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CONSTRUCTIVIST APPROACH AS A GATEWAY TO IMPROVING STUDENTS' PERFORMANCE IN INDICES AND LOGARITHMS

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Abstract

This study employed the use of constructivist approach to improve students' performance in indices and logarithm. It was carried out on class five students of Demonstration Secondary School, at A.D. Rufa'I College of education legal and general studies Misau, Bauchi State. The population of the study is 81. Purposive sampling technique was used to select 50 students, including 28 males and 22 females. To make an in-depth investigation into the impact of constructivist approach of instruction on students' understanding of indices and logarithm, the study used pre-test, post-test and verbal interview as instruments for data collections. The research design used in this study was action research in which a constructivist based teaching approach was employed to measure students' conceptual understanding of indices and logarithms. It was found that with the intervention using this approach, students understand indices and logarithms better. The study also found that students develop interest in learning indices and logarithms when given chance to interact among themselves with the instructor serving as a facilitator of learning.

Keywords:
Constructivist Approach, Improvement, students' performance, Indices, logarithms.

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTRODUCTION

Persistent students' poor performance in indices and logarithm calls for the attention of educators and researchers into what approach of teaching be used to reverse the situation. What it means for students to understand indices and logarithms remains the topic that has been under-research. According to Williams (2011), '' a common practice taught to students learning logarithms, switching from logarithmic form to exponential form, was found to possibly have negative effects on student understanding of logarithms''. It was also reported by Aziah (2014) that, when working logarithmic problem, students made four major errors which were in algebra, the generalization of logarithmic law, misconception of the index concept and rarely follow instructions. It can be understood here that only students who understand the mathematical concept are able to consistently check their own to identify errors and use their knowledge beyond solved problem already seen. Agommuch and Ifeanacho (2013) contended that, many researchers blame the use of inappropriate teaching strategies as the genesis of poor achievement in mathematics. They further attributed students' lack of interest and retention of mathematical concepts to the use of inappropriate teaching strategy. Additionally, Jeje and Olagoke (2010) maintain that under a condition where students are taught with inappropriate teaching strategy, they are not likely to acquire needed knowledge and skills for science, technology and engineering advancement.

However, researchers have shown an increased interest in the used of various approaches in the learning and teaching of mathematical concepts, including indices and logarithmic functions (Bukari & Yakubu, 2018). Constructivist teaching approach is one of the approaches that dominate discussions in many professional conferences and practitioner journals. According to Bhattacharjee (2015), Constructivism is an epistemology or a theory used to explain how people know what they know. Bukari and Yakubu (2018) argued that 'constructivist approach to teaching gives learners the opportunity for concrete, contextually meaningful experience through which they can search for patterns; raise questions; and model, interpret and defend their strategies and ideas'.

Furthermore, Afolabi and Akinbobola (2009) defined constructivism as a theory that suggests that learners construct knowledge out of their experiences which is associated with pedagogical approaches that promote learning by doing or active learning. To sum all, this work tested constructivist approach to improve the students' understanding of indices and logarithms.

EDITOR-IN-CHIEF
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INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

Statement of the problem

From experience as mathematics teacher in secondary school for almost fifteen years, it was observed that there is an urgent need to identify an approach of teaching capable of facilitating the learning of mathematics. Indices and logarithms remain challenging to many secondary school students, in Bauchi state, as many Students show difficulty in applying definition of the concepts. For example, one can see a senior secondary school student conceiving expression in index form as multiplication of the exponent by the base. To this student, an expression 3^5 means 3×5 , instead of $3 \times 3 \times 3 \times 3 \times 3$. In logarithm, students often do cancelation on a logarithmic form. For example, in the logarithmic equation log (5x - 3) = 4 log x, many students write it as (5x - 3) = 4x. This misconception results in many errors by the students when given problem on indices and logarithms. According to Dintarini (2018) Students reveal several difficulties such as applying definition, determining logarithmic properties to solve problems, applying logarithmic properties and applying the prerequisite material.Traditional method of teaching often used by mathematics teachers, in Bauchi State might be rooted to persistence of this misunderstanding. However, despite this misconception of indices and logarithms reveal by secondary schools students in Bauchi State, little or no research is conducted to address the problem. Thus, the recurring students' failures in these equations test prompt the researchers to employ the use of Constructivist approach aiming at enhancing students understanding of the concept of indices and logarithms.

Purpose of the Study

The purpose of this study was to determine possible misconceptions of indices and logarithms among students of Demonstration Secondary School in A.D.Rufa'i College of Education Legal and General Studies Misau, Bauchi State. The study hoped to design meaningful and effective activities to enhance their understanding of the concept of indices and logarithm. This paper came out with an intervention strategy using constructivist based instructional approach capable of enhancing the performance of Demonstration Secondary School Students in these topics (indices and logarithms).

Research Questions

1. Does the use of constructivist based instruction have any effect on students' understanding of concept of Indices and logarithms?

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

2. To what extent can constructivist based instruction enhance students' performance in solving problems on indices and logarithms?

Methodology

The methods used in conducting this research are explained below:

Research Design

The research design used in this study was action research. Constructivist based instructional approach was to investigate students' understanding of indices and logarithmic function with the aim to bring about improvement in students' conceptual understanding of the topics.

Population and Sample of the Study

The target population for this study was all the students of Demonstration Secondary School at A.D.Rufa'i College of Education Legal and General Studies, Misau Bauchi State. The school has a population of four hundred and seven (407) students. Eighty one (81) of these students are in form two, comprising forty-three males and thirty-eight females. The study was conducted on senior two students

Sample and Sampling Technique

The study used purposive sampling technique to select 50 students ranked on the basis of their third term examination results. These students were 28 males and 22 females.

Methodology

The study was conducted using constructivist approach to guide the students on how to approach problems in indices and logarithms. The laws of indices and logarithms were presented to the students, before guiding them on how to use them, through constructivist approach of teaching. Data was collected by means of Pre-test and Post-test on indices and logarithms. After the tests five students were selected for an unstructured interview to explain their reasoning during the tests. The study used the same questions in both pre-test and Post-test. This adapted the method used by Bukari and Yakubu (2018) since it is an action research, for clarity of the results.

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

Laws of indices and logarithms

The basic laws of indices and logarithms are presented in Table 1 and Table 2 below:

Table 1: Laws of indices

1.	**If numbers with equal bases are separated by multiplication sign, keep the base and add the powers** **Example;** $3^2 \times 3^4 = 3^{2+4} = 3^6$
2.	If numbers or quantities with equal bases are separated with subtraction sign, keep the base and subtract the powers. Example; $5^7 \div 5^3 = 5^{7-3} = 5^4$
3.	If a number or quantity raised to a certain power is again raised to another power, multiply the powers. Example; $(x^n)^m = x^{nm}$ or $(5^2)^3 = 5^{2\times3} = 5^6$
4.	When the product of different factors are raised to a certain power, distribute the power over each factor. Example; $(xyz)^n = x^n \times y^n \times z^n$
5.	If a number or quantity is raised to power zero, the result is 1. Example; $x^0 = 1 \; or \; 3^0 = 1$
6.	A number raised to a negative index equals the reciprocal raised to the same positive index. Example; $5^{-3} = \frac{1}{5^3}$
7.	If a number is raised to a fractional index, find the root of the denominator and later raise the outcome to the power of the numerator. For example; $8^{\frac{2}{3}} = \left(\sqrt[3]{8}\right)^2 = 2^2$
8.	If an expression is in decimal form, convert the decimals to fraction before solving. Example; $(0.027)^{\frac{1}{3}} = \left(\frac{27}{1000}\right)^{\frac{1}{3}}$

1. Solve for x if $5\times 125^x = 1$

   Many students did well in answering this question. However, some students failed to conceive expressing the equation in lowest common bases. As a result of this, the students were guided thus; Relate 125 and 1 to base 5. That is $125 = 5^3$ and $1 = 5^0$. As such, the equation becomes $5\times 5^{3x} = 5^0$. Then apply the multiplication law to the left hand side. It was then written as $5^{1+3x} = 5^0$. Most of the students could continue to equate the powers and find the solution as $1+3x=0$ and by subtracting 1 from both sides, $3x=-1$. They then divided both sides by 3 and obtained $x=\frac{-1}{3}$

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

The students were guided using constructivist approach to answer question 2 as follows;

a. Read the question carefully and analyze it on the basis of laws of indices
b. Reduce the bases in the equation to lowest common bases
c. Apply the law of multiplication to the left hand side before equating the power
d. Substitute the value of x obtained into the equation and see whether the left hand side equals the right hand side.

2. Solve for x if $9^{2x-1} \times 3^{3x-1} = 27^{x+3}$

Researcher: What are we asked to find?
Students: The value of x
Researcher: What is the first step to start with?
Students: Reducing the equation to lowest common bases
Researcher: Do it
Students: $3^{2(2x-1)} \times 3^{3x-1} = 3^{3(x+3)}$
Researcher: What do we do next?
Students: Apply multiplication law
Researcher: Do it
Students: $3^{2(2x-1)+(3x-1)} = 3^{3(x+3)}$
Researcher: What is the next step?
Students: Equate the powers and solve for x
Researcher: Do, let me see.
Students: 4x-2+3x-1=3x+9
7x-3x=9+3 (collecting like terms)
4x=12
Dividing both side by 4
x=3
Researcher: What is left to do?
Students: Checking whether the left hand side equals the right hand side
Researcher: Check, let me see.
Students: $9^{2\times3-1} \times 3^{3\times3-1} = 27^{3+3}$
$9^5 \times 3^8 = 27^9$

$3^{2\times5} \times 3^8 = 3^{3\times3+9}$
$3^{10} \times 3^8 = 3^{18}$

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

$3^{10+8} = 3^{18}$

$3^{18} = 3^{18}$ (Left Hand Side equals Right Hand Side)

Table 2: Laws of logarithm

1.	**If two logarithmic functions are separated by addition sign means 'multiply' Example; Logx+Logy=Logxy**
2.	If two logarithmic functions are separated by subtraction sign, means 'divide' Example; Log5x-Log3=Log$\frac{5x}{3}$
3.	Logarithm of a function with an exponent that is Logx^3 implies 3Logx.

1. Convert $\log_3 3x$+$\log_3 5$=1 to an exponential function. This question taught and tested the students' ability to express logarithms in exponential forms. Many students were able to recall and use the laws as expected, with the exception of few who still expressed their answer as 3^{15x}=1. They were expected to write 15x=3^1. As such, it was explained to them through constructivist approach as follows:
   Apply addition law of logarithm to the left hand side. $\log_3 15x = 1$. Then,using the definition of logarithm, express the equation in exponential form. Now, the students were able to write 15x=3^1.

The study further used constructivist approach as an intervention measure, before the Post-test, to guide the students solves the following logarithmic problem. This activity started as follows;

i. Read the following question carefully and analyze it on the basis of laws of logarith
ii. Apply the divisibility law to the left hand side
iii. Convert the logarithmic function to an exponential function and find the value of 'x'
iv. Put the value of x you obtained into the logarithmic equation to check whether the left hand side equals the right hand side

2. solve $\log_2(3x-2) - \log_2 x + 1 = 3$

Researcher: What are we trying to find?
Students: The value of x
Researcher: How do we start the solution?

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

Students: We are to apply the divisibility law on the left hand side
Researcher: Do it, let me see.

Students: $\log_2 \frac{(3x-2)}{(x+1)} = 3$
Researcher: What do we do next?
Students: Change the logarithmic function to exponential function
Researcher: Go ahead and change
Students: $2^3 = \frac{(3x-2)}{(x+1)}$

$8= \frac{(3x-2)}{(x+1)}$

$8(x+1)= (3x-2)$ (cross multiplying)

$8x+8 = 3x-2$

(Collecting like terms)
$8X-3X = -2-8$
$5X= -10$
$X= -2$ (Dividing both sides by 5)

Researcher: What is next to do?
Students: Checking for the equality of left hand side and right hand side
Researcher: How do we check, then?

Students: $8(-2+1) = ((3\times -2)-2)$
$8 \times -1 = -6-2$
$-8 = -8$ (Left Hand Side equals Right Hand Side)

Data Analysis and Result
The pre-test and post-test scripts were collected for data analysis. Each script was marked and compared with its corresponding interview script to have the details by each items. The results from the data analysis are shown in the table 3 and 4 below.

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Prof. E. Mclenna [Australia]

Table3.

Concept of indices	Pre-test		Post-test	
	Number	Percentage	Number	Percentage
Able to analyze	14	28	37	74
Unable to analyze	36	72	13	26
Able to reduce to lowest common base	12	24	41	82
unable to reduce to lowest common base	38	76	9	18
Correct application of law	10	20	37	74
Wrong application of law	40	80	13	26
Able to obtain correct answer	10	20	37	74
unable to obtain correct answer	40	80	13	26

The analysis of students' answer scripts has shown that only 14 (28%) students were able to analyze the indicial problems given to them in pre-test. This meant that 36 (72%) of the students could not analyze the questions. From the table above, it could be seen that there was an improvement in the number of students who could analyze the indicial problems. This happened as a result of the guide they received before the post-test. The number of those who were able to make reduction to lowest common bases equally increased in the post-test as evident in the table. The findings also revealed only 10(20%) students who applied laws correctly, in pre-test. This number fell far below 37(74%) students who applied the laws successfully, in post-test. To this end, it could be seen from the table1 above that only 10(20%) out of 50, could obtain the correct answer. Unlike post-test in which 37(74%) were able to reach correct answer. By constant comparison, one can impeccably argue that there was a remarkable change in the post-test as the number of successes continued to be higher, compared to what was obtainable in the pre-test. The figure 1 and 2 below depict the situation of students' performances in pre-test and post-test on the concept of indices.

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

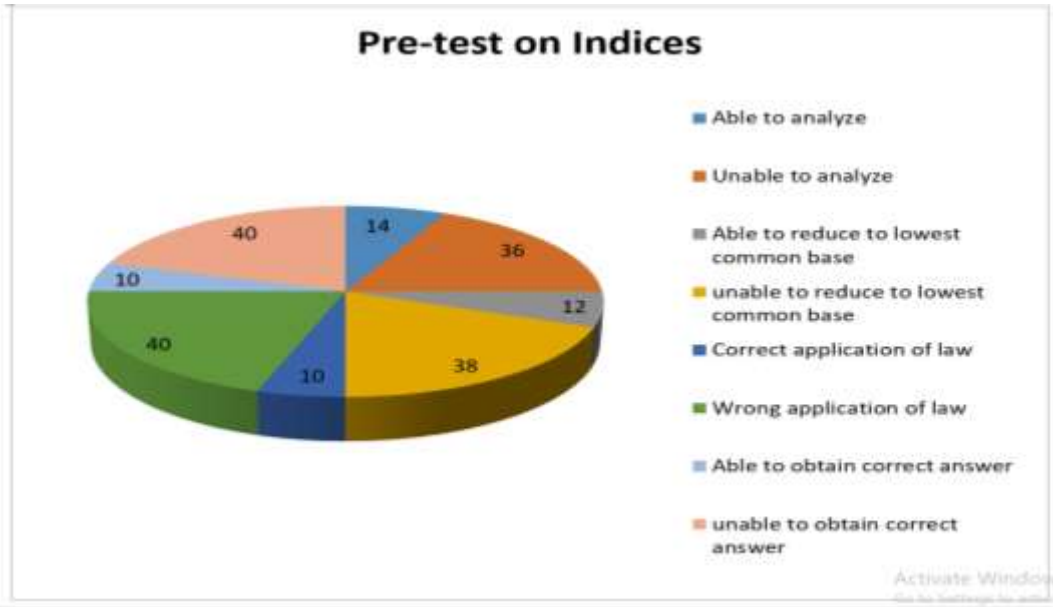
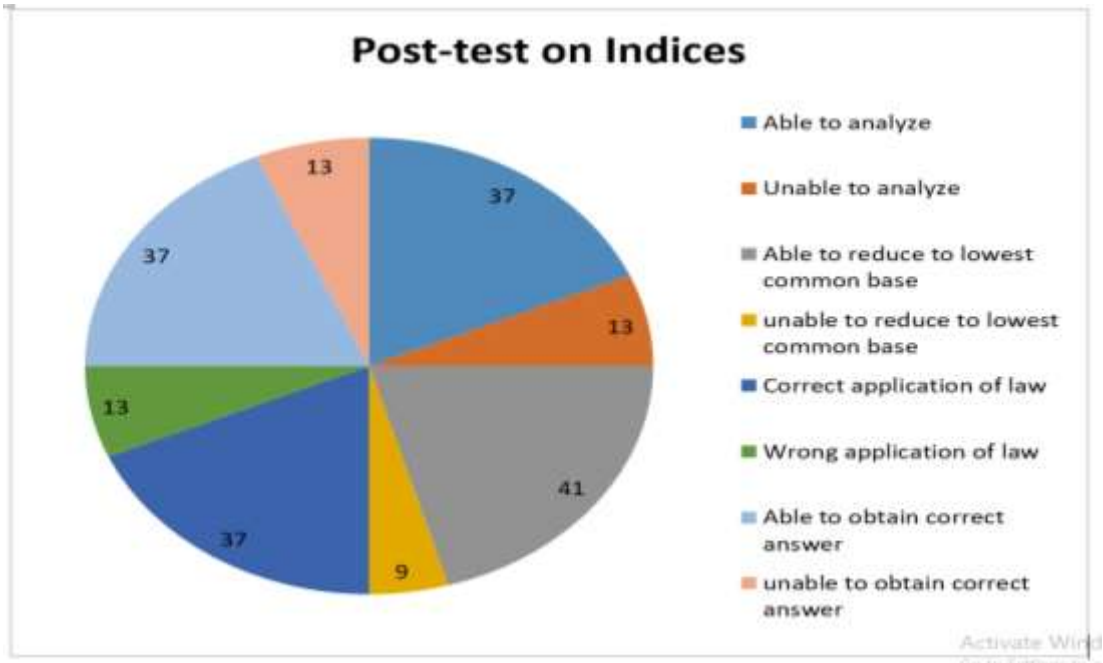


Figure1.

The students' post-test's results on the concept of indices are depicted in the figure 2 below.

Figure2.



EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

INTERNATIONAL JOURNAL – NSAR
VOL. 02 NO.1 OCT-2023 ISSN: 1115-8492

The analysis of students' scripts in pre-test and post-test on the concept of logarithm also replicates that of indices, as the results revealed significant difference between students' performances in the two different tests conducted. From the table 4, one can clearly see the better performance recorded in post-test, as compared to that of pre-test. For example, only 17(34%) of the students could analyze the questions given to them in pre-test. This portrays students better performance in the post-test as 45 (90%) of them succeeded in making the analysis of the questions. Only fifteen students could correctly apply laws of logarithms to the problems given in pre-test, as compared to 44(88%) who were able to apply the laws correctly, in the post-test. It was also observed that 13(26%) students successfully converted logarithmic forms to exponential forms, in pre-test. That was against 37(74%) of the students who failed in the conversion. In respect of post-test, 43(86) of the students were able to convert logarithmic forms to exponential forms. This meant only 7(14%) of the students could not make the conversion. Finally, pre-test has recorded 13(26%) of the students who obtained correct answers. The number has significantly increased, as 43(86%) of the students were able to reach correct answers in post-test.

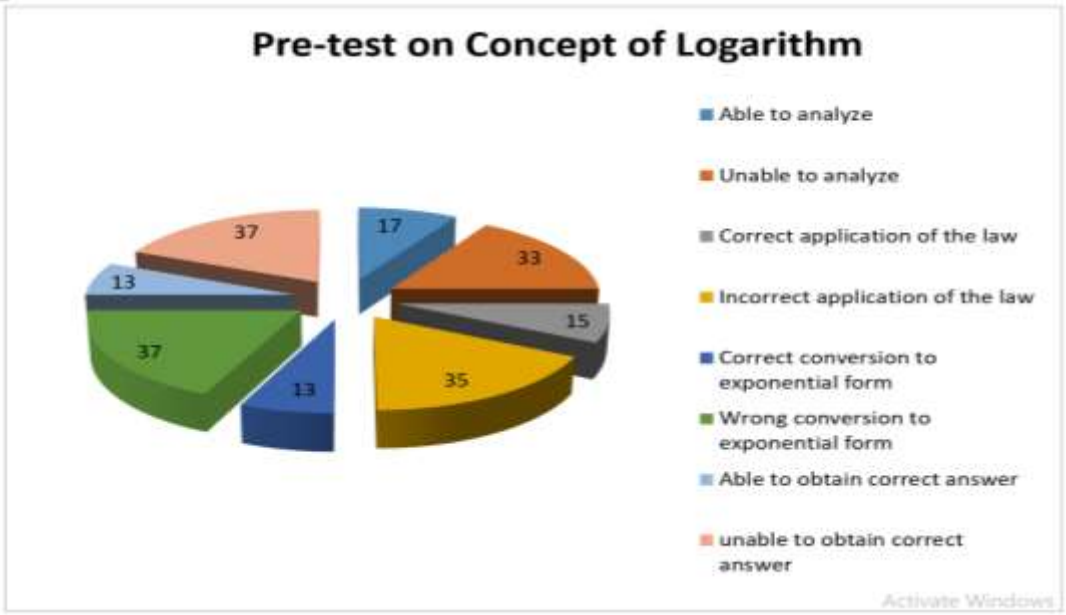
Table4.

Concept of logarithms	**Pre-test**		**Post-test**	
	Number	Percentage	Number	Percentage
Able to analyze	17	34	45	90
Unable to analyze	33	66	5	10
Correct application of the law	15	30	44	88
Incorrect application of the law	35	70	6	12
Correct conversion to exponential form	13	26	43	86
Wrong conversion to exponential form	37	74	7	14
Able to obtain correct answer	13	26	43	86
unable to obtain correct answer	37	74	7	14

The figure below represents the results of pre-test in respect of logarithms.

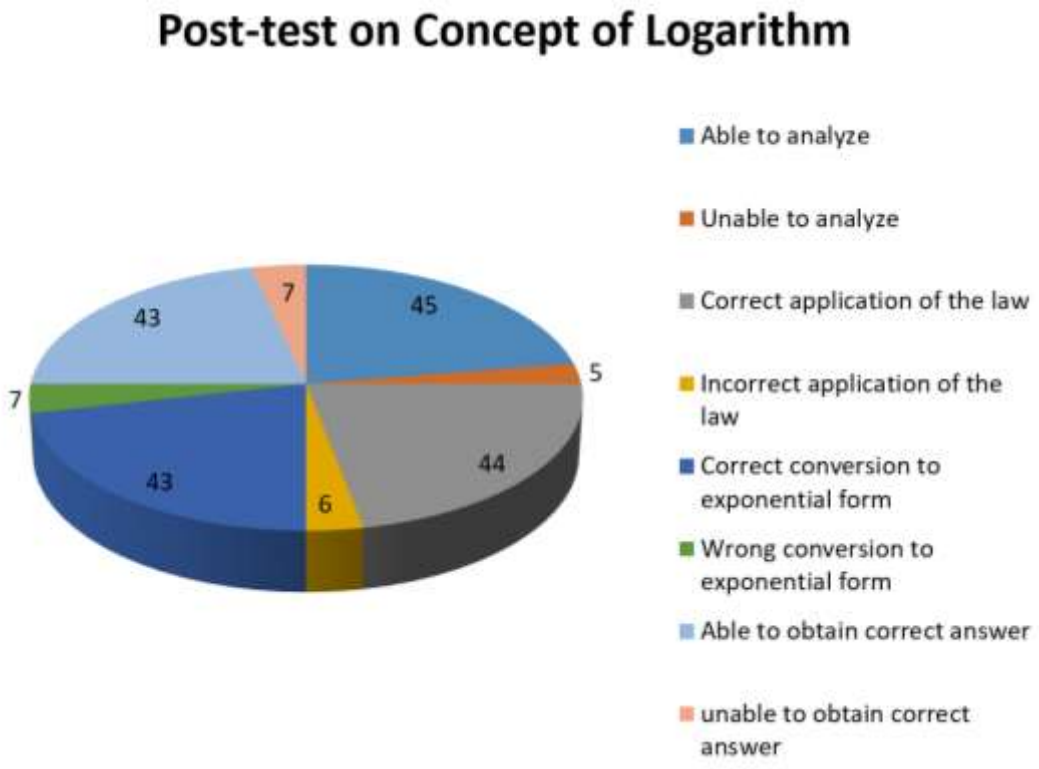
EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

Figure 3.



The pie-chart below shows the students' performance in post-test in respect of logarithm.

Figure4.



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Prof. E. Mclenna [Australia]

DISCUSSION

The outcome of intervention using constructivist approach to teaching has shown a great improvement in the students' performance in indices and logarithms. The results from pre-test have shown an urgent need for intervention to take place. This prompted the use of constructivist approach to give the students chance of interaction and encourage active participation of students. This approach, revealed increasing interest in studying the concept of indices and logarithms. Deduced from analysis of data, the students' successes in answering questions have significantly improved, in the post-test. This approach used, enhanced the students ability to apply basic concepts and strategies in learning of indices and logarithms. It was also evident in this study that students learn better from interaction among themselves, especially when they are given room to interact and criticize one another. At the time of intervention, the students were given strategies, opportunities and responses to what they were doing. They were carried along by question one of each concept, in order for them to discover the laws and properties of indices and logarithms. The researchers facilitated the learning through guiding the students know the conditions necessary for applying the laws and properties. To investigate whether the Constructivist approach will result in improving performance of senior two students of Demonstration Secondary School of A.D.Rufa'i College of Education Legal and General Studies, the study attempted to answer two research questions. From the results of this study, it is indisputable that constructivist approach has a great effect on students understanding of indices and logarithms. This is so, because during the pre-test before the intervention, many students revealed misconception of indices and logarithms. However, with the intervention using the constructivist approach to instruction, this misconception dissipated from many of them. As such, the answer to first research question is obtained that constructivist based instruction have effect on students' understanding of concept of Indices and logarithms. The extent to which constructivist based instruction enhances students' performance in solving problems on indices and logarithms also proves to be large. This is clearly seen in the improvement of results from 20% in the pre-test on indices to 74% in the post-test. Similarly, the success increased from 26% in pre-test to 86% in post-test, on the concept of logarithms. This margins answered the second research question which asks ''To what extent can constructivist based instruction enhance students' performance in solving problems on indices and logarithms?" The findings of this study is consistent with that of Bukari and Yakubu (2018) when

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

they found that students had understood basic concepts and strategies involving logarithmic functions with constructivist approach as an intervention, which made them improved tremendously in their performance.

Conclusions

It can be concluded that the students have problem in perception while studying indices and logarithms. They only see the surface structure of the expression or the equation. Reading the concept and principle of indices and logarithm became difficult to them. But, with the intervention using constructivist approach to instruction, their performance improved beyond expectation. As such, it is suggested that the process of teaching and learning should embrace the use of constructivist approach as it proves its capacity to increase students' interest in indices and logarithms. It is also recommended that future study should look at neuroscience on conceptual learning of index and logarithms.

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