The Effect of Concrete Representational Abstract (CRA) Instructional Strategy on form two Students' Achievement in Algebra in Secondary Schools in the South West Region of Cameroon

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ABSTRACT

This study investigated the effect of the Concrete Representational Abstract (CRA) instructional strategy on form two students' achievement in Algebra in Secondary Schools in the South West Region of Cameroon. The research questions were: What is the difference in the mean achievement scores of form two students taught directed numbers using the Concrete Representational Abstract (CRA) instructional strategy as compared to those taught using the Conventional Abstract Instruction (CAI)? What is the difference in the mean achievement scores of form two students taught simplification of algebraic expressions using the Concrete Representational Abstract (CRA) instructional strategy as compared to those taught using the Conventional Abstract Instruction (CAI)? The study made use of a quasi-experimental non-randomized pre-test, post-test research design. The target population of this study was made up of form two students of all public secondary schools in Meme and Fako Divisions. The accessible population consist of form two students of Government High School (GHS) Bokwango and Cameroon College of Arts and Science (CCAS) Kumba. The Sample comprised of 464 Form 2 students with 215 students from GHS Bokwango and 249 from CCAS Kumba. Three research instruments were used namely: The Algebra Achievement Test (AAT) and Algebra Interest Inventory (AII) for students and the interview guide for 2 teachers of the experimental school. The reliability coefficients for AAT and AII were 0.87 and 0.81 respectively showing that the instruments were reliable and could be used for the study. The results revealed that Form 2 students performed better in Algebraic concepts of directed numbers and simplification of algebraic expressions when taught using the CRA Instructional Strategy compared to those taught using the Conventional Abstract Instruction (CAI). In addition, CRA instructional strategy arouses students' interests in algebra. The recommendations for the study were: The Concrete Representational Abstract (CRA) instructional strategy should be adopted in the teaching and learning of algebra in particular and Mathematics in general in Cameroon schools. Also, teachers should be trained on how to teach Algebra in particular using the CRA Instructional Strategy and CRA should be incorporated into teacher training education programmes to equip potential teachers with the skills of CRA instructional strategy.

Keywords: Concrete Representational Abstract, Instructional Strategy, Mathematics, Algebra and Students' Achievement

INTRODUCTION

Mathematics is one of the core subjects in the Cameroon primary and secondary school curricular. It is also considered as the core of the sciences, technology and engineering. More so, its use is indispensable in daily activities such as buying and selling of goods, building and road construction, engineering and medical fields and decision making. Mathematics is regarded by the society as the foundation for scientific and technological knowledge critical to nation building and development efforts (Nekang, 2016). It is an important tool and language used in Physics, Chemistry, Biology, Geology, Economics, Accounting, Computer Science and Geography. Despite the importance attributed to Mathematics, the achievement in Mathematics and algebra in particular is still low.

Algebra in particular has most often been taught without the use of instructional materials and this makes students see it to be abstract and difficult where students have to memorise rules on how to solve equations and problems. This lack of use of concrete materials has also resulted to many misconceptions in algebra concepts in secondary schools such as $x + x = x^2, x.x = 2x, 4x + 3y = 7xy$. Students have also scarcely been seen solving linear equations using concrete objects. According to the Ministry of Secondary Education (MINESEC) Mathematics teaching syllabus (2014), there are five modules in form three Mathematics syllabus. The module on algebra and logic alone has 40 teaching hours out of a total of 104 hours whereas the other modules numbers, fundamental operation and relationships in the sets of numbers and between elements in a set covers 20 hours; plane geometry 24 hours: solid figures 10 hours and statistics and probability covers 24 hours. So, algebra alone covers 38.46 % of the form three Mathematics syllabus. This great quota has been attributed to algebra due to its application in all topics and branches in Mathematics. Form two algebra is also a module on its own to prepare students to become versed with the form three algebra concepts. Despite this great quota, teachers can be seen facing challenges to use concrete objects to teach algebra and students on their part cry daily of its difficult nature that they keep "finding x and y everyday". This makes the teaching of algebra to be cut off from the society and this can to a certain extent be attributed to inappropriate teaching strategies and methods used in algebra instruction. Algebra deals with abstract concepts and for students to achieve this abstract ability, it takes something bridging from concrete to abstract (Satria Adi Nugroho and Jailani, 2019). They equally added that students should be given the opportunity to present ideas through the form of mathematical representations which are concrete models, images or other forms.

The Concrete Representational Abstract (CRA) Instructional strategy helps to promote conceptual understanding by teaching starting from concrete to semi concrete and finally abstract. When teaching algebraic concepts, the first stage which is the concrete stage, uses concrete objects such as algebra tiles, followed by the use of pictorial representations using pictures, drawings or digital tools and finally end with the abstract stage. According to Savas and Beverly (2024), the CRA instructional strategy help students to build a student-centered Mathematics classroom grounded in evidence based practices where they are given the opportunity to learn in the context of concrete and pictorial models as opposed to how students are often taught Math in a rush by the use of standard algorithms. Thus, the CRA promotes the hands on experiences of solving problems in algebra by not just teaching students steps to memorise in solving problems. In addition, it helps meet the needs of the varied learners in the classroom since they are learners with varied learning styles in the classroom. Teaching using the CRA provides multiple means of representation of knowledge and thus accommodates visual, auditory and kinaesthetic learners. Prosser and Bismark (2023) equally reveal that the CRA is an evidence based strategy which has been used while teaching with manipulatives for decades in the United States of America and has been shown to be an effective approach in Mathematics classrooms that include students with disabilities. In an attempt to find the solution to the low achievement in Algebra in Cameroon, this study seeks to find out the effect of the Concrete Representational Abstract (CRA) instructional strategy on Form Two Students' Achievement in Algebra in Secondary Schools in the South West Region of Cameroon.

BACKGROUND TO THE STUDY

Several attempts were made by educators across the globe to make Mathematics in general and algebra in particular accessible to all learners. During the 17th century in the USA, the teaching method was the rule method in which a particular problem was presented, memorised and then drilled (Bidwell & Ciaso, 1976). The rule method was teaching by providing steps to solve a problem, students memorised the steps to solve the problems without necessarily understanding the reason behind the steps. In 1726, arithmetic was taught in secondary schools since it was a pre-requisite to study Mathematics in Havard University and other branches of Mathematics such as algebra and geometry were introduced in 1820 and 1844 respectively and later advanced topics (Furr, 1996). Furr added that due to the demand in basic commercial computational skills, many students were taught arithmetic to meet the needs of the society.

The rule method had its limitations and for that reason in 1821 Warren Colburn's first lessons in Arithmetic became available in the USA based on ideas derived from Pestalozzi (Furr, 1996). Furr added that Colburn's teaching method begins teaching arithmetic with practical problems such as counting beans, making combinations with buttons and practices these until the child has grasped an understanding of the operation.

Abstract numbers and signs are only introduced to help the student develop a general principle. In addition, Colburn's personal ideas about the purposes of studying Mathematics were first for its practical use and secondly for the mental discipline value (Bidwell & Ciason, 1970). The teaching of Mathematics to help solve societal problems was a priority.

Moreover, throughout the 19th century there was a persistent use of drill and practice which occupied half of every school day and this method contributed to massive failure and thus arithmetic became the major cause of non- promotion in 1800s (Grouws, 1992). In 1920, Thorndike joined the team of those in support of difficult, laborious and abstract Mathematics without necessarily relating its application to real life. So, to Thorndike, Mathematics was to be taught to promote critical thinking in learners. More so, in 1923 a report was published by the national committee on Mathematical requirements. In this report, some topics in algebra and geometry were recommended to be used in junior high schools and courses in statistics, shop Mathematics, surveying, navigation or descriptive geometry were suggested for others who choose not to follow the college preparatory progression (Bidwell & Ciason, 1970).

Furthermore, between 1950s and 1960s, there was a "New Math" movement which aimed at reforming math instruction (Furr, 1996). This reform looked into how Mathematics should be taught to facilitate learners' understanding of concepts. During this same period, Skinner developed a method of instruction called programmed instruction. Programmed instruction was differentiated instruction in which learners are taught with respect to their needs. The needs of individual learners are to be met when their difficulties have been identified and learners are taught at their own pace.

In an attempt to promote conceptual understanding in Mathematics, Bruner in 1966 in his book *Toward a theory of instruction* developed an instructional strategy called the enactive-iconic-symbolic modes of representation. To Bruner (1966), the teaching of Mathematics should follow three stages starting from an enactive or concrete form. In this enactive form, learners develop Mathematical concepts by manipulating concrete objects physically (Kim, 2020). The next stage is the iconic form in which students learn to represent a concept in Mathematics using graphs or pictures. The third and last stage is the symbolic stage in which learners represent a concept using abstract symbols only.

In the early 1980s, Singapore developed an instructional strategy called the Concrete Pictorial Abstract (CPA) which is an adaptation of Bruner's Enactive-Iconic-Symbolic mode of representation (Leong, Ho & Cheng, 2015). The CPA is an activity-based approach consisting of hands-on activities with the teacher as the facilitator. The CPA has remained a key instructional strategy since its inception in the 1980s as advocated by the Singapore's ministry of education (Leong et al., 2015). Singapore's CPA follows same sequence of instruction as Bruner's Enactive-Iconic-Symbolic modes.

Moreover, even in the USA it has another adaption and appellation called the Concrete Representational Abstract (CRA) instructional strategy (Kim, 2020). Bruner's CRA has been used to aid students with Mathematics learning difficulties and those at risk of failure in special education settings in the USA.

In Korea, Bruner's appellation of his theory as Enactive-Iconic-Symbolic (EIS) is maintained (Kim, 2020). Kim equally adopts the term concreteness fading in order to emphasize the techniques of gradual progression in a continuum from concreteness to abstractness. As the instructor progresses from concrete to representational and finally to abstract, the use of concrete objects decreases till the abstract stage where there is no teaching with concrete resources and thus the concrete fades away.

Mathematics education in Cameroon started as far back as the pre-colonial era. During the pre-colonial era, the teaching of Mathematics was characterised by use of activities aimed at meeting the needs of the indigenes (Nekang, 2016). He added that Mathematics could be used in counting, buying and selling, and carving. During this period, concepts of addition, subtraction, multiplication and division using concrete objects. Thus, during this era, teaching was activity- oriented and collaborative with the acquisition of life long skills.

During the colonial period between 1884 and 1961, topics such as algebra, coordinate geometry and Euclidean geometry were taught with rote learning and memorisation as teaching methods. This made acquisition of skills and understanding of concepts difficult. The topics lessons were not related to the direct society.

Furthermore, the post-independence period between 1961 and 1977 witnessed a number of conferences aimed at improving on the teaching and learning of Mathematics. These conferences included the Rehovoth conference in 1960, the Endicolt House conference in Delham, Massachussets in 1961 and the Edinburg conference in 1969 in which participants agreed that the secondary Mathematics curricula failed to prepare students to cope with modern sciences and the environment in Africa (Nekang, 2016).

Moreover, the teaching of Mathematics in Cameroon between 1961 and 2021 has been shaped by numerous pedagogical approaches. Firstly, from independence to 1996, the pedagogical approach used was the content-based approach (Alemnge, 2020). In this approach, the teaching method was predominantly the lecture method with students following rules and procedures to solve problems. Since the teaching methods were teacher-centred, it made the learners passive.

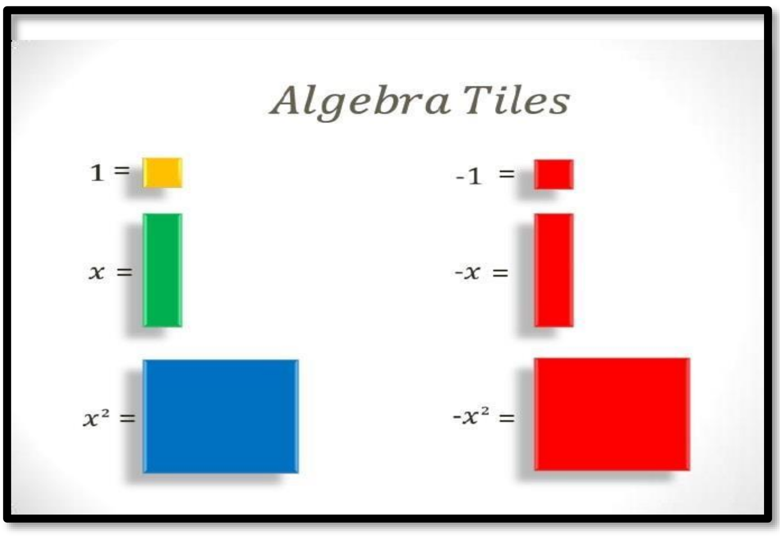
Secondly, was the objective based approach between 1996 and 2011. This approach rose up due to the shortcomings of the content-based approach. With this approach, the lessons had to be interactive and activity-based since the teaching methods were learner-centred. In this approach, the teacher was considered as a facilitator. This approach also had shortcomings. To Alemnge (2020), the most important weakness of this approach was that the learner learnt many things separately but the activities were not put together to meet the challenges of life and societal needs.

In addition, from the 2012/2013 academic year the competency-based approach was introduced (MINESEC, 2014) to bring a solution to the lapses of the objective-based approach to teaching and learning in Cameroon schools. The Competency-Based Approach through real life situations that prepares learners for smooth insertion into the society (MINESEC Mathematics Teaching Syllabus for Forms 3, 4 and 5, 2014). This approach develops knowledge, skills and attitudes in learners to integrate in the society and thus enables them to solve problems in real life situations. The teaching methods advocated are learner-centred and Mathematics lessons should have teaching/learning activities (MINESEC Mathematics Teaching Syllabus for Forms 3, 4 and 5, 2014).

REVIEW OF RELATED LITERATURE

Gagné, Wager, Golas and Keller (2005) define instruction as a set of events embedded in purposeful activities that facilitate learning. Tambo (2012) opines that teaching strategies represent the most general way teachers behave when interacting with students. The Concrete Representational Abstract (CRA) instructional strategy is a three-stage learning process where students learn through physical manipulation of concrete objects, followed by learning through pictorial representations of the concrete manipulations, and ending with solving problems using abstract notation (Witzel, 2005). Concrete materials which can be used in teaching algebra and Mathematics include algebra tiles and integer counters as illustrated in figures 1 and 2 below respectively:

Figure 1 Algebra Tiles



Source: Adopted from Pinterest (2022)

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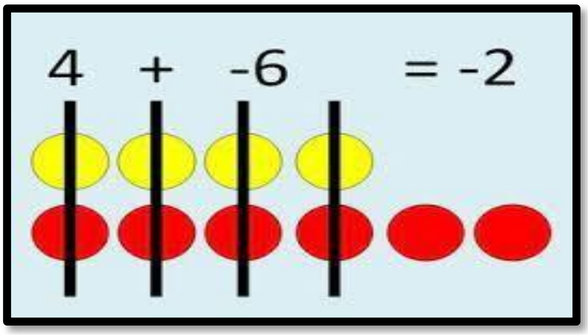
Figure 1 shows concrete objects called algebra tiles which can be used to teach algebra concepts such as simplification of algebraic expressions, linear equations and expansion. A green rectangular bar or cardboard is used to represent the variable x and the red rectangular bar to represent $-x$, a blue square of sides x units used to represent x^2, a yellow square of each side 1 unit used to represent +1 and the red one to represent -1. Coloured counters are shown in figure 3 below.

Figure 2 Coloured Integer Counters

Source: Adapted from Pinterest (2022)

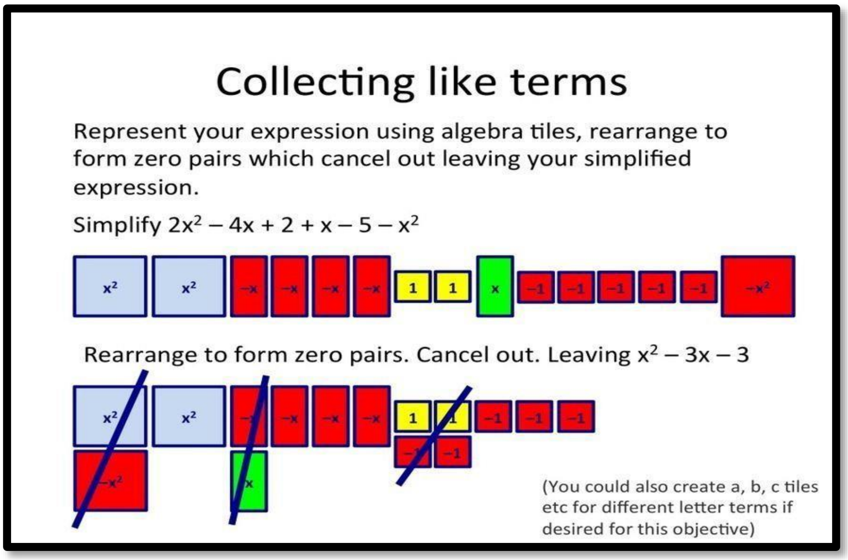
Figures 3 and 4 below shows a pictorial or visual representation of Mathematical concepts of addition of integers and simplification of algebraic expressions respectively.

Figure 3 Addition of Integers Using Visual Representation



Source: Adapted from Pinterest (2022)

Figure 4 Pictorial Representation of Simplification of Algebraic Expression



Source: Adopted from Pinterest (2022)

Academic achievement represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university (Steinmayr, Meibner, Weidinger and Wirthwein , 2015). To Gray (2024), achievement is the degree to which each student is able to meet or exceed the required minimum content standards. To know if students are meeting the desired learning goals and competences, achievement tests are used to measure knowledge and skills. The Algebra Achievement Test was used to measure the knowledge and skills acquired in algebra.

Theoretically, the theories relevant to this study are: Bruner's theory of instruction (1966) where he proposed three modes of representation of knowledge namely enactive, iconic and symbolic modes of representation. To Bruner (1966), learning should start from a concrete manipulation of objects (enactive), followed by visual representations (iconic) and end with the symbolic stage. The other theories are Kolb (1984) Experiential learning theory, Piaget's theory of Cognitive development (1936) and Walberg's Theory of educational productivity (1984). According to Kolb (1984), the learning process is cyclical starting from concrete experience to reflective observation followed by abstract conceptualisation and finally ends up with active experimentation. Students should be taught by starting with their concrete experiences before going to abstract conceptualisation. In a concrete experience, learners will engage in an activity or task. In an algebra lesson, teaching should start by exposing the learners to a concrete experience followed by a reflective observation. During the reflective observation, students reflect on the experience they witnessed. This is followed by abstract conceptualisation where they learn from the experience. After learning from the experience, it's time for the learners to do active experimentation by practising what they have learned.

Empirically, Sahat, Tengah and Prahmana (2018) researched on the teaching and learning of addition and subtraction of integers through manipulative in Brunei Darussalam and the students scored higher. Another study by Maccini and Hughes (2000), as cited in Watt (2013) was conducted on 6 students of grades 9-12 with learning disabilities in Algebra to teach addition, subtraction, multiplication, and division of integers (directed numbers) and results indicated problem-solving skills involving integer numbers drastically improved following instruction at the concrete, semi concrete, and abstract levels. Also, Kurniawan, Budiyono, Sajidan and Siswandari (2020) carried out a research on Concrete-Pictorial-Abstract (CPA) approach on Student's Motivation and Problem-Solving Performance in Algebra and the findings revealed that when the CPA is used, students are able to distinguish variables, constants and coefficients appropriately. This helps them avoid algebra conceptual errors and thus improves their performance in simplification of algebraic expressions. Moreover, Castro (2017) researched on the Effect of Algebra tiles on Mathematical Achievement of Students with Learning Disabilities and results revealed that the achievement scores increased.

Statement of the Problem

Mathematics is one of the core and compulsory subjects in the Cameroon secondary school curricular. Algebra is a core branch of Mathematics which consists of using variables to represent numbers or unknown quantities. Letters of the alphabet such as x, y and z are used to represent variables. These variables are used because they have varied applications such as x and y used to represent number of pens and books when solving a simultaneous equation as well as in other subjects used in transposition of formula in Physics, Chemistry and Economics. The use of variables x and y in algebra has created misconceptions and also greatly contributed to Mathematics phobia in students. These misconceptions and phobia in algebra has greatly contributed to students' poor performance in algebra and Mathematics in general. The GCE Examiners' report of the 2021 marking session revealed that the concept of algebra was poorly attempted.

Despite the misconception in algebra, the method of instruction in teaching algebra by some teachers is still teacher-centred due to its abstract nature leading to students memorising rules and procedures to solve problems. Thus, may not promote students' conceptual understanding. Also, it is not activity oriented and might not promote creativity. In addition, this method of instruction is not accessible to students with the various learning styles which are auditory, visual and kinaesthetic. Also, teaching algebra without concrete materials focuses mainly on symbols which are abstract concepts, making it difficult for understanding and also putting all students and in particular those with difficulties in algebra at a disadvantage. More so, the continuous use of teacher-centred methods alienates students from the subject. This destroys their foundation in algebra and makes them develop negative attitudes towards Mathematics and thus might further affect their achievement in Mathematics in higher classes and also goes a long way to affect their achievement in GCE Ordinary Level Mathematics Examinations.

The results between 2010 and 2016 revealed an average percentage passed in Mathematics of 12.84 %. During this period, 84.4 % of the students who wrote the examination scored a U grade while 8878 of them were absent. In addition, the percentage passed in Mathematics at the GCE Ordinary level in 2021 was 27.59 %, though an increment compared to the other years but still low. This low achievement reduces the enrolment of students in Mathematics related fields in high school and university. This reduces the quality and quantity of engineers, scientists and researchers, limits business and bank transactions and land projects. In addition, algebra is a pre requisite to understand Physics, Chemistry, Economics, Accounting, Biology, among others. In all, low achievement in Mathematics and algebra in particular retards scientific and technological advancement and a country's economic growth. Therefore, this study seeks to find out the effect of the Concrete Representational Abstract instructional strategy on Form 2 students' achievement in Algebra in Secondary Schools in the South West Region of Cameroon.

Research Questions

General Research Question

What is the mean difference in the mean achievement scores of form two students taught algebra using the Concrete Representational Abstract (CRA) as compared to those taught using the Conventional Abstract Instruction (CAI)?

Specific Research Questions

The following specific research questions guided the study:

1. What is the difference in the mean achievement scores of form two students taught directed numbers using the Concrete Representational Abstract (CRA) instructional strategy as compared to those taught using the Conventional Abstract Instruction (CAI)?
2. What is the difference in the mean achievement scores of form two students taught simplification of algebraic expressions using the Concrete Representational Abstract (CRA) instructional strategy as compared to those taught using the Conventional Abstract Instruction (CAI)?

Research Hypotheses

Hypotheses were formulated and tested to provide a framework for drawing conclusions. In answering the research questions, the following hypotheses were formulated to test the results at $p \leq 0.5$ alpha level of significance.

General Research Hypothesis

H_0: There is no statistically significant difference in the post test mean achievement scores of form two students taught algebra via CRA and those taught using the CAI.

H_a: There is a statistically significant difference in the post test mean achievement scores of form two students taught algebra via CRA and those taught using the CAI.

Specific Hypotheses

H_{01}: There is no statistically significant difference in the post test mean achievement scores of form two students taught directed numbers via CRA and those taught using the CAI.

H_{a1}: There is a statistically significant difference in the post test mean achievement scores of form two

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students taught directed numbers via CRA and those taught using the CAI.

H_{02}: There is no statistically significant difference in the post test mean achievement scores of form two students taught simplification of algebraic expressions via CRA and those taught using the CAI.

H_{a2}: There is a statistically significant difference in the post test mean achievement scores of form two students taught simplification of algebraic expressions via CRA and those taught using the CAI.

RESEARCH METHODOLOGY

Research Design

This study made use of a quasi-experimental non-randomized pre-test, post-test research design.

Area of the Study

This refers to the geographical location intended to be covered in the study. The study was carried out in Meme and Fako Divisions of the South West Region of Cameroon. The South West region is one of the two English speaking regions of Cameroon and it is divided into six Divisions namely: Fako, Meme, Manyu, Ndian, Lebialem and Kupe Maunengouba Divisions. It is bordered to the West by the Federal Republic of Nigeria, to the East by Littoral, West and North West regions of Cameroon and opens to the Atlantic Ocean on the South. The regional headquarter of the South West Region is Buea and the region covers a surface Area of 25,410 km^2 with an estimated population of 1,481,433 inhabitants according to the 2013 population census. In addition, it is characterised by numerous touristic sites such as Mount Cameroon, the Korup National Park, the Limbe Botanical garden and Zoological centre.

Target Population

The target population is the population to which the researcher ultimately wants to generalize the results. The target population of this study consist of form two students of all public secondary schools in Meme and Fako Divisions.

Table 1 Distribution of Schools and Students in the South West Region of Cameroon

Division	**Number of Schools**	**Number of Students for (Boys)**	**Number of Students (Girls)**	**Total**
Fako	44	18069	20933	39002
Lebialem	36	350	348	698
Kupe Muanenguba	34	1619	1065	2684
Manyu	63	2738	2209	4947
Meme	63	5542	5350	10892
Ndian	39	767	665	1432
Total	**279**	**29082**	**30570**	**59652**

Source: Delegation of Secondary Education, South West Region of Cameroon (2023)

Accessible Population

In this study, the accessible population consists of form two students of GHS Bokwango and Cameroon College of Arts and Science (CCAS) Kumba.

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Sampling Technique

Purposive sampling technique was used to select two schools so that these schools were as homogenous as possible with respect to some predetermined aspects like: school size, class size, staff strength and general performance. For this reason, the schools selected were GHS Bokwango and CCAS Kumba. In addition, simple random sampling was performed to determine the experimental group. To do this, the names of the two schools were written on two separate pieces of papers, folded and a neutral person was introduced to pick one of the papers which happened to be CCAS Kumba. So, form two students of CCAS Kumba became the experimental group while those of GHS Bokwango the control group.

Table 2 Accessible and Sample population of the study

School	Accessible population	Sample
GHS BOKWANGO	**215**	**215**
CCAS Kumba	**249**	**249**
Total	**464**	**464**

Source: School registers of the above-mentioned schools (2023)

Instruments for Data Collection

The Algebra Achievement Test (AAT), the Form 2 Algebra interest inventory questionnaire and the interview guide for teachers will be used to collect the data. The AAT comprised of 2 structural questions based on directed numbers and simplification of algebraic expressions. Spaces were provided for students to answer the questions. The questions were set based on the expected knowledge and skills required by form two students according to the National form two Mathematics syllabus.

The Form 2 algebra interest inventory comprised of 12 items to answer the 2 research questions making 6 items per question. This enabled the researcher to study the effect of CRA on students' interest on algebra.

In addition, the interview guide was used to interview teachers based on the effect of CRA in teaching algebra and equally on the teachers view on the effect of CRA on gender.

Validity of the Instruments

The content and face validity of AAT, Form 2 Algebra Interest inventory and interview guide was done by experts from the faculty of education and sampled schools. A total of ten experts comprising Mathematics teachers, a Chief examiner for GCE Ordinary level Mathematics and lecturers of the faculty of education of the University of Buea validated the instruments. Face validity was done by validators going through the questions checking the appropriate adjectives and language used in setting the questions. The content validation was done by experts and corrections were made after their remarks. Based on the comments and corrections, question 1 was rephrased to test students' level of evaluating directed numbers by replacing a variable with a numerical value rather than evaluating the directed number directly.

Reliability of the Instruments

The reliability of the AAT and Algebra Interest Inventory (AII) was determined using Conbrach α. The reliability coefficients for AAT and AII were 0.87 and 0.81 respectively showing that the instruments were reliable and could be used for the study.

Administration of Instruments

The class teacher of the experimental group was trained on the use of CRA teaching strategy to teach algebra while the class teacher for the control group used the conventional abstract teaching strategy.

At the onset of the experiment, the students in both groups were subjected to a pre-test, which acted as a baseline evaluation and used to compare with the post test. The pre-test was scored and recorded by the researcher. Students in the treatment and control group received instruction using the same length of time (period). Each of the school was taught using four periods every week for two weeks. CRA was used to teach the experimental group while the CAI was used to teach the control group. Teaching using the CRA started at the Concrete phase by using algebra tiles and integer counters. The second phase which is the representational phase used drawings and pictures. The third phase which is the abstract phase involved solving in algebra mainly using algebraic expressions and equations, variables, constants, coefficients and terms without any instructional materials.

METHOD OF DATA ANALYSIS

The independent variable is the CRA instructional strategy and the data collected from this variable was categorical precisely in two categories which were CRA instructional strategy and the conventional teaching strategy while the dependent variable was achievement in algebra and the data collected from this variable is continuous.

Based on the nature of the data collected from the independent variable and the dependent variable, the research questions were answered using mean and standard deviations while the hypotheses were tested using the independent t-test to test the differences between the mean Algebra achievement scores of form two students in the experimental and control groups.

DATA PRESENTATION AND RESULTS

The study investigated the effect of the Concrete Representational Abstract instructional strategy on form two students' achievement in algebra in the South West Region of Cameroon. This chapter presents the analyses carried out and the results arrived at and organised with respect to the objectives of the study.

The research questions were answered using mean scores and standard deviations while the hypotheses were tested using the independent t-test to test the differences between the mean Algebra achievement scores of form two students in the experimental and control groups.

Decision level for the questionnaire: Mean, $x = \frac{4+3+2+1}{4} = \frac{10}{4} = 2.5$

Respondents accepted or agreed with the opinion expressed in the item if the mean score is 2.5 and above. Otherwise, they rejected or disagreed with the item stated.

Table 3 Pre-test Mean Achievement Scores and Standard Deviations for CRA and CAI

Variable	N	X	S	Std Error	Mean difference
PRE.CON-TOTAL	215	3.330	3.190	.220	
PRE.EXP-TOTAL	253	3.830	4.080	.280	0.500

$\bar{x}$ **= Mean score S = Standard deviation Std Error = Standard Error**

The performance of form two students during the pre-test in the experimental group ($\bar{x}$ = 3.830±4.080) was almost equal to performance of those in the control group ($\bar{x}$ = 3.330±3.190). A mean difference of only 0.5 shows that the two groups were almost at the same achievement level before the beginning of the experiment.

Research Question One: What is the difference in the mean achievement scores of form two students taught directed numbers using the Concrete Representational Abstract (CRA) instructional strategy as compared to

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those taught using the Conventional Abstract Instruction (CAI)?

Table 4 presents the mean achievement scores and standard deviations of form two students taught directed numbers using the CRA instructional strategy as compared to those taught using the CAI.

Table 4 Mean Achievement Scores and Standard Deviations for Directed Numbers Using CRA and CAI

Variable	N	X	S	Std Error	Mean difference
PRETEST-CONTROL	215	0.870	1.100	.080	
POSTTEST-CONTROL	213	1.580	1.460	.100	**0.710**
PRETEST-EXP'TAL	253	0.940	1.350	.080	
POSTTEST- EXP'TAL	249	2.080	1.920	.120	**1.140**

$\bar{x}$ = Mean score   S = Standard deviation   Std Error = Standard Error

The mean achievement scores and standard deviations of form two students taught directed numbers using CAI ($\bar{x}$ = 0.870±1.100) during the pre-test was lower than that of the same group ($\bar{x}$ = 1.580±1.460) during the post test. A mean gain score of 0.710 shows that the group did not achieve much in directed numbers when taught using CAI.

Meanwhile, the mean achievement scores and standard deviations of form two students taught directed numbers using CRA ($\bar{x}$ = 0.940±1.350) during the pre-test was lower than that of the same group ($\bar{x}$ = 2.080±1.920) during the post test. A mean gain score of 1.140 shows that the group achieved better in directed numbers when taught using CRA. The results show that the Concrete Representational Abstract (CRA) instructional strategy is better than the Conventional Abstract Instruction (CAI) in the teaching of directed numbers. Students taught directed numbers starting from concrete objects such as building blocks followed by visuals and end up with symbols master the concepts better than those taught using CAI. This is because teaching using CRA provides multiple means of representation of concepts which are concrete, representational and abstract which takes into consideration the different learning styles. Thus, CRA takes into account the learner variability when planning instruction and teaching.

Verification of Hypothesis One

H_{01}: There is no statistically significant difference in the post test mean achievement scores of form two students taught directed numbers via CRA and those taught using the CAI.

Table 5 Independent T-Test for Directed Numbers Using CRA and CAI

Variable	X	Mean Difference	Std Error	St	df	Sig. (2-tailed)
POSTTEST EXPERIMENTAL	2.080					
POSTTEST CONTROL	1.582	.498	.161	3.087	460	.002

$\bar{x}$ = Mean score t = t-calculated value df = degree of freedom Std Error = Standard Error

The independent t-test analysis shows that the $t_{\text{cal. value =}}$ 3.087 is greater than then the $t_{\text{crit. value}}$ = 1.960 at $\alpha < .05$ level of significance, with degree of freedom (df) = 460. We therefore reject the null hypothesis and conclude that there is a statistically significant difference in the post test mean achievement scores of form two students taught directed numbers via CRA than those taught using the CAI.

The table 6 below presents the mean achievement scores and standard deviations of the questionnaire responses from form two students taught directed numbers using the CRA instructional strategy.

Table 6 Responses on Directed Numbers When Taught Using CRA

SN	Directed numbers	$\bar{X}$	S	Decision
1	Teaching directed numbers starting with seeds, balls, pictures and ending with numbers is interesting.	3.66	.54	A
2	I develop a lot of interest in directed numbers when my teacher uses seeds and objects to teach.	3.73	.61	A
3	I enjoy learning directed numbers using balls and pictures.	3.44	.85	A
4	Teaching addition and subtraction of integers without objects is interesting.	3.06	.91	A
5	Learning about directed numbers is useful.	3.35	.82	A
6	I talk to my friends about things I learn in directed numbers.	3.15	.83	A
	MRS	**3.40**	**.76**	**A**

MRS = Mean response score $\bar{x}$ = Mean score S = Standard deviation

The table above shows that form two students taught directed numbers using the CRA instructional strategy developed much interest in algebra ($\bar{x}$ = 3.40±.76). This is equally showing that the CRA engages learners to the fullest and as a result enables them develop interest in directed numbers

Interview Question to Teachers: Please explain your experiences in teaching Directed numbers using the CRA teaching strategy.

Teacher 1 responded that:

"To be honest, since I started teaching Mathematics, I was very amazed and impressed with the learners' behaviour (attention) and participation in class during my lessons when I used the CRA teaching technique. It really makes them understand the concepts better."

Teacher 2 responded that:

"CRA has made the teaching of directed numbers really easy and understood by all the students. Using coloured building blocks to add and subtract integers makes the students so happy and interested to learn. They are equally happy to see it applied to daily life. It made them avoid misconceptions in directed numbers."

Both teachers affirmed that using building blocks to teach directed numbers made the students happy and interested to learn.

The results of the findings are in conformity with that by Maccini and Hughes (2000) cited in Watt (2013) whose results indicated problem-solving skills involving integer numbers drastically improved following instruction at the concrete, semi concrete, and abstract levels. Also, Sahat, Tengah and Prahmana (2018) had similar findings on the teaching and learning of directed numbers using manipulatives which improved the performance of students in the addition and subtraction of integers

According to Bruner's theory of instruction, learning should be from the enactive to iconic and finally symbolic modes of representation. Teaching of directed numbers should start from concrete to symbolic by starting with building blocks, images, and pictures before moving to numbers only. This will equally help to greatly overcome misconceptions in directed numbers. Similarly, Kolb's Experiential learning equally makes learners start with a concrete experience. When students are taught directed numbers using concrete objects, they gain a concrete experience and can practice through Kolb's stage of active experimentation.

Research Question Two: What is the difference in the mean achievement scores of form two students taught simplification of algebraic expressions using the Concrete Representational Abstract (CRA) instructional strategy as compared to those taught using the Conventional Abstract Instruction (CAI)?

Table 7 Mean Achievement Scores and Standard Deviations for Simplification of Algebraic Expressions Using CRA and CAI

Variable	**N**	$\bar{X}$	**S**	**Std Error**	**Mean difference**
PRETEST-CONTROL	215	1.320	1.230	.080	0.090
POSTTEST-CONTROL	213	1.410	1.430	.100	
PRETEST-EXP'TAL	253	1.350	1.110	.070	1.290
POSTTEST- EXP'TAL	249	2.640	1.660	.110	

$\bar{x}$ **= Mean score S = Standard deviation Std Error = Standard Error**

The mean achievement scores and standard deviations of form two students taught simplification of algebraic expressions using CAI ($\bar{x}$ = 1.320±1.230) during the pre-test was lower than that of the same group ($\bar{x}$ = 1.410±1.430) during the post test. A mean gain score of 0.090 shows that the group did not achieve much in simplification of algebraic expressions when taught using CAI.

Meanwhile, the mean achievement scores and standard deviations of form two students taught simplification of algebraic expressions using CRA ($\bar{x}$ = 1.350±1.110) during the pre-test was lower than that of the same group ($\bar{x}$ = 2.640±1.660) during the post test. A mean gain score of 1.29 shows that the group achieved better in simplification of algebraic expressions when taught using CRA. The result has shown that the Concrete Representational Abstract (CRA) instructional strategy is better than the Conventional Abstract Instruction (CAI) in the teaching of simplification of algebraic expressions. Simplification of algebraic expressions has often led to misconceptions with students simplifying $2x + x$ to give $3x^2$ instead of $3x$. However, teaching simplification of algebraic expressions using the CRA has proven that students master the concepts better as revealed in the findings. CRA provides three modes of representation of concepts by starting the teaching of simplification of algebraic expressions using algebra tiles (Concrete stage) then move to the pictorial stage where students simplify expressions by drawing shapes and finally using only variables and terms.

Verification of Hypothesis Two

H_{02}: There is no statistically significant difference in the post test mean achievement scores of form two students taught simplification of algebraic expressions via CRA and those taught using the CAI.

Table 8 Independent T-Test for Simplification of Algebraic Expressions Using CRA and CAI

Variable	$\bar{X}$	**Mean Difference**	**Std Error**	**t**	**df**	**Sig. (2-tailed)**
POSTTEST EXPERIMENTAL	2.643	1.234	.146	8.479	460	.000
POSTTEST CONTROL	1.409					

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$\bar{x}$ = Mean score t = t-calculated value df = degree of freedom Std Error = Standard Error

The independent t-test analysis shows that the $t_{\text{-cal. value =}}$ 8.479 is greater than then the $t_{\text{-crit. value}}$ = 1.960 at α < .05 level of significance, with degree of freedom (df) = 460. We therefore reject the null hypothesis and conclude that there is a statistically significant difference in the post test mean achievement scores of form two students taught simplification of algebraic expressions via CRA and those taught using the CAI in favour of the students who were taught using CRA.

The table below presents the mean achievement scores and standard deviations of the questionnaire responses from form two students taught simplification of algebraic expressions using the CRA instructional strategy.

Table 9 Responses on Simplification of Algebraic Expressions When Taught Using CRA

SN	Simplification of algebraic expressions	$\bar{X}$	S	Decision
1	Simplification of algebraic expressions becomes interesting when taught using seeds and balls.	3.37	.88	A
2	I do not understand simplification of algebraic expressions when it is taught using variables x and y.	2.81	1.08	A
3	Teaching simplification of algebraic expressions with pictures and other visuals makes it more interesting.	3.43	.87	A
4	I develop a lot of interest in simplification of algebraic expression when taught using cardboards and pictures.	3.46	.81	A
5	Simplification of algebraic expressions is boring when taught using objects.	2.82	1.12	A
6	I discuss with my friends and family about things I learn in simplification of algebraic expressions.	3.10	.89	A
	MRS	**3.17**	**.94**	**A**

MRS = Mean response score $\bar{x}$ = Mean score S = Standard deviation

Table 9 shows that simplification of algebraic expressions when taught using the CRA instructional strategy arouses interest in form two students ($\bar{x}$ = 3.17±.94).

Interview Question to Teachers: Please explain your experiences in teaching Simplification of algebraic expressions using the CRA teaching strategy.

Teacher 1 responded that:

"In the beginning as I introduced this particular lesson it wasn't that easy but as I brought in the CRA technique using different colours and dimensions of cardboards it was well understood."

Teacher 2 responded that:

"For the first time in my career I noticed that simplification of algebraic expressions could be taught practically by using concrete objects such as cardboards to represent 1, x *and* x^2. *This helps reduce errors in simplification of algebraic expressions such as,* $x + x = 2x^2$. *"*

Teachers were so overwhelmed with the teaching and learning of simplification of algebra using the CRA because it arouses students' interest thereby keeping them engaged and it equally helped avoid misconceptions. It also makes the teaching of algebra more practical not using on variables all the times.

These findings are similar to studies by Kurniawan, Budiyono, Sajidan and Siswandari (2020) whose findings revealed that when the CRA is used, students are able to distinguish variables, constants and coefficients appropriately. This helps them avoid algebra conceptual errors and thus improves their performance in simplification of algebraic expressions. Moreover, the study is also in conformity with that by Castro (2017) who found out that teaching algebraic expression using concrete objects such as algebra tiles help improve comprehension of algebraic expressions with students with disabilities.

According to Bruner's theory of instruction, teaching of concepts in Mathematics in general and algebra in particular should move from concrete to representation and finally the abstract stage. When teaching simplification of algebraic expressions at the concrete stage, algebraic tiles consisting of squares and rectangles are used to represent the variables, constants and terms. This concrete representation of knowledge gives room for exploration and discovery. It equally provides another means of representation of knowledge by taking into account the various learning styles. After the concrete stage, the next stage which is the pictorial representation is taught using drawings and images. At this stage, squares and rectangles to model the concrete stage can be drawn on the board. Finally, move to the abstract stage where students master concepts by using variables, coefficients, constants and terms only. Passing through these three stages promotes mastery because it is like teaching the same concept three times but providing multiple means of representation so as to accommodate many learners and make all learners engaged.

In another dimension, according to Kolb (1984), learning should start by a concrete experience of facts first before moving to abstract conceptualization. According to his theory, when teaching algebraic expressions, students should first of all be given the opportunity to feel (touch) what is called a term, a variable or constant before being introduced to the abstract nature.

CONCLUSION

In a nutshell, the difference of the mean scores obtained from the AAT is higher when taught Algebra using the CRA instructional strategy than using the CAI. Thus, the CRA is therefore a good teaching strategy which also bridges the gender gap in Mathematics and equally arouses students' interest in Algebra.

RECOMMENDATION

The recommendations for the study were: The Concrete Representational Abstract (CRA) instructional strategy should be adopted in the teaching and learning of algebra in particular and Mathematics in general in Cameroon schools. Also, teachers should be trained on how to teach Algebra in particular using the CRA Instructional Strategy and CRA should be incorporated into teacher training education programmes to equip potential teachers with the skills of CRA instructional strategy.

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