions.

Enhanced Lesson Plan's algorithmic approach exemplifies best practices in mathematics education. By systematically addressing identified learning gaps, scaffolding student thinking, integrating multiple representations, and fostering active engagement, the plan creates an environment conducive to improving student performance and understanding. It equips learners with reliable problem-solving strategies and conceptual insights that are essential for success in advanced mathematics.

4. Conclusion

The following conclusions were drawn:

- The pre-test results indicated no significant difference between the control and experimental groups, confirming that both groups had comparable levels of prior knowledge and skills before the intervention. This establishes a fair baseline for evaluating the effectiveness of the instructional methods used.
- The post-test results, however, showed a significant difference in performance between the two groups. The control group outperformed the experimental group, demonstrating higher mastery in key skills such as evaluating functions, performing operations, solving real-life problems, and working with rational expressions. This suggests that the instructional approach used for the control group was more effective in enhancing students' understanding and application of the concepts.
- Although the experimental group showed improvement, certain skills—particularly identifying the domain and range of rational functions, solving rational equations and inequalities, and distinguishing among rational functions, equations, and inequalities—remained less mastered. These areas highlight the need for additional instructional support to ensure full mastery. In summary, the findings underscore the critical role of teaching strategies in student achievement and suggest that targeted interventions may be necessary to address specific learning gaps in complex mathematical concepts.
- The results of the pre-test revealed no statistically significant difference in the performance of the control and experimental groups across the various skills assessed, indicating comparable levels of prior knowledge. However, the post-test results showed a statistically significant difference between the two groups. It suggests that the instructional intervention had a measurable impact on student performance.
- The post-test analysis of the experimental group indicates that, despite achieving overall mastery, certain skills were identified as least mastered. These include identifying the domain and range of rational functions (85%), solving rational equations and inequalities (86%), and distinguishing between rational functions, rational equations, and rational inequalities (87%). Although these scores are categorized as near mastery, they are comparatively lower than other skill areas, highlighting persistent difficulties among students. This suggests that students continue to face challenges with complex and abstract mathematical concepts that require higher-order thinking and deep conceptual understanding. To address these gaps, focused instructional strategies and targeted interventions are necessary. Emphasizing conceptual clarity, providing additional practice, and employing varied teaching approaches could enhance students' comprehension and help them achieve complete mastery of these topics.
- The researcher developed lesson exemplars applying the algorithm approach to address the least mastered skills.

Compliance with ethical standards

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"But seek ye first the kingdom of God, and his righteousness; and all these things shall be added unto you."

Matthew 6:33

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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.

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