Comparative Effectiveness of Inductive and Deductive Teaching of Indices in Secondary Schools in Bamenda Municipality-Cameroon

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Abstract: **The purpose of the study was to compare the mean achievement scores of students taught indices using the inductive and the deductive methods and to ascertain which of these two methods could minimise gender inequality in the learning of indices. The study adopted the quasi-experimental research design where two Form Three intact classes were sampled using both the purposive and the simple random sampling techniques. A pre-test and a post-test were administered to the two intact classes to determine their cognitive levels before and after the experiment respectively. Two equivalent forms of a Mathematics Achievement Test (MAT) in indices were used to achieve this purpose. The findings of the study revealed that students taught indices using the inductive method performed significantly better than those taught using the deductive teaching method. The findings also showed that female students performed better than their male counterparts when taught indices using the inductive teaching method, while the male students performed better than their female counterparts when taught indices using the deductive teaching method. It was recommended that mathematics teachers in Bamenda municipality should adopt the inductive method in teaching indices. Seminars could be organised to build their capacities in relation to the use of this teaching method. Lastly, if education stakeholders in Bamenda municipality are interested in maintaining gender equality in the learning of mathematics and specifically in the learning of indices, then the inductive teaching method is strongly recommended.**

Keywords: **inductive teaching, deductive teaching, indices, mathematics, students' performance, Bamenda municipality**

I. INTRODUCTION

The importance of mathematics to human life in general, and to the Cameroonian society in particular is incredible. This subject whose importance stems back to the creation of the world has affected human existence from decade to decade and from century to century till present day. The subject is even considered as a tool in many other subjects studied at varied levels of schooling. Some of the subjects such as physics, chemistry, economics, computer studies, just to name a few, draw heavily from mathematics. This is probably one of the reasons why this subject is considered as a compulsory subject in the first cycle of Cameroonian secondary schools. The aforementioned suggest that care should be taken in the teaching and learning of such and important subject as it is indispensable in the lives of Cameroonian. No doubt one of

the 21st century skills as indicated by Stauffer (2021) is digital or numerical literacy. 21st century skills are believed to be skills that learners need to acquire at all cost to enable them thrive in the 21st century; a century characterised by 'explosion' in technological advances. Indices has been one of the areas in mathematics that has contributed so greatly to the massive technological advances experienced in this present century.

Indices are at the foundational level of numerical or digital literacy. Exponents or indices or powers or logarithms, have lots of applications in this modern technological world. They are used in Computer Games, Physics, Economics, Richter Measuring Scales, Accounting, Science, Finance, Engineering, and many other disciplines. Thus, so many professionals make use of exponents in the daily discharge of their duties viz: Computer Programmers, Bankers, Chemists, Economists, Geologists Sound Engineers, Financial Advisors, Insurance Risk Assessors, Geographers, Mathematicians, Physicists, just to name a few. For instance, exponential growth is an extremely important aspect of economics, finance, biology, demographics, electronics, economics, and many other areas. Furthermore, dangerous chemicals, sound, light, radioactive waste, and sporting fixtures, etc, are greatly associated to exponential decay.

The numerous applications of indices suggest that this topic should be handled with much care, especially when secondary school students are officially introduced to it for the first time. Students need very deep understanding of this topic as it is one of the foundational topics in developing numerical literacy. Unfortunately, from experience, many Form four secondary school students, who officially get exposed to the topic for the first time, find it difficult developing mastery of the various concepts and laws of indices. Experiences shared during Mathematics Teachers' Association Seminars in the North West suggest that most teachers approach this topic by first stating each law, followed by specific examples. However, literature suggests that mathematics in general and indices in particular could either be taught inductively or deductively.

Narendra (2017) describes the inductive method as being based on the principle of induction. Thus, induction has to do with the establishment of common truths. This, according to

Atta et al. (2015) can be achieved by systematically showing that if something is true for a particular case and is further true for a reasonable number of cases, then it can be considered true for all such cases. To Atta et al., this method develops curiosity in the individual. The aforementioned suggests that in the field of mathematics, the inductive method can be used to develop or construct mathematical formulas after examining a good number of concrete specific cases. Narendra (2017) further suggests that in this method, at first stage a problem is solved on the basis of previous knowledge, discernment, reasoning and the application of insight by the learner. This stage is void of the knowledge about any formula, principle or method for solving given problems. Many adequate similar examples, facts or objects are presented to the learners, they attempt solutions using their previous knowledge. They are further guided to arrive at generalizations or to derive a formula through a convincing process of reasoning from the solved examples (Narendra, 2017). Thus, formulas are constructed when this method is applied, and not supplied by the teacher, as it is common practice in classrooms throughout Bamenda municipality. Atta et al. (2015) emphasize that mathematical topics such as algebra, geometry, trigonometry and arithmetic could better be taught and learnt using the inductive method.

Deductive teaching method on the other hand is grounded on deduction. This teaching method suggests that we advance from general to particular cases and from abstract to concrete cases (Atta et al., 2015). In other words, this teaching method suggests that the teacher gives the general formula, rule, principle or law to the learners first. He/she then proceeds to help the learners understand the general rule, principle or law, by using a number of specific examples. Thus, in deductive teaching, general rules are given and then learners are requested to apply the given rules to solve many given problems. This method proceeds from abstract generalisations to concrete examples. Therefore, in this teaching method, the learner's responsibility is only to perform calculations. He or she is required to substitute known values in the given formula and then simplify to get the solution of the given problem. Atta et al. (2015) assert that this method is mainly used in the teaching of Trigonometry, Algebra, Arithmetic and Geometry. According to the authors, help in this approach is derived from assumptions, guesses and other axioms of mathematics. This is the method commonly used in teaching mathematics in secondary and high schools in Bamenda Municipally.

The opinions and research findings of authors have not been unanimous. Nicole and Timothy (2007) argue that when using the deductive teaching method, the thinking capacity of the students cannot be developed. They however continue to assert that the inductive method of teaching has the capacity to develop the thinking and inquisitiveness of the students as they can easily build from what they know. Wardani and Kusuma (2020) carried out a study aimed at comparing students' achievements when the inductive and deductive

approaches are used to determine their conceptual understanding based on international standard curriculum. Using the triangulation analysis technique, they found that the deductive approach was more effective in improving students' conceptual understanding of Chemistry and material topics as well as material classification. While the inductive approach proved more effective in particle kinetic theory.

Objectives of the Study

- To compare the mean achievement scores of students taught indices using the inductive and the deductive methods.
- To compare the mean achievement scores of male and female students taught indices using the inductive and deductive methods.

Research Questions

- What are the mean achievement scores of students taught indices using the inductive and the deductive methods?
- What are the mean achievement scores of male and female students taught indices using the inductive and deductive methods?

Hypotheses

H0₁: The mean achievement scores of students taught indices using the inductive and the deductive methods do not differ significantly.

Ha₁: The mean achievement scores of students taught indices using the inductive and the deductive methods differ significantly.

H0₂: The mean achievement scores of male and female students taught indices using the inductive and deductive methods do not differ significantly.

H0₂: The mean achievement scores of male and female students taught indices using the inductive and the deductive methods differ significantly.

II. METHODOLOGY

The study adopted the quasi-experimental research design. Two Form Three intact classes were sampled using both the purposive and the simple random sampling techniques. Firstly, two public secondary schools (Government Bilingual High School (GBHS) Bayele and GBHS Down Town) were purposively sampled. The schools were functional and were considered to be far apart to avoid the contamination effect. Secondly, a Form three class was then selected in each of the schools using the simple random sampling technique. Thirdly, one of the classes (in GBHS Bayele) was randomly assigned as the Experimental group (E) and the other (in GBHS Down Town) acted as the Control group (C).

The two mathematics teachers of the various intact classes were trained on how to teach indices inductively and deductively. This was done in order to prevent the teacher variable being extraneous. A pre-test comprising of a

Mathematics Achievement Test (MAT) was administered to the two intact classes to determine their cognitive levels before the commencement of the experiment. The pre-test also helped to check the negative effects of non-randomisation of subjects into the various intact classes. The MAT comprised 20 standardised Multiple-Choice Questions (MCQs) on indices – it was also interested in the sex of the students.

After the administration of the pre-test, the topic Indices was then taught to the experimental group using the inductive teaching method, and to the control group using the deductive teaching method at the beginning of the 2021/2022 academic year. The teaching was effected by the respective class teachers. At the end of the experiment which lasted for two weeks, a post-test comprising of the equivalent forms of the MAT pre-test was again administered to the two groups. The MAT collected from the pre-test and post-test administrations were scored and the various scores recorded under the respective groups (that is, the experimental and the control groups). Gained scores were obtained for each student by subtracting their pre-test scores from their post-test scores. Means were used to answer the research questions while t-test for independent samples was used to test the hypotheses at a 5% level of significance.

III. FINDINGS

Mean Achievement Scores of Students Taught Indices Using the Inductive and the Deductive Methods

- What are the mean achievement scores of students taught indices using the inductive and the deductive methods?

Table 1: Mean Achievement Scores for Students in Inductive and Deductive Groups

GROUP		PRE-TEST	POST-TEST	GAIN SCORE
Inductive Teaching Method (E)	Mean	4.07	12.05	7.98
	N	57	57	57
	Std. Deviation	2.008	3.829	2.716
Deductive Teaching Method (C)	Mean	3.91	9.57	5.66
	N	65	65	65
	Std. Deviation	1.958	2.716	2.938

Table 1 reveals that students taught indices using the inductive teaching method (experimental group) had a mean gain score of 7.98. On the other hand, those taught indices using the deductive teaching method (control group) had a mean gain score of 5.66. This, suggests that students taught indices using the inductive method perform better than those taught using the deductive teaching method.

H0₁: The mean achievement scores of students taught indices using the inductive and the deductive methods do not differ significantly.

Ha₁: The mean achievement scores of students taught indices using the inductive and the deductive methods differ significantly.

Table 2: Independent Samples Test for Mean Achievement Scores of Students in Inductive and Deductive Groups

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
GAINSCORE	Equal variances assumed	4.509	120	.000	2.321	.515
	Equal variances not assumed	4.533	119.656	.000	2.321	.512

Table 2 reveals that the difference of the mean gain scores obtained by students in the inductive teaching group (experimental group) and those in the deductive teaching group (control group) is 2.321. This mean difference is significant ($t = 4.509$, $df = 120$, $p = 0.000$) at the 0.05 level of significance. Thus it can be concluded that the mean achievement score of students taught indices using the inductive teaching method is significantly higher than that of students thought indices using the deductive method.

Mean Achievement Scores of Male and Female Students Taught Indices Using the Inductive and Deductive Methods

- What are the mean achievement scores of male and female students taught indices using the inductive and deductive methods?

Table 3: Achievement Scores for Male and Female Students in Inductive and Deductive Groups

GROUP	SEX		PRETEST	POST TEST	GAINS CORE
Inductive Teaching Method (E)	Males	Mean	3.30	10.87	7.57
		N	23	23	23
		Std. Deviation	1.795	4.341	3.145
	Females	Mean	4.59	12.85	8.26
		N	34	34	34
		Std. Deviation	2.002	3.267	2.391
Deductive Teaching Method (C)	Males	Mean	3.64	10.32	6.68
		N	25	25	25
		Std. Deviation	1.823	2.926	3.119
	Females	Mean	4.08	9.10	5.02
		N	40	40	40
		Std. Deviation	2.043	2.499	2.665

Table 3 reveals that for students taught indices using the inductive teaching method (experimental group), the males had a mean gain score of 7.57 while the females had a higher mean gain score of 8.27. This, shows that female students perform better than their male counterparts when taught indices using the inductive teaching method. On the other

hand, for those taught indices using the deductive teaching method (control group) the male students had a mean gain score of 6.68 while the females had a lower mean gain score of 5.02. This, shows that male students perform better than their female counterparts when taught indices using the deductive teaching method.

H0₂: The mean achievement scores of male and female students taught indices using the inductive and deductive methods do not differ significantly.

H0₂: The mean achievement scores of male and female students taught indices using the inductive and the deductive methods differ significantly.

Table 4: Independent Samples Test for Mean Achievement Scores of Male and Female Students in the Inductive Group

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Inductive Teaching Method (E)	Equal variances assumed	-.953	55	.345	-.699	.734
	Equal variances not assumed	-.904	38.623	.371	-.699	.773

Table 4 shows that the difference of the mean gain scores obtained by male and female students in the inductive teaching group (experimental group) is -0.699. This mean difference is not significant (t = -0.953, df = 55, p = 0.345) at the 0.05 level of significance. Thus it can be concluded that the mean achievement score of male students taught indices using the inductive teaching method is not significantly lower than that of the female students.

Table 5: Independent Samples Test for Mean Achievement Scores of Male and Female Students in the Deductive Group

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Deductive Teaching Method (C)	Equal variances assumed	2.281	63	.026	1.655	.726
	Equal variances not assumed	2.199	45.120	.033	1.655	.753

Table 5 shows that the difference of the mean gain scores obtained by male and female students in the deductive teaching group (control group) is 1.655. This mean difference is significant (t = 2.281, df = 63, p = 0.026) at the 0.05 level of significance. Thus it can be concluded that the mean achievement score of male students taught indices using the deductive teaching method is significantly higher than that of the female students.

IV. DISCUSSION OF FINDINGS

The findings of the study revealed that students taught indices using the inductive method performed significantly better than those taught using the deductive teaching method. This finding aligns with that of Wardani and Kusuma (2020) who showed that the inductive approach was more effective in teaching particle kinetic theory than the deductive approach. The finding further confirms the assertions of Nicole and Timothy (2007) that the inductive method of teaching has the capacity to develop the thinking and inquisitiveness of the students as they can easily build from what they know. Students appear to be more comfortable when teachers help them to discover what they don't from what they know. Thus, the researcher recommends that mathematics teachers in Bamenda municipality should adopt the inductive method in teaching indices. Seminars could be used to build their capacities in relation to the use of this teaching method.

The findings also show that female students perform better than their male counterparts when taught indices using the inductive teaching method. Furthermore, male students perform better than their female counterparts when taught indices using the deductive teaching method, which is a very common teaching method in Bamenda municipality. The inductive teaching method seems to give everybody, irrespective of their gender, the opportunity to build new knowledge from what they already know, instead of always making them grapple with new knowledge all the time, where male students appear to have an upper hand over the females. These findings suggest that if education stakeholders in Bamenda municipality are interested in maintaining gender equality in the learning of mathematics and specifically in the learning of indices, then the inductive teaching method is strongly recommended.

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