

Instructional Model and the Application of Biotechnology Knowledge (Problem Solving in Biotechnology) by High School Students in the Anglophone Subsection of Education in Cameroon

Ekwale Emilia Ada

PhD Research Student, Faculty of Education, University of Buea, Buea, Cameroon

ABSTRACT

This study was a pretest and posttest experimental research design which set out to investigate the impact of an Instructional Model (Ekwale Ada's Instructional Model) on the application of biotechnology knowledge by high school students in the Anglophone Subsection of Education in Cameroon. That is to investigate whether students taught with the Ekwale Ada's Instructional Model for Biotechnology Knowledge Application exhibit a higher level of problem solving in biotechnology than students who were taught without the model (traditional methods of teaching). The Ekwale Ada's Instructional Model for Biotechnology Knowledge Application was an instructional package which integrated Inquiry based learning (Hands on), collaborative learning (cooperative learning), Demonstrations, increase in the length of time learners are engaged in activities, Scaffolding and Remediation. The target population was Upper Sixth Science students in the Anglophone Subsection of Education in the North West Region, South West Region, and some displaced Upper Sixth Science students from North West and South West Regions into the Littoral Region for the 2018/2019 academic year.

The researcher constructed a Biotechnology Application Test (BAT) in the form of a pretest and a post test. These tests contained three sections: An MCQ section, a short answer section and a section in which practical activities were carried out.

KEYWORDS: *Instructional Model, Biotechnology Application, Biotechnology Knowledge, Problem solving in Biotechnology, Science High School, Students Anglophone Subsection, Education, Cameroon*

The indicator of biotechnology knowledge application was problem solving in biotechnology. For problem solving, the researcher created an inventory for the respondents to attend to which involved identification of a problem in the society which can be solved by a biotechnology product; Description of the problem clearly; Statement of multiple solutions to the problem; Selection of the best solution to the problem; Statement of the consequences of the best solution; and usage of the best solution to solve the problem. The researcher created a five point inventory scale which ranged from excellent (5 marks); Good (4 marks); average (3 marks); below average (2 marks); and poor (1 mark) used to grade the problem solving activities. The students who were taught with the Ekwale Ada's Instructional Model for biotechnology knowledge Application (experimental group) scored higher in problem solving than those who were taught with traditional methods (control group) with a calculated independent t test value of 58.28 for the experimental group and 1.40 for the control group with a critical t-value of 1.96 at 0.05 level of significance with 70 degrees of freedom.

The sample of the study was 72 science high school students who offer biology (36 students for the experimental group

and 36 students for the control group). Out of the 36 students from both the experimental and control groups, 18 were males and 18 were females making a total of 36 males and 36 females for the whole experiment. The sample was obtained from one government school, one mission school and one lay private school in each region. In the North West Region, 24 students were sampled 12 males and 12 females (08 from GBHS Bayelle, 08 from St Paul High School Nkwen and 08 from St Michael's High School). 24 students were sampled in the South West Region 12 males and 12 females (08 from GHS Buea, 08 from Baptist High School and 08 from Frankfils Comprehensive College Buea). In the Littoral Region, 24 displaced students 12 from the North West Region and 12 from the South West Region were sampled 12 males and 12 females (08 from GBHS Bonaberi, 08 from PHS Douala and 08 from Mother Theresa College Bonaberi Douala). Therefore the sample was 72 individuals (36 for the experimental group and 36 for the control group).

The study was an experimental study in which a teacher made pretest was administered to both the experimental and control groups; the students of the experimental group were taught with the Ekwale Ada's Instructional Model for biotechnology knowledge application (treatment) while

How to cite this paper: Ekwale Emilia Ada "Instructional Model and the Application of Biotechnology Knowledge (Problem Solving in Biotechnology) by High School Students in the Anglophone Subsection of Education in Cameroon"

Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-2, February 2020, pp.535-555, URL: www.ijtsrd.com/papers/ijtsrd30072.pdf

Copyright © 2019 by author(s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0)

(<http://creativecommons.org/licenses/by/4.0>)



IJTSRD30072



those of the control group were taught without the model (traditional methods of teaching). After the treatment, a teacher made post test was administered both to the experimental and the control groups. The experimental group was located in GHS Mamfe while the control group was located in Progressive Comprehensive High School Bamenda.

One non-directional hypothesis was stated in both the null and alternate forms. The null hypothesis was:

1. There is no significant difference in problem solving in biotechnology between students taught with the Ekwale Ada's model and those who were taught without the model.

The data for the pre-test and the post-test for the experimental group and control group were collected in the form of scores. The data was analysed using the SPSS Programme. The independent t test was used to find out the difference in means of the scores of the pretest of the experimental group and the control group and the difference in mean of the scores of the posttest of the experimental group and the control group. The null hypothesis was rejected and the alternate hypothesis was retained. They indicated that there was a significant difference in the means of the post-test of the experimental group and the control group.

The result of the study was:

1. There was a significant difference in problem solving in biotechnology between students taught with the Ekwale Ada's Model and those who were taught without the model. The experimental group on whom the treatment was administered performed significantly better (58.28) than the control group (1.40) on whom the treatment was not administered.

INRODUCTION

In a world that is increasingly becoming complex, success does not only depend on knowledge acquisition but on knowledge application. If knowledge is only gained and is not used for the good of humans, then all the resources used for the acquisition of that knowledge are wasted. Knowledge can only be applied when higher order skills such as problem solving, critical thinking and creativity are exhibited by learners. Most developing Countries including Cameroon have students and graduates who are turgid with head knowledge but almost impossible to apply the knowledge acquired to solve problems which would contribute to the advancement of their societies. Application of knowledge gained from schools is very important if societal problems must be solved. Drucker, (1994) stated that, "how well an individual, an organization, an industry, a Country, does in acquiring and applying knowledge will become the key competitive factor. There will be no "poor" Countries but there will be ignorant Countries". To Drucker, rich Countries are those who apply knowledge to solve societal problems while Countries which do not apply knowledge to solve societal problems are designated ignorant countries.

According to Endeley and Kintati (2017), the high unemployment among secondary school leavers in Cameroon poses fundamental questions about the skills students are impacted with in secondary schools through instruction and their relevance to the job market. This is to

say that, higher order skills such as problem solving, critical thinking and creativity can only be acquired by students through quality instruction. Higher order skills such as problem solving, can also be acquired by students through well-structured school curriculum. Agborbechem (2006) was in line with this when he postulated that, the curriculum of Cameroon schools should be structured in such a way that, school leavers would acquire all the skills that will make them fit into the Cameroon labour and industrial market. It is only when learner centred methods of teaching are used that higher order skills such as problem solving, critical thinking and creativity are evoked in learners and it is only with the endowment of these skills that learners are able to apply acquired knowledge to solve societal problems. The absence of these higher order skills has a negative impact on knowledge application and makes the school leavers unfit for the job market. Tanyi (2016) created a student adjustment inventory manual which could be used to conquer the barriers of inclusive classrooms. When inclusion is practised in classrooms, and the barriers of these classrooms are eradicated, the individual differences among the learners would be taken care of and the learners would be able to exhibit higher order skills such problem solving, critical thinking and creativity which will help them to compete in the national and international labour market.

In recent years, a key concern for policy makers had been how to ensure that, the wealth of knowledge generated within schools can be transferred to industry. This would enable society in general and local businesses in particular to benefit from the scientific and technological expertise of schools. As Justman and Teubal (1991) and Bell and Pavitt (1993) explain, technology is central to the development process and long term structural change is driven by technology. Any Country that wishes to be developed must first make sure her learners apply science and technology knowledge to solve societal problems because that is what development entails. Freeman (1987), Camison and Fores (2010), Etzkowitz; Ranga; Benner; Guarany; Maculan and Kneller; (2008), focus broadly on facilitating the transfer of knowledge from the university to industry. According to Mwamadzingo (1995), the science-push theory recognizes science and technology as independent determinants of industrial innovations leading to economic growth. These innovations cannot take place in the absence of higher order skills. According to (Vijayaratham, 2012), we need "thinking" students who can incessantly respond to real-world demands by the use of higher order skills. Thinking students would be students who have acquired higher order skills such as critical thinking, problem solving and creativity and use these skills to develop their countries. According to Mosk (2001), Countries like Japan and Korea, have become industrialized due to a high level of applicability of science and technology knowledge by their students and graduates. In developing countries like Cameroon, where science and technology are essential ingredients for economic growth, much attention is given to the acquisition of higher order skills (problem solving, critical thinking and creativity) which lead to achievement in science and technology courses in schools.

Education is meant to develop the individual intellectually (cognitive domain), morally (affective domain) and psychomotorly in order to equip him or her to function effectively in the society. Each time all the domains of

learning are exploited, individuals will develop creativity skills and therefore participate with increased capacity in the development of their Country. Ahidjo (1967) was in line with this when he posited that, the end of education is not to instruct people for the pleasure of instructing them; it is to enable them to participate with increased output capacity in the development of their country. Similarly, Ukeje (1966) stated that it is the role of education is to promote participation in social improvement; to influence people's ways of doing things; to be in accord with the changing times; to improve standards of living; show ways of preventing sickness and practicing sound habits of health, sanitation and nutrition. Standards of living cannot be improved if knowledge gained in schools is not applied. How can the products of schools participate with increased output capacity in the development of their Country when they lack higher order skills such as creativity? There are many factors that affect knowledge application and quality instruction which impacts the learners with higher order thinking skills might be one of the factors. Without collaborative learning, inquiry based learning, engagement of students in group learning activities, increase in the length of time learners are engaged in the activities, scaffolding and remediation, higher order skills such as creativity cannot be developed in students.

BACK GROUND OF THE STUDY

Higher order skills such as creativity are essential ingredients of technological advancement in any society since it leads to innovation. Quality instruction elicits higher order skills such as creativity. According to Eggen and Kauchak (2001), an instructional model incorporates a variety of teaching strategies and therefore causes instruction to be effective. Instructional models always enhance students' higher order skills such as problem solving, creativity and critical thinking since they incorporate several teaching strategies.

Instructional Models for increase students' level of problem solving. This is in congruence with Gupta (2005); Goyak (2009); Dewey (1930); Bloom (1970); Gage & Berliner (1992); Samson (2015); Nafees (2012); Munyaradzi (2014); Yi Lin (2017); Adebola (2011); Dudley (1971); Oslen (1973); Adedayo (1998); Lynn (2016); Yusuf & Nuradeen (2012); Gokhalo (1995); Adams (2001); Baylor (2002); Walker (2003); Barel (2006); Walker (2000); Zion & Sadeh (2007); Duckworth (1990); Creemers & Kyriakides (2006); Kreizberg Kreizberg (2009); Guleker (2015); Endeley & Kintati (2017); Dettaan (2009); Samson (2015); Marzano (2001); Glaser (2012); Marzano (2012); Pushkin (2007) and Friedel, Irani, Rudd, Gallo, Eckhardt & Ricketts (2008).

Inquiry based learning (Hands on learning) one of the indicators of the Ekwale Ada's Instructional Model for biotechnology knowledge application enhances problem solving in learners. Past research work of Abdi (2014); Kim (2005); Shymansky, Hedges & Woodworth (1990); Kazempour (2013); Gokhalo (1995); Kara (2012); Spektor-Levy (2004)¹; Grasha (1996); Tambo (2012); Spektor-Levy (2004)² Ajaja (2013); Schwartz (2012); Marx, Blumer Field, Krajcik, Fishman, Soloway, Geier and Tal (2004); Rudina (2011); and Marx, Blumerfield, Krajeik, Fishmann, Geier & Tal (2004) posit that Inquiry based learning (Hands on learning) enhances problem solving.

Cooperative Learning (Collaborative Learning) which is one of the indicators of the Ekwale Ada's Instructional Model for biotechnology knowledge application enhances problem solving in learners. Ajaja (2013); Rudina (2011); Shymansky, Hedges & Woodworth (1990); Goyak (2009); Loeser (2008); Brophy (1987); Rowntree (1981); Habeshaw (1997); Michaelsen, Knight & Fink (2004); Freeman et al (2014); Hake (1998); Springer, Stanne & Donovan (1999) postulated that, Cooperative Learning (Collaborative Learning) enhances problem solving in learners.

Demonstration which is one of the indicators of the Ekwale Ada's Instructional Model for Biotechnology knowledge Application enhances problem solving. Eley & Norton (2004); Doise (1975); Valiant & Euler (1982); Adenle & Uwameiye (2012) and Hodson (1990) are in congruence with the fact that, demonstrations enhance problem solving.

The length of time that students are engaged in activities promotes the development of higher order skills such as critical thinking, problem solving and creativity. Frederick et al (2004); Klem & Connel (2004); Putman et al (2013) and Kozloff (2002); John Carroll (1963); Bloom (1976); Ellis & Worthington (1994); Olufumilaya (2014); Slavin (1994); Connel (2004); Hake (1998); Springer et al (1999); Frederick & Walberg (1980); Karweit (1989); Stephenson & Stigler (1992) Klen Stevenson Stigler (1992) and Knight & Wood (2005) postulated that, the length of time that the learners are involved in activities promotes critical thinking, problem solving and creativity.

Scaffolding one of the indicators of the Ekwale Ada's Instructional Model for biotechnology knowledge application fosters problem solving in learners. Scaffolding within the zone of proximal development is an appropriate approach which helps learners to learn more skills and solve problems independently as posited by Asimow (2015); Research Gate (2015); Clark (2017); Kim (2011); Haataja (2019); Ringenberg (2006) and Frederick (2014).

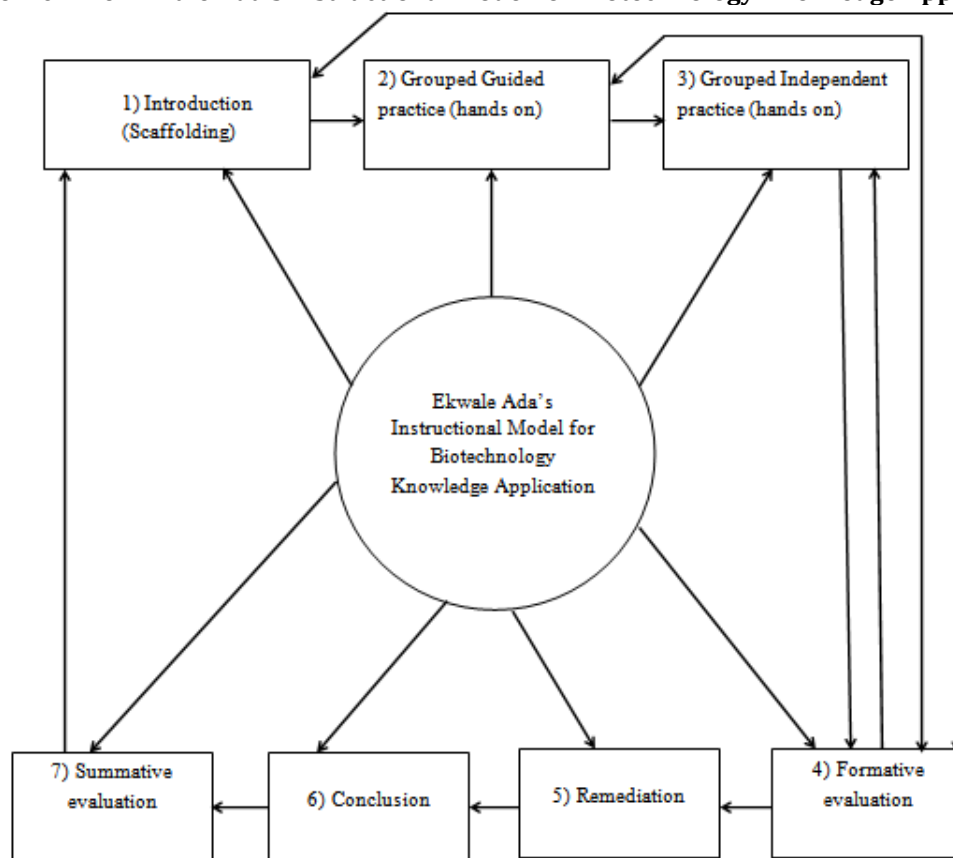
Remediation one of the indicators of the Ekwale Ada's Instructional Model for biotechnology knowledge application fosters problem solving in learners as posited by Thomas (2000); Bishara (2016); Todd Higgs & Mumford (2019); Martin, Elliott & Mumford (2019); Dees (1991); Fuchs, Powell & Zumeta (2009) & Nozari & Siamian (2014).

The Competence Based Approach was instituted in 1996 by the Cameroon Government to Secondary Schools in order to enable learners apply the knowledge acquired in each unit of study. It also encourages teachers to teach learners using learner centred methods of teaching and also by using material and examples which are found in the learners' context of existence which could easily lead to the acquisition of higher order skills such as creativity, critical thinking and problem solving. This programme had been implemented in the junior secondary school since 1996 and in the senior secondary school September 1999. The Competence Based Approach has not been very successful because many teachers are neither willing to teach using the new syllabus nor are they ready to pass through the rigorous exercise of teaching large numbers of students using learner centred methods of teaching.

In 1986, President Ahidjo created the Institute of Rural Applied Pedagogy (IRAP) in all Regional headquarters in Cameroon which adapted programs that integrated training which combined general knowledge with practical work in agriculture, animal husbandry, poultry, bricklaying, carpentry, etc. This was an endeavour to make sure the knowledge gained in school was applied. Today, these

institutes are not functioning well and some are almost abandoned. How then can the products of schools participate with increased output capacity in the development of their Country when students are turgid with head knowledge but cannot apply the knowledge? This lack of knowledge application is due to the absence of higher order skills such as Creativity, critical thinking and problem solving.

Figure 1.0: The Ekwale Ada's Instructional Model for Biotechnology Knowledge Application



The Ekwale Ada's Instructional Model for Biotechnology Knowledge Application

The stages (steps) of the model and their explanations were outlined below:

1. Introduction:

Introduction involves the following: Review of theory work (Test prior knowledge; importance of the lesson to the life of the learners; goal(s) of the lesson; statement of specific objectives in the cognitive, psychomotor and the affective domains from the goal). Review the content under subheadings each subheading covering a particular objective by scaffolding. This is to help the students to have a mastery of what they learnt in biotechnology during the theory classes.

2. Guided practice (hands on with the teacher scaffolding):

The learners in their groups select a biotechnology problem they wish to solve, think of a product they wish to produce, state the recipes/ procedures for the production of the products, design equipment they feel will help them to produce the product. The teacher provides materials and the equipment which the learners will use for their activities. That is the learners perform the activities with the teacher guiding them (hands on). The learners develop their own step by step procedure for the activities (the students

constructed recipes and procedural guidelines for the production of the products). They manipulate the materials and the locally made equipment to create and thus produce the biotechnology product that will solve the pertinent problem in the society which they anticipated with the guidance of the teacher. They design the labelling containers/packages and state a particular name of the product. The learners worked in groups. The learners made use of inquiry learning, collaboration and demonstrations. The teacher observes the students and gives them guidance by scaffolding where the task seems difficult and answers the questions posed by the students.

3. Independent practice (hands on without the teacher scaffolding):

The learners in their groups select another biotechnology problem different from the one above, produce the recipes/ procedures for the production of the products, design equipment they feel will help them to produce the product. The teacher provides materials and the equipment which the learners will use for their activities. That is the learners perform the activities without the teacher guiding them. The learners develop their own step by step procedure for the activities (the students construct recipes and procedural guidelines for the production of the products). They manipulate the materials and the locally made equipment to create and thus produce the biotechnology product that will

solve the pertinent problem in the society which they had anticipated without the guidance of the teacher. They design the labelling containers/packages and state a particular name of the product. The learners worked in groups. The learners make use of inquiry learning, collaboration and demonstrations.

4. Formative Evaluation:

The teacher conducts formative evaluation by asking the students questions. The responses were graded and the data was used as feedback for some corrective mechanisms.

5. Remediation:

The teacher uses the information from the formative evaluation to scaffold the groups of students who could not go through their activities and those who were deficient in some of the steps they created.

6. Conclusion:

The module was brought to a 'conclusion' and the teacher allows the students to recap what they covered in the activities. It was meant to remind the learners about the goal for the instruction.

7. Summative Evaluation:

In this evaluation, the teacher administered (BAT) the biotechnology knowledge application test (pretest and posttest); scored and graded it. A certificate or attestation of biotechnology knowledge application was issued to each of the participants.

Time frame for the use of the Model:

The time frame for the whole experiment was six weeks. The time frame for administration of the pretest was one week. The time frame for the model (treatment) was four weeks. The first week of the treatment was used to accomplish step one (introduction which involved scaffolding the students on biotechnology content). The second week of the treatment was used on step two (guided practice hands on). The third week of the treatment was used for step three (Independent practice hands on) and step four (Formative evaluation). The fourth week was used for step five (Remediation) and step six (conclusion). The post test was administered for one week. The posttest was the summative evaluation. The pretest covered a time span of one week. The treatment covered a time span of four weeks. The posttest covered a time span of one week. Therefore the whole experiment covered a time span of six weeks.

During the first week of the treatment, the teacher did a review of the theory part of biotechnology by scaffolding students on biotechnology content and assigned the students to groups by random sampling. During the second week of the treatment, the students identify a biotechnology problem in the society and constructed a recipe/procedural guideline for the production of the products and design the equipment to be used on paper. The teacher provides materials and equipment to the students and the students then engage in the activities by manipulating the materials and the equipment to produce the biotechnology product that will solve the biotechnology problem identified. As this was going on, the teacher gave guidance and scaffolded the students. During the third week of the treatment, the students identified another biotechnology problem in the society and constructed a recipe/procedural guideline for

the production of that product and design the equipment to be used on paper. The teacher provides materials and equipment to the students and the students then engage in the activities by manipulating the materials and the equipment to produce the biotechnology product that will solve the biotechnology problem identified. As this was going on, the teacher did not give guidance and did not scaffold the students but allowed them to undergo independent activities. As the activities were going on the teacher conducted formative evaluation. During the fourth week of the treatment, the teacher did remediation to groups of students who were in difficulty and concluded the module. The treatment covered a time span of four weeks. The pretest covered a time span of one week and the posttest covered a time span of one week. The posttest was the summative evaluation questions. The pretest and the posttest were marked by the researcher with the help of three research assistants. The participants were given certificates designed by the researcher.

PROBLEM STATEMENT

Problem solving is a higher order skill which is lacking in learners due to the fact that learners are exposed to poor instruction. Since the Cameroon GCE BOARD included biotechnology as part of the advanced level biology syllabus in 2003, the number of students who answer questions on biotechnology and score a pass mark had been low as compared to the numbers who answer questions and score a pass in other parts of biology. The advanced level subject report for GCE general subjects from 2004 to 2019 reveal that, the parts of advanced level biology questions which deal with application of biotechnology knowledge were poorly handled as evidence of the very low scores by students. In the biotechnology questions, the students measure up a bit in parts that do not deal with application of biotechnology knowledge while 95% of the candidates score 0 in parts of questions that deal with application of biotechnology knowledge. In the 2017 GCE, the score for the biotechnology question slightly improved but the same problem came up in that, the candidates still performed extremely poor in the section of the question that dealt with application of biotechnology which is a pertinent problem that has been occurring. As a teacher of advanced level Biology since 1999 and a marker of advanced level biology since 2001, I had observed that students perform poorly in the section of biotechnology that deals with knowledge application. This might be due to the absence of higher order skills such as critical thinking, problem solving and creativity. Critical thinking, problem solving and creativity skills can only be acquired by students when the instruction is of quality and when good teaching strategies are used.

The programme for advanced level biology in Anglophone Cameroon includes short term projects in which students are supposed to carry out production of yoghurt, afofop, corn beer, baking etc. but they only write small essays about the products without practically producing them which rules out critical thinking, problem solving and creativity. After school, they would not be able to invent/create new biotechnology products. Therefore, biotechnology knowledge is being accumulated at this level of Education so that application would be done in the University. With this schedule, application of biotechnology knowledge cannot occur as one big magic step at the tertiary level of education. It should first start in the secondary level so that it can take place with

increasing sophistication at the university and other tertiary institutions which is the essence of spiral education. The students had never used their own critical thinking, problem solving and creativity to invent new products which do not exist, design local equipment for the production of the products, develop procedures for the production of the products, use the equipment and materials in the learners context of existence to produce the products and preserve, parcel and label the products using their knowledge in biotechnology. The teachers had never used learner centred methods of teaching biotechnology syllabus, therefore, there had been no promotion of deep learning. This showed that, the level of biotechnology application is low and if nothing is done about it, Cameroon will lag behind the other African Countries in biotechnology knowledge application.

The Competence Based Approach instituted to Secondary Schools by the Cameroon Government to encourage learner centred approach to teaching, skill development and the self-reliant nature in learners is slow in gaining grounds as most teachers do not want to teach using the new syllabus and they do not wish to face the challenges of teaching large numbers of students with learner centred methods of teaching. How then can our learners apply the knowledge acquired from schools? There is therefore a gap between knowledge acquisition in biotechnology on one hand and applicability of this knowledge on the other hand.

THEORIES

Bloom's theory of Mastery Learning

Benjamin Bloom stated that, the basic task in education is to find strategies which will take individual differences into consideration but which will do so in such a way as to promote the fullest development of the individual. The two main ideas of mastery learning are time and quality instruction which enables learning for all kinds of learners. Benjamin Bloom coined the term "Learning for Mastery" and then later "Mastery Learning" in 1968 and 1971 to describe an educational method in which each student stays with a certain unit of learning material in a process of assessing and correcting until the objectives of that unit are mastered before moving on to the next unit. This theory is related to this work in that, learners have to be scaffolded by the teacher above their natural aptitudes and attitudes in order for them to gain mastery in the learning and therefore be able to show high levels of knowledge application.

Gagne's Theory on conditions of learning

This theory stipulates that, there are several different types or levels of learning. The significance of these classifications is that, each different type requires different types of instruction. Gagne identifies five major categories of learning: Verbal information (Declarative knowledge); Intellectual skills (concept learning, procedural learning, principle learning and problem solving); Cognitive strategies (Organizing strategies, elaborating strategies, rehearsing strategies and metacognitive strategies); Motor skills (Psychomotor skill learning) and Attitudes (Cognitive, behavioural and affective component). He identified different internal and external conditions which are necessary for each type of learning.

Gagne (1965) identified the mental conditions for learning. These were based on the information processing model of the mental events that occur when adults are presented with

various stimuli. Gagne created a nine-step process called the events of instruction, which correlate to and address the conditions of learning. These events of learning are Gain attention (Reception); Inform learners of the objectives (Expectancy); Stimulate recall of prior learning (Retrieval); Present the content (Selective perception); Provide learning guidance (Semantic encoding); Elicit performance (Responding or providing practice); Provide feedback (Reinforcement); Assess performance (Retrieval); Enhance retention and transfer to the job (Generalization).

This theory is related to this work in that, instruction in biotechnology involves: Intellectual skills (concept learning, procedural learning, principle learning and problem solving); Cognitive strategies (Organizing strategies, elaborating strategies, rehearsing strategies and metacognitive strategies) and motor skills (Psychomotor skill learning). The events of learning satisfy or provide the necessary conditions for learning (Gagne, Briggs and Wager, 1992). When the events of learning are followed chronologically, during instruction, learning takes place easily and the knowledge gained can also be applied easily. The ninth event of learning specifically is on how to enhance learning in such a way that will lead to knowledge application or transfer of knowledge to jobs which is highly related to this topic.

Social Constructivist Theory by Vygotsky

Vygotsky was a social constructivist. He theorised that, the most important tool that shapes cognitive functioning is language (Robbins, 2001). His theory also emphasize that knowledge is situated and collaborative (Bearison and Dorval, 2002) and Maynard (2001). That is knowledge is distributed among people and environments which include objects, artefacts, tools, books and the communities in which people live. This shows that knowledge can best be advanced or students understand better through interaction with others in cooperative activities. One of Vygotsky's ideas was the concept of the Zone of Proximal Development (ZPD) which is the range of tasks that are too difficult for children to master alone but can be adequately learnt with the guidance and assistance of a teacher, adults or more skilled children. The lower limit of the ZPD is the level of problem solving reached by the child when he/she is working independently while the upper limit is the level of additional responsibility the child can accept with the assistance of a good instructor and probably quality instruction. Hasse (2001) found out that, social interactions during instruction between the learners and the instructor and between the learners and other learners helps in developing children's cognition. According to this researcher, social interactions might go further to develop the child's affective domain as the child sees his/her instructor and peers behave and the psychomotor domain as he/she sees the instructor and the peers manipulate objects such as materials and equipment.

This theory is relevant to this work in that, as students learn in groups during class activities and during practical activities; they easily learn psychomotor skills, language skills and social skills and can later apply the knowledge gained effectively. This theory is also related to this work in that, instruction has to be of quality in order to target the upper limit of the ZPD and produce profound learning in the cognitive, affective and psychomotor domains without which learners cannot apply the knowledge acquired.

Bloom et al (1956) Taxonomy of Educational Objectives

Work on the cognitive domain was completed in the 1950s and is commonly referred to as Bloom's Taxonomy of the Cognitive Domain (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). Others have developed taxonomies for the affective and the psychomotor domains. The major idea of the taxonomy is that what educators want students to know (encompassed in statements of educational objectives) can be arranged in a hierarchy from less to more complex. The levels are understood to be successive, so that one level must be mastered before the next level can be reached. The original levels by Bloom et al. (1956) were ordered as follows: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

Anderson and Krathwohl (2001) and Krathwohl (2002) revised Bloom's taxonomy to fit the more outcome-focused modern education objectives, including switching the names of the levels from nouns to active verbs, and reversing the order of the highest two levels. The lowest-order level (Knowledge) became **Remembering**, in which the student is asked to recall or remember information. Comprehension became **Understanding**, in which the student would explain or describe concepts. Application became **Applying**, or using the information in some new way, such as choosing, writing, or interpreting. Analysis was revised to become **Analyzing**

requiring the student to differentiate between different components or relationships, demonstrating the ability to compare and contrast.

This theory is related to this research in that, biotechnology knowledge can be learnt cognitively by the learners being able to store large amounts of knowledge in their long term memory. The learners learn psychomotorly by being involved in class and practical activities in which they manipulate materials and equipment. The learners learn affectively by developing interest in the subject especially during collaborative activities. In this case, the learners are holistically trained and can therefore apply the knowledge appropriately. The levels of Bloom's taxonomy involved in this study are two of the simple cognitive levels which are knowledge and comprehension and three of the complex levels which are application, synthesis and evaluation.

Theory of Critical thinking & problem solving:

Garrison (1992) developed a theory of critical thinking as a problem solving process in five stages: Problem identification; problem definition; Problem exploration; Problem applicability and Problem integration. These five steps are explained by Henri (1991) as critical reasoning skills shown in the table below

Table 1.0: The five Staged theory of Critical thinking & problem solving

Garrison's CT stages	Henri's critical reasoning skills
1. Problem identification a triggering event arouses interest in a problem	Elementary clarification observing or studying a problem, identifying its elements, observing their linkages
2. Problem definition define problem boundaries, ends and means	In-depth clarification analysing a problem to understand its underlying values, beliefs and assumptions
3. Problem exploration ability to see to heart of problem based on deep understanding of situation	Inference admitting or proposing an idea based on links to admittedly true propositions
4. Problem applicability evaluation of alternative solutions and new ideas	Judgement making decisions, evaluations and criticisms
5. Problem integration acting upon understanding to validate knowledge	Strategies for application of solution following on choice or decision

Robert J Sternberg's (1998) Triarchic Theory of Human Intelligence

According to this theory, creativity is a balance among three forms of thinking which are:

- 1. Analytical thinking:** It involves critique, judge; compare/contrast; evaluate and assess.
- 2. Creative thinking:** It involves assess, discover, imagine, suppose and predict.
- 3. Practical thinking:** It involves every day problem solving.

Howard Gardner's (1983) 8 intelligences

According to Howard Gardner, intelligence can be seen in the following specific areas: Linguistic intelligence; Logic/mathematical intelligence; Musical intelligence; Spatial intelligence; Bodily/Kinaesthetic intelligence; Interpersonal intelligence; Intrapersonal intelligence; Naturalistic intelligence and Existential intelligence (ability to use intuition to understand one's environment).

The theories of critical thinking, problem solving and creativity have an impact on this research work since the indicators of biotechnology knowledge application are critical thinking, problem solving and creativity.

METHODOLOGY**Research Design**

The research design that was adopted for this study was the Pretest-Posttest experimental research design. Padidar (2013) defined experimental research design as observation under controlled conditions which is concerned with examination of the effect of the independent variable on the dependent variable where the independent variable is manipulated through treatment or intervention(s), and the effect of those interventions is observed on the dependent variable.

Padidar (2013) defined the pretest-post-test design as the design in which subjects are randomly assigned to either the experimental group or the control group and the effect of the dependent variable on both groups is seen before the

treatment (pretest) and later, the treatment is carried out on the experimental group only, and after treatment, observation of the dependant variable is made on both the groups to examine the effect of the manipulation of the independent variable on the dependant variable.

Target Population

The target population of the study consisted of Upper Sixth Science high school students in the North West and South West Regions of Cameroon and the displaced North West and South West students in the Littoral Region in the 2018/2019 academic year.

Sample of the Study

The sample size was 72. This was because sample sizes for experimental studies are usually small to enable proper handling of the experiment. The sample of the study was 72 Upper Sixth Science students who offer biology (36 students for the experimental group and 36 students for the control group). Out of the 36 students from both the experimental and control groups, 18 were males and 18 were females making a total of 36 males and 36 females for the whole experiment. The sample was obtained from one government school, one mission school and one lay private school in each region. In the North West Region, 12 students were sampled 6 males and 6 females.

Sampling Technique

The sampling method or sampling technique of this study was both the probability sampling and the non-probability sampling. The difference between nonprobability and probability sampling is that nonprobability sampling does not involve random selection and probability sampling does. Probability sampling ensures that all individuals have equal chance of being selected. The nonprobability sampling does not give individuals equal chance of being selected.

For the nonprobability sampling, the purposive sampling was used to select the Government, Mission and Lay Private schools where there were Biology-Chemistry and Food Science Laboratories. This was done so that the food products should be produced in the Food Science Laboratory while the drugs and other products should be produced in the Biology and Chemistry Laboratories.

For the probability sampling, the stratified random sampling was used in order to select male and female students from Government, Mission and Lay private schools and from the North West, South West and the Littoral Regions. The sample was made up of 72 students (36 males and 36 females).

Instrumentation

Test

Since the study was experimental and therefore a quantitative study, a pretest was administered to both the experimental group made up of 36 students and the control group was also made up of 36 students. The treatment was given to the experimental group. The post test was administered to both the experimental group and the control group.

DESCRIPTIVE STATISTICS

The descriptive statistics were the means, standard deviations, bar charts and pie charts for the test and the questionnaire administered.

The pretest and the posttest were parallel tests which contained three sections each. Section one covered 20 MCQ questions for a time frame of 40 minutes scored for 20 marks. Section two covered short answer essay questions for a time frame of one hour 30 minutes scored for 50 marks. Section three covered application of biotechnology knowledge (practical work) in which the students produced valuable products using the materials and equipment provided for a time frame of four hours scored for 30 marks.

The Ekwale Ada's Inventory for the grading of biotechnology practical activities was developed by the researcher and used to grade the practical part of the test in the laboratory.

Questionnaire

The researcher also developed another inventory which was a questionnaire containing 04 questions two negative and two positive and created its grading system which was used to investigate biotechnology instruction and biotechnology knowledge application.

Method of Data Collection

Tests were administered and data collected through, pretest-posttest. On the first day, section one and two of the pretest were administered on both the experimental group and the control group made up of 36 students each. On the second, third, fourth, fifth and sixth days, section three, was administered. The treatment was given to the experimental group for four school weeks. Then the posttest was administered on the experimental group and the control group for one week after the treatment. A total of six weeks were used for the experiment. Upon arrival at each school, the researcher presented herself to the head of the institution and she was granted access into the school which facilitated the administration of the treatment and the instruments. The experimental group was taught in GHS Mamfe (South West Region). The control group was taught in Progressive Comprehensive High School in Bamenda (North West Region).

Method of Data Analysis

Both descriptive and inferential statistics were used for data analyses. For descriptive statistics, means, standard deviations, pie charts and bar charts were used. For inferential statistics, the Independent t test was used to analyse the data. Before the data were collected through tests, participants were informed of the nature of the study, and reassured of anonymity and confidentiality as such, their names were not mentioned on the test papers.

FINDINGS

Hypothesis Ho: There is no significant difference in problem solving in biotechnology between students taught with the Ekwale Ada's model and those who were taught without using the model.

Ha: There is a significant difference in problem solving in biotechnology between students taught with the Ekwale Ada's model and those who were taught without the model. This hypothesis is analysed in two sections:

Table 2.0: Means and Standard deviations of problem solving, considering the test administered before treatment

T e s t A d m i n i s t e r e d	No. of respondents	No of sections	M e a n	Std. Deviation
P r o b l e m S o l v i n g				
E x p e r i m e n t a l G r o u p	3 6	3	2 1 . 8 6	4 . 0 1
C o n t r o l G r o u p	3 6	3	2 0 . 6 1	3 . 5 7

Table 3.0: Means and Standard deviations of problem solving, considering the test administered after treatment

T e s t A d m i n i s t e r e d	No. of respondents	No of sections	M e a n	Std. Deviation
P r o b l e m S o l v i n g				
E x p e r i m e n t a l G r o u p	3 6	3	7 5 . 9 7	3 . 3 1
C o n t r o l G r o u p	3 6	3	2 4 . 8 6	4 . 0 9

Table 4.0: Means and Standard deviations of problem solving, considering the Questionnaire administered before treatment

Q u e s t i o n n a i r e A d m i n i s t e r e d	No. of respondents	No of Items	M e a n	Std. Deviation
P r o b l e m S o l v i n g				
E x p e r i m e n t a l G r o u p	3 6	4	7 . 7 5	2 . 4 2
C o n t r o l G r o u p	3 6	4	7 . 3 6	2 . 1 8

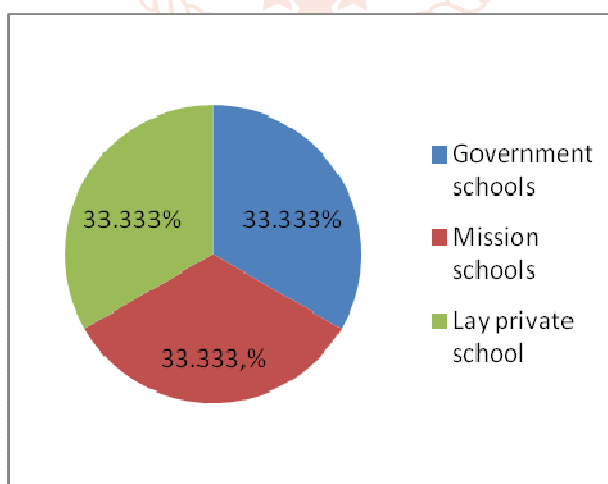
Table 5.0: Means and Standard deviations of problem solving, considering the Questionnaire administered after treatment

Q u e s t i o n n a i r e A d m i n i s t e r e d	No. of respondents	No of Items	M e a n	Std. Deviation
P r o b l e m S o l v i n g				
E x p e r i m e n t a l G r o u p	3 6	4	1 8 . 0 0	3 . 1 5
C o n t r o l G r o u p	3 6	4	9 . 9 4	2 . 1 9

Table 6.0 Description of sample according to schools attended in the experimental group

School Attended	Sample	Percentage (%)
Government schools	12	33.333
Mission schools	12	33.333
Lay private school	12	33.333
Total	36	100.0

Description of Sample Characteristics Experimental Group

**Fig. 2.0: Pie-chart illustrating information on table 6.0****Table 7.0: Description of Sample of Control Group According to School Attended**

School Attended	Sample	Percentage (%)
Government schools	12	33.333
Mission schools	12	33.333
Lay private school	12	33.333
Total	36	100.0

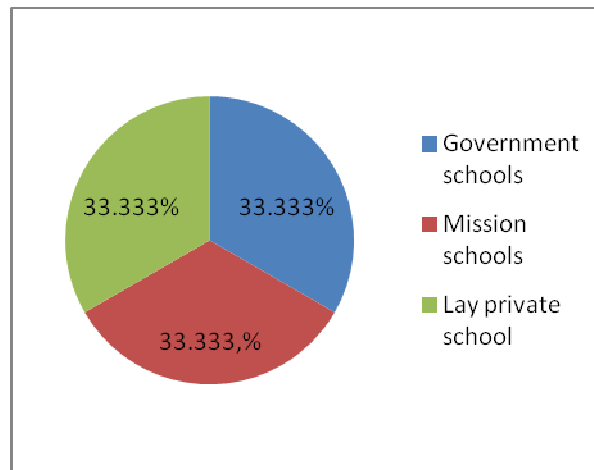


Fig. 3.0: Pie-chart illustrating information on table 7.0

Results on tables 6 and 7 including figure 2 and figure 3 show that the sample in the experimental and control groups each had equal representation from government, mission and lay private schools. That is 33.333% each for government, mission and lay private schools.

Experimental Group

Table 8.0: Description of sample according to gender in the experimental group

Gender	Sample	Percentage (%)
Females	18	50.0
Males	18	50.0
Total	36	100.0

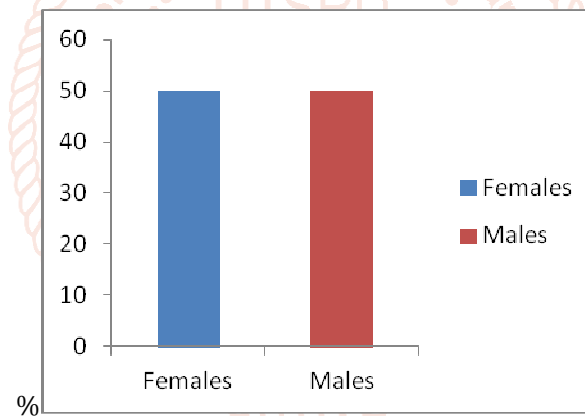


Fig. 4.0: Bar charts illustrating information on table 8.0

Control Group

Table 9.0: Description of sample according to gender in the control group

Gender	Sample	Percentage (%)
Females	18	50.0
Males	18	50.0
Total	36	100.0

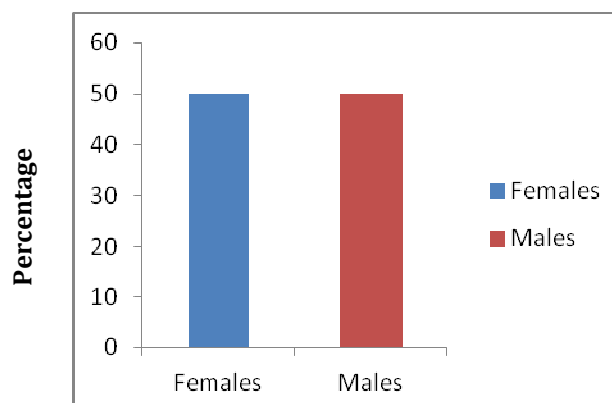


Fig. 5.0: Bar charts illustrating information on table 9.0

Results on table 8 and 9 including fig. 4 and 5 show that the sample in the experimental and control groups each had equal representation of females and males. That is 50.0% of their respective samples.

Experimental Group

Table 10.0: Description of sample according to region in the experimental group

Region	Sample	Percentage (%)
North West	12	33.333
South West	12	33.333
Internally displaced North West	06	16.666
Internally displaced South West	06	16.666
Total	36	100.0

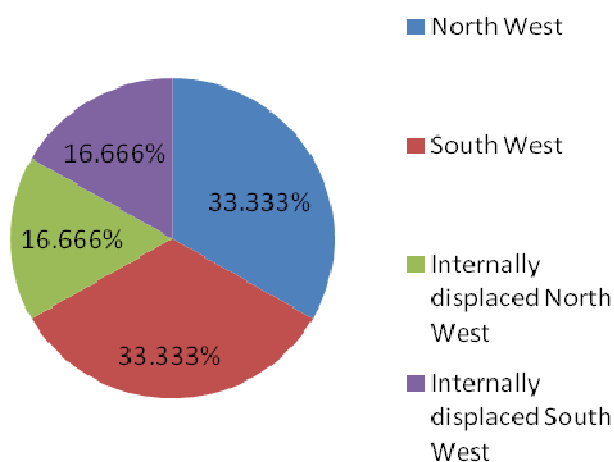


Fig. 6: Pie chart illustrating information on table 10

Control Group

Table 11.0: Description of sample according to Region in the control group

Region	Sample	Percentage (%)
North West	12	33.333
South West	12	33.333
Internally displaced North West	06	16.666
Internally displaced South West	06	16.666
Total	36	100.0

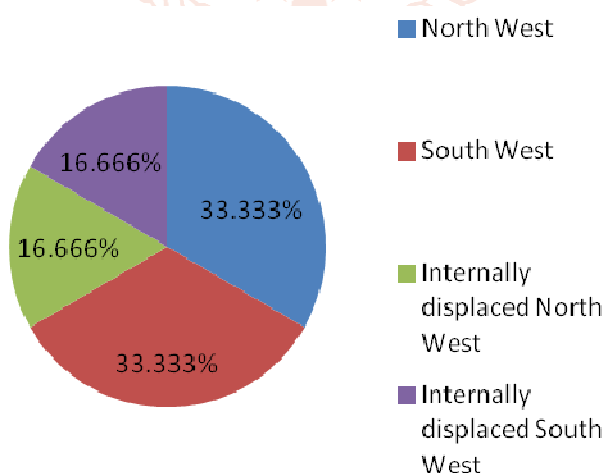


Fig. 7: Pie chart illustrating information on table 11

Results on table 10 and 11 including figures 6 and 7 show that, the sample in the experimental and control groups each had equal representation as far as regions are concerned. North West and South West Regions each had a representation in each group of 33.333%. The internally displaced in each of the two regions was 16.666%.

The sample characteristics therefore as analysed from tables 06 to 11 and represented on figures 2 to 7 show each group had identical representation for the stated characteristics of type of school attended, gender, and region in all respect.

INFERENTIAL STATISTICS**Nominal Data****Table 12: Nominal description of Pre-test Results for Problem Solving**

Treatment in view	Group	Performance	Sample
Problem solving	Experimental group	Passed	-----
		Failed	36
	Control Group	Passed	----
		Failed	36

The pre-test was scored on a maximum performance of 100. A pass was rated at 50/100. From this rate, the nominal results of the pre-test shows that for both the experimental and control groups, before the application of the treatment, no student passed when problem solving was scored. All failed at the pre-test level.

Table 13: Nominal Description of Post-Test Results for Problem Solving

Treatment applied	Group	Performance	Sample
Problem solving	Experimental group	Passed	36
		Failed	-----
	Control Group	Passed	-----
		Failed	36

Results on Table 13 show that, when the treatments of problem solving was applied, the posttest results proved that, the entire sample in the experimental group passed, while those in the control group all failed.

Table 14: Nominal Description of Pre-test Responses for the Questionnaire in relation to Problem Solving

Before treatment of the following	Group	Performance	Sample
Problem solving	Experimental group	Passed	02
		Failed	34
	Control Group	Passed	01
		Failed	35

Results on Table 14 show that scores emanating from the pre-test responses for the questionnaire indicated that, before treatments were applied, those who scored in their responses above 50% were as follows; two students for the experimental and one student for the control group in problem solving. The scores for the responses were rated at a maximum of 24.

Table 15: Nominal Description of Post-Test Responses for the Questionnaire in Relation to Problem Solving

After Treatment of the Following	Group	Performance	Sample
Problem solving	Experimental group	Passed	36
		Failed	----
	Control Group	Passed	02
		Failed	34

Results on Table 15 show that the responses on the questionnaire for the experimental group registered a significantly overwhelming pass rate of (36 on 36) than for the control group (02 on 36). For problem solving, 2 students scored below 50% mark.

Hypothesis Analysis**The hypothesis was analysed in two sections:**

The pretest and posttest results for problem solving for the experimental group and the control group were compared using the independent t-test. This is to ensure that the two groups were at the same level before the experiment and after the treatment the post test results were also compared for the two groups, to establish whether the use of the Ekwale Ada model had an impact on the students using the independent t-test.

The independent variable in this hypothesis was test groups, while the dependent variable was the students' performance in the test for problem solving.

Group 1: Experimental Group**Group 2: Control Group**

The scores of the dependent variable were got from the scores recorded from the problem solving test which was administered to the students before and after the administration of the model. The statistical analysis technique used to test this hypothesis was the independent t-test. The result of the analysis was presented in Table 4.6

Table 4.6: Independent t-test analysis of difference between Control Group and Experimental Group in the pretest and posttest results of the problem solving test which was administered (N=72)

Groups in experiment on problem solving	N	M	e	a	n	S	D	t - value
Experimental Group before treatment	3	6	2	1	. 8 6	4	. 0 1	
								1 . 4 0
Control Group before treatment	3	6	2	0	. 6 1	3	. 5 7	
Experimental Group after treatment	3	6	7	5	. 9 7	3	. 3 1	
								5 8 . 2 8 *
Control Group after treatment	3	6	2	4	. 8 6	4	. 0 9	

* $p < 0.05$, $df = 70$; critical $t = 1.97$

The result of the analysis in table 4.6 reveals that the calculated t-value of 1.40 is lower than the critical t-value of 1.96 at 0.05 levels of significance with 70 degrees of freedom. With this result the null hypotheses was retained and alternative rejected for the problem solving skills before treatment. This means that there is no significant difference in the students' problem solving skills between the control group and the experimental group before the administration of the Ekwale Ada's Model.

After the treatment was administered the calculated t-value of 58.28 is higher than the critical t-value of 1.96 at 0.05 levels of significance with 70 degrees of freedom. With this result the null hypotheses was rejected and alternative retained for the problem solving skills after treatment. This means that there is a significant difference in the students' problem solving between the control group and the experimental group after the administration of the Ekwale Ada's Model. A further examination of the difference revealed that the experimental group on whom the treatment was administered performed better (mean=58.28) than the control group on whom the treatment was not administered.

Summary of Findings

There is a significant difference in problem solving in biotechnology between students taught with the Ekwale Ada's model and those who were taught without the model. The experimental group on whom the treatment was administered performed better (mean=58.28) than the control group (1.40) on whom the treatment was not administered.

REFERENCES

- [1] Adams, M.I. (2001). Thinking Skill Curricular. Their Premise and Progress, Educational Psychologist, 24, 25-77 In Endeley, M.N, and Kintati, R.S. (2017). Teaching Practices which Influence Higher Order Thinking Skills. European Journal of Education Studies.
- [2] Adebola, S.I. (2011). The Effect of Behavioural Objectives on students' Achievement in Senior Secondary School Mathematics Instructions when used As Advance <http://www.Scihub.Org/AJSIR/PDF/2011/2AJSIR-2-2-129-135.pdf> 18/10/2016 at 05:33 a.m.
- [3] Adedayo, O. (1988). Instructional Objectives: What Effect do they have on Students' Attitudes? Towards Integrated Science? Online Library. Wiley. Com/doi/10.1002/tea.
- [4] Adenle, S.O. (2005). Funding Technical Education for Sustainable Youth Employment. Journal of Nigerian Association of Teachers of Technology 5,302-305. Journal of Academic Research in Progressive education and Development (4). In Akon, E.O. Curriculum and Teaching in Nigeria. Calabar. The CIRN press Limited.
- [5] Adenle, S.O., and Uwameiye, R., (2012). Issues in Utilization of Equalization of Educational Opportunities: Implications for Peace Education in Nigeria. International Journal of Academic Research in Progressive Education and Development (4). In Akon, E.O. Curriculum and Teaching in Nigeria. Calabar. The CIRN press Limited.
- [6] Ahidjo, A. (1967). "Discourse d'ouverture de la Réunion du Conseiller l'enseignement Supérieur, 31 mai 1967" in Amadou, Ahidjo (1980), Anthologie de Discourse, 1957-1979 (PP.761- 766). Dakar. Les Nouvelles Edition Africaines. In Tambo, L.V (2012). Principles and Methods of Teaching. (2nd edition) Limbe: ANUCAM.
- [7] Agboola, O.S and Oleyede, E. O (2007) Effects of Project, Inquiry and Lecture Demonstration Teaching Methods on Senior Secondary Students' Achievement in Separation of Mixtures Practical Test. Educational Research Review Vol.2 (6) Pp 124-132, June, 2007. <http://www.academicjournals.org/ERR>. 13/08/2018 at 18:32pm.
- [8] Agborbechem, P.T. (2006). Curriculum Structure and the Cameroonian Labour and Industrial Market. International Journal of English Language Teaching Vol.4, No.3, pp.23-33, March 2016. Retrieved from www.eajournals.org/.../Curriculum-Structure-and-the-Cameroonian-Labour-and-Industrial-Market.pdf. 15/08/2018 at 10:40 am.
- [9] Ajaja, O.P. (2013). Which Strategy best Suits Biology Teaching? Lecturing, Concepts Mapping, Cooperative Learning or Learning Cycles? Electronic Journal of Science Education. Vol 17 N^o 1(2013). In ejse.southwestern.edu/article/view file/11522/8115.17/10/2016 at 09:13am.
- [10] Alazzi, K. (2008). Teachers' Perception of Critical Thinking: A Study of Jordanian Secondary School Social Studies Teachers. The Social Studies, 99(6)2008. Pp 243-248. Cross Ref. View in Record in Scopus. Google scholar on the 10/12/2019 at 10:21 am.
- [11] Alibali (2006). Instructional Scaffolding to Improve Learning. Northern Illinois University. Retrieved from <https://www.niu.edu>strategies> on the 07/12/2019 05:40 am.
- [12] Aschenbrener; M., Terry, R. and Torres, R.M. (2010). Creative and Effective Teaching Behaviours of University Instructors as Perceived by Students.

- Retrieved from <https://www.researchgate.net/public.08/08/2018> at 12:15pm.
- [13] Ashwin, P. (2009). Analyzing Teaching Learning Interactions in higher education: Accounting for Structure and Agency. London: Continuum. In South African Journal for open and Distance learning and practice (progress) vol.35 No 2 2013. UNISA (University of South Africa).
- [14] Astin, A.W (1984) Student Involvement. A Developmental Theory for Higher Education. Journal of College Student Development. 25 Pp297-308 in Trowler, V. (2010). Student Engagement Literature.
- [15] Astin, A.W (1993). What matters in College? Four critical years revisited. San Francisco: Jossey- Bass in Trowler V. (2010). Student engagement Literature review.
- [16] Asimow, J. (2015). Scaffolding for Problem Solving- - Math at Home. Retrieved from <https://mathathome.org/scaffolding> on the 06/12/2019 at 03:30 am. <http://doi.org/10.1016/j.abspro.2014.01.321>. At 7:00pm on 06/08/2018.
- [17] Battaglia, M. (2018). Test Performance and Remedial Education: Good News for Girls. Retrieved from Conference.iza.org>Battaglia on the 08/12/2019 at 05:00 am.
- [18] Barringer, C. And Gholson B. (1979) Effects of Type and Combination of Feedback upon Conceptual Learning by Children: Implications for Research in Academic Learning. Review Of Educational Research 49(3): 459-478.
- [19] Barel, J. (2006) Teaching for Thoughtfulness: Classroom Strategies to Enhance Intellectual Development. New York: Longman in Endeley, M.N and Kintati R.S (2017).
- [20] Berger, J. B. and Milem, J.F (1999). The Role of Students Involvement and Perceptions of Integration in a Causal Model of Students Persistence. Rrsume in higher education. 40(6)<http://arizonapiveelsever.com/./the-role-of-student-involvementandperception-of-interhration>. 13/08/18 at 16:38pm
- [21] Batzer, L.A. (1997). The Impact of Remedial Classes on Performance. Retrieved from <https://scholar.najah.edu/files> on the 08/12/2019 at 04:39 am.
- [22] Baylor, A.L and Ritchie, D. (2002) What Factors Facilitate Skills, Teaching Morale and Perceive Students Learning in Technology Using Classrooms? Computer and Education 39, 395-414. In Endeley, M.N., and Kintati R.S., (2017).
- [23] Bell, R.M. and Pavitt, K. (1993). Technological Accumulation and Industrial Growth: Contrasts between Developed and Developing countries. Industrial and Corporate change, 2(2).
- [24] Bloom, B.S (1976). Human Characteristics and School Learning. New York: Mc Graw-Hill. Review of Educational Research 49(3) : 459-478. Retrieved from <http://www.sciencedirect.com/science/article.pii/518770428/002/53>. At 23:30 on 27/7/2018.
- [25] Bloom, B., Englehart, M. Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of Educational objectives: The classification of educational goals. Handbook I: Cognitive Domain. New York, Toronto: Longmans, Green.
- [26] Bloom, B.S (1976). Human Characteristics and School Learning. New York: Mc Graw-Hill. Review of Educational Research 49(3) : 459-478. Retrieved from <http://www.sciencedirect.com/science/article.pii/518770428/002/53>. At 23:30 on 27/7/2018.
- [27] Blyth, K. (2010) Effectiveness of Using Inquiry Based Instruction to Increase Students Performance in High School Biology at Bardwell Institute. <http://digitalcommons.odu.edu/gi/viewcontent.cgi?article.projects.13/08/2018> at 17:32pm.
- [28] Boylan, H.R; (2012). Exploring Alternatives to Remediation- Welcome/National Center for Developmental Education- Appalachian State. Retrieved from <https://ncde.appstate.edu/files>. On the 08/12/2019 at 03:01 am.
- [29] Braun, N.M. (2004). Critical thinking in business curriculum. Retrieved from ajet.org.au on the 06/12/2019 at 02:00 am.
- [30] Brophy, J. (1987). Synthesis of Research on Strategies for Motivating Students to Learn. Educational leadership 5: (oct): p 40-48.
- [31] Camison, C. and Fores, B. (2010). Knowledge absorptive capacity: New insights for its conceptualization and measurement. Journal of Business Research, 63:707-715.
- [32] Cheong, C.M; & Cheung, W.S. (2008). Online Discussion and Critical thinking Skills: A case study of Singapore Secondary School. Australian Journal of Education. Retrieved from ajet.org.au on the 06/12/2019 at 02:45 am.
- [33] Chickering, A.W. and Gamso, Z. (1987). Seven Principles for Good Practice in Undergraduate Education. Retrieved from <http://eric.ed.gov//id=ERICED282491>. 13/08/2018 at 16:40pm.
- [34] Chikwature, W. & Oyedele, V. (2016). The Impact of Remediation in the Teaching and Learning of Map Work in Geography Subject at ZJC Level: A Case of Marange High School. Retrieved from <https://www.researchgate.net/3301> at 08/12/2019 at 02:50 am.
- [35] Clark, R.M. (2017).Scaffolding to Support Problem Performance in a Bioengineering Lab. A Case Study- IEEE Journals & Magazine. Retrieved from
- [36] Collins, A; Brown, J.S; & Holum (1991). Cognitive Apprenticeship. Making Thinking Visible. American Educator (Winter) 15(1991).Pp 6-1138-46. Retrieved in Google scholar on the 10/12/2019 at 10:24 am. <https://ieeexplore.ieee.org/document>. On the 07/12/1019 at 01:58 am.
- [37] Cooper, J. (1995). Cooperative Learning and Critical Thinking. Teaching of Psychology, 22(i)(1995). Pp 7-9. Google scholar on the 10/12/2019 am.

- [38] Creemers, B.P & Kyriakides, L. (2006) Critical Analysis of the Current Approaches to Modeling Educational Effectiveness: The Importance of Establishing a Dynamic Model, School Effectiveness and School Improvement, 17(3), 347-366 in Endeley M.N and Kintati R.S (2017)
- [39] Csikszentmihalyi, M. (1996). Creativity: Flow and the Psychology of Discovery and Invention. Harper Collins Publishers: New York, NY. <https://digitalauthorshipuri.files.wordpress.com/Csikszentmihalyi>.
- [40] Darling-Hammond, L. (2019). Implications for educational Practice of the Science of Learning and development: Applied Developmental Science. Retrieved from <https://www.tanfonline.com>>full on the 07/12/2019 at 03:45 am.
- [41] Darling-Hammond, L. (2008). Introduction: Teaching and Learning for Understanding. Powerful Learning: What We Know about Teaching for Understanding. (Pp. 1-9.) San-Francisco, C.A: Jessey-Bass. <http://galideo.org/focus-on-inquiry-lit-review> Pdf. 12/08/2018 at 08:21am
- [42] Dee Castle, T. (2014). The Impact of Cooperative Learning on the development of needs for Cognition Among First Year College Students. Retrieved from <https://ir.uiowa.edu/cgi/viewcontent>. Cgi/article=54788content=etd 12/08/2018 at 15:21pm
- [43] Dettaan, R.L. (2019). Teaching Creativity and Inventive Solving in Science- NCBI. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc> on the 10/12/2019 at 10:41 am.
- [44] Doise, W. and Mugney G. and Peret-clermont, A.N. (1975). Social European Journal of Social Psychology 9, (5) 3. In Akon, E.O. Curriculum and Teaching in Nigeria. Calabar. The CIBN press Limited.
- [45] Donovan, J.J., Leonard, S., & Stanne, M.E. (1999). Effects of Small Group Learning on Undergraduates in Science, Mathematics, Engineering and Technology: A Meta-Analysis. Review of Educational Research. SAGE Journals. Retried from <https://doi.org/10.3102/00346543069001021> on the 23/01/2020 at 04.00 am.
- [46] Druker, P., (1994). The Age of Social Transformation. The Atlantic Monthly, November 1994. In Hood, P., (2002). Perspectives of Knowledge Utilization in Education. San Francisco. 4-West. Ed. <http://www.West.ed.org>. Retrieved on 17/10/2016 at 10:20 am.
- [47] Duckworth, E. (1990). Science Education: A mind on Approach for the Elementary years. Hillsdale, NJ: (Laurence Erlbaum.
- [48] Dudley, J.H. (1971). The Effect of Behavioural Objectives on Student Achievement in College
- [49] Eggen and Kauchak (2001). [https://WWW.2.K1zalbemarle.Org/acps/divisions/tq/pages/Appendix-D instructional Models- Teaching Content and Thinking – skills.aspx](https://WWW.2.K1zalbemarle.Org/acps/divisions/tq/pages/Appendix-D%20instructional%20Models-Teaching%20Content%20and%20Thinking-skills.aspx).
- [50] Eley, M.S and Norton, P. (2004). The Structuring of initial descriptions in the Teaching of Procedures. Internal Journal of Math Education, Science and Technology, 35(6) in www.learn.c.org/ip/pages/518 No learn.c.org/IP/pages/5181 notere f1.On 15/10/2016 at 18:00p.m.
- [51] Ellis, E.S and Worthington, L.A (1994) Research Synthesis on Effective Teaching Principles and the Design of Quality Tools for Educators. University Of Oregon: National Centre to Improve the Tools of Educators. <http://people.uncw.edu/kozloff/scaffolding.pdf>. On 29/07/2018 at 15:10pm.
- [52] Endeley, M.N and Kintati, R.S (2017) Teaching Practices Which Influence Higher Order Thinking Skills and Creativity Such As Critical In Secondary Schools in the North West Region of Cameoon. European Journal of Education Studies. [http://www.google.com/teaching practices-which-influence-higher order skills](http://www.google.com/teaching-practices-which-influence-higher-order-skills). Retrieved on 05/08/2018 at 07:17am.
- [53] Eno, M. (2019). Impact of Remedial Teaching on ESL/EFL Low Achievers. AN Arabian Gulf Experience. Retrieved from <https://www.researchgate.net>>3301 on the 08/12/2019 at 04:58 am.
- [54] Etzkowitz, H, Ranga, M, Benner, M. Guarany, L., Maculan, A. and Kneller, R. (2008). Pathways to the Entrepreneurial University: towards a global convergence science and Public policy, 35 (9): 681-695.
- [55] Fennell, H.A. (1992). Students' Perceptions of Cooperative Learning Strategies in Post-Secondary Classrooms. (ERIC Document in post-secondary education. Youth Studies Australia, 12(4), 41-46. In Goyak, A. (2009). The Effects of Cooperative Learning Techniques.
- [56] Ford, W. (2014). Students' Inquiry and Critical Thinking. <http://www.nwmissouriedu/library/researchpapers/2015/ford,%20William.Pdf>. 12/08/2018 at 11:13am.
- [57] Foster, J. S. And Lemus, J. D. (2015) Developing the Critical Thinking Skills of Astrobiology Students through Creative and Scientific Inquiry. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4290794>. 12/08/2018 at 09:33am.
- [58] Freeman, C, (1987). Technology and Economic performance: lessons from Japan. London Pinter.
- [59] Freeman, S; Eddy, S.L.; Mc Donough, M., Smith, M.K.; Okorafor, N; Jordt, H & Wenderoth, M.P. (2014). Active Learning Increases Students Performance in Science. Retrieved from <https://serccarleton.edu/sp/ierary/.../rationale.html>. 13/08/2018 at 07:09am.
- [60] Frederick, M.L. (2014). Scaffolding Techniques in Problem Solving. <https://files.eric.ed.gov/fulltext> on the 06/12/2019 at 03:33 am
- [61] Frederick, W. and Walberg H. (1980). Learning As a Function of Time. Journal Of Educational Research 73: 183-194. <http://model.umons.ac.be/plungifile.php/168300/model-folder/intro/slavinmodelQAiT>.

- [62] Friedel, C.; Irani, T.R.; Rudd, R.; Gallo, M.; Eckhardt, E. and Ricketts, J.(2008). Overtly Teaching Critical Thinking and Inquiry –Based Learning: A Comparison of two Undergraduate Biotechnology Classes. Retrieved from <http://www.jae-online.Org/attachments/Friedel-et-al-49172-84.pdf>. 12/08/2018 at 12:15pm.
- [63] Fuchs, L.S; Powell, S.R. & Zumeta, R.O. (2009).Remediating Number Combination and Word Problem Deficits Among Students with Mathematics Difficulties: A Randomised Control Trial. Journal of Educational Psychology. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc> on the 08/12/2019 at 04:15 am.
- [64] Gage, N. and Berliner, D., (1992). Educational Psychology (5th ed). Princeton, New Jersey: Houghton Mifflin Company in http://www.edpsycinteractive.org/papers/model_tch.html. 17/10/2016 at 21:46 p: m.
- [65] Gokhalo, S. (1995) Full Text of Bulletin of the Deccan College Research Institute Vol 18. <http://archive.org/201598337.Bulletin-of-the-deccan-college-research-institute>. In Endeley M.N
- [66] Goodsell, a. s, Maher, M.R. and Tinto, V. (1992). Teamwork and Cooperative learning in Technical 6p- Eric-US. Retrieved from files.eric-ed.gov/fulltext/ED398398.PDF. 13/08/2018
- [67] Goyak, A. (2009). The effects of cooperative learning techniques on Perceived Classroom Environment and critical thinking skills of pre service teachers. Retrieved from <https://digitalcommons.library.edu/cgi/viewcontent.cgi?article=1166>. 12/08/2018 at 13: 22pm
- [68] Grasha, A.F. (1996). Teaching with style. <https://ilteach.com/what/teachers-teach/teaching-methods>. 15/10/2016 at 13.48a.m.
- [69] Gupta, G. (2005). Improving Students' Critical Thinking Logic and Problem Solving Skills. Journal of College Science Teaching. 34(4)(2005). Pp 48- 51. Google Scholar on the 10/12/2019 am.
- [70] Hake, R. R. (1998) Interaction- Engagement versus Traditional Methods: American Journal of Physics, 66, 64. Retrieved from www.montana.edu/misse/Data.doi:10.1119/1.18809. view online. 13/08/2018 at 07:14am.
- [71] Hendrickson (2017). Influence of Additive Manufactured Scaffold Architecture on the Distribution of Surface Strains and Fluid. Retrieved from <https://www.frontierin.org/full> on the 07/12/2019 at 04:00 am.
- [72] Hiebert, J.D. Wearne and S.Taber (1991). Fourth Graders' Gradual Construction of Decimal Fractions during Instruction Using Different Physical Representations. Elementary School Journal 91: 321-341.<http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodel.QAIT>.
- [73] Hmelo-Silver, C.E., Duncan, R.G., and Chinn, C.A. (2007). Scaffolding and Achievement in problem-based and Inquiry Learning. A Response to kirschner, Sweller and Clark (2006). Educational Psychology Review, 16(3). Pp 235-266. In www.lbo.org/globalassets/publications/ibresearch/approaches-to-learning.pdf. on 17/10/2016 at 19:03 p.m.
- [74] Hodson, D. (1990). A critical look at pratical work in school science. School science review, vol 70(no 256, pp, 33-40, in WWW. Unifield foundation. Org/ practical work-learning/ teaching – and learing –suing practical work. 15/10/2016 at 21.05 p.m.
- [75] Hu, D. (2006). The Effects of Scaffolding on the Performance of students in a Biology Achievement Test. Retrieved from <https://pdfs.seniahitscholar.org/> on the 07/12/2019 at 05:11 am.
- [76] Gelder, T.V. (2001). How to Improve Critical Thinking Using Educational Technology and Scaffolding. Retrieved on 06/12/2019 at 02:30 am
- [77] Glaser, R. (2012) Model of Effective Instruction. <http://www.slideshare.net-AileenAsim>.
- [78] Guleker, R. (2015) “Albanian Pre Service Teachers' Perspectives on Critical Thinking Dispositions”. Proceedings of Teaching and Education Conferences. Retrieved From <http://ideasrespect.org/p/sek/tepno/2905314>. On 06/08/2018 at 11:39pm.
- [79] Kara, M.W. (2012).The Effects of an Instructional Model Utilizing Hands-on Learning and Manipulatives on Maths Achievement of Middle Schools Students in Georgia. Digital Commons Liberty.edu/cgi/viewcontent.cgi? Article, 1653 and Content, doctoral.17/10/2016 at 13:58 p.m.
- [80] Karweit, N.L (1989). Time and Learning. A Review in School and Classroom Organisation, Ed. In R.E. Slavin, Hillsdate, Nj: Erbaum. 69-95. <http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodel.QAIT>
- [81] Kazempour, E. (2013). The Effects of Inquiry-Based Teaching on Critical Thinking of Students. Journal of Social Issues and Humanities, 1(3), pp. 23-27. In, Ford, W. (2014). Students Inquiry and Critical Thinking. <http://www.nwmissouriedu/library/researchpapers/2015/ford,%20William.Pdf> 12/08/2018 at 11:15am
- [82] Khan, M., Niaz, M., Maqsood, A., Saeed, F. and Khan, S.A. (2012). IMPACT OF Activity- Based Teaching on Students' Academic Achievement in Physics at Secondary Level. In Academic Research International. vol 3, N^o1, July 2012. In WWW. Savap. Org. PK/ Journals\ ARInt/ vol.3(1)/2012(3.1- 19) pdf. on 17/10/2016 at 12:47 pm.
- [83] Kim, M.C. (2011). Scaffolding Problem Solving in Technology- Enhanced learning Environments (TELEs): Bridging Research and Theory with Practice in Everyday Classrooms. Retrieved on the 07/12/2019 at 03:01 am.
- [84] Kim, J. (2005).The Effects of Constructivists Teaching Approach on Students Academic Achievement, Self Concept and Learning Strategies. Asian Pacific Education Review. 6(1).7-19. In www.lbo.org/globalassets/publications/ib-research/approaches-to-learning.Pdf. on 17/10/2016 at 19:08p.m.

- [85] Knight, J.K., & Wood, W.B. (2005). Teaching more by lecturing less. *Cell Biology education*, 4(4). 298-310. Doi, 10, 1187/05-06-0082. Retrieved from www.scip.org/.../reference/References/papers.aspx? Reference iD. on 13/08/2018 AT 09:11 am.
- [86] Kozloff, M.A (2002) Three Requirements of Effective Instruction: Providing Sufficient Scaffolding, Helping Students Organize and Activate Knowledge and Sustaining High Engaged Time. <http://people.uncw.edu/thozloff/scaffolding.pdf> on 29/07/2018 at 15:33pm.
- [87] Kreizberg, A.P, and Kreizberg, C.B. (2009). Higher Order Thinking: A Business Survival Skill of the 21st Century, In Endeley M.N. & Kintati R.S (2017).
- [88] Kuh, G.D. & Vesper, N (1997). The Development of Process Indicators to Estimate Student gains. Retrieved from <https://link.springer.com/article/10.1023/A:10233/A:1024962526492> 13/08/2018.
- [89] Gage, N. and Berliner, D., (1992). *Educational Psychology* (5th ed). Princeton, New Jersey: Houghton Mifflin Company in <http://www.edpsycinteractive.org/papers/modeltch.html>. 17/10/2016 at 21:46 p: m.
- [90] Gagne, R.M., Wager, W.W., Golas. K.C. and Keller, J.M. (2005): 13/10/2016. *Principles of Instructional Design* (5th Ed). 10 Davis Drive Belmont USA: Thomson Wadsworth. 13/10/2016.
- [91] Garrison, D. L. (1992) *Self Directed Learning: Towards a Comprehensive Model*-D. R. Journals. [Sagepub.com/doi/abs/10.1177/07471369704800103](http://sagepub.com/doi/abs/10.1177/07471369704800103). 13/08/2018 Henri, T. (1991) *A Prepos d'Henri*. <http://www.cinache.com/films/a-prepos-d-henri>. 13/08/2018.
- [92] Glaser, R. (2012) *Model of Effective Instruction*. <http://www.slideshare.net/AileenAsim>.
- [93] Gokhalo, S. (1995) Full Text of Bulletin of the Deccan College Research Institute Vol 18. <http://archive.org/201598337>. Bulletin-of-the-eccan-college-research-institute. In Endeley M.N
- [94] Goyak, A. (2009). The effects of cooperative learning techniques on perceived classroom environment and critical thinking skills of pre service teachers. Retrieved from <https://digitalcommons.library.edu/cgi/viewcontent.cgi?article=1166>. 12/08/2018 at 13: 22pm
- [95] Grasha, A.F. (1996). Teaching with style. <https://teach.com/what/teachers-teach/teaching-methods>. 15/10/2016 at 13.48a.m.
- [96] Grit, L. (2001). Collaborative Creativity and Rewards: Why and How Scientists Collaborate. *International Journal of Technological Management*. Vol. 22: Issue 7-8: Pp. 762-78. Retrieved from <http://doi.org/10.1504/IJTM.2001.002990>. 08/08/2018 at 4:46pm
- [97] Guleker, R. (2015) "Albanian Pre Service Teachers' Perspectives on Critical Thinking Dispositions". *Proceedings of Teaching and Education Conferences*. Retrieved From <http://ideasrespect.org/p/sek/tepno/2905314>. On 06/08/2018 at 11:39pm.
- [98] Gupta, G. (2005). Improving Students' Critical Thinking Logic and Problem Solving Skills. *Journal of College Science Teaching*. 34(4)(2005). Pp 48- 51. Google Scholar on the 10/12/2019 am.
- [99] Hake, R. R. (1998). Interaction- Engagement versus Traditional Methods: *American Journal of Physics*, 66, 64. Retrieved from www.montana.edu/misse/Data.doi:10.1119/1.18809. view online. 13/08/2018 at 07:14am.
- [100] Haataja (2019). Teacher's Visual Attention when Scaffolding Collaborative Mathematical Problem Solving- Science Direct. <https://www.sciencedirect.com>pii>. Retrieved on the 07/12/2019 at 03:03 am.
- [101] Hasse, C. (2001). Institutional Creativity: The Relational Zone of Proximal Development. *Culture and Psychology*, 7, 199-221. In Santrock, J.W (2004). *Educational Psychology*. New York: McGraw Ill.
- [102] Henri, T. (1991) *A Prepos d'Henri*. <http://www.cinache.com/films/a-prepos-d-henri>. 13/08/2018.
- [103] Hodson, D. (1990). A critical look at practical work in school science. *School science review*, vol 70(no 256, pp, 33-40, in WWW. Unifield foundation. Org/ practical work-learning/ teaching – and learning – suing practical work. 15/10/2016 at 21.05 p.m.
- [104] Huitt, W. (1995). *A Systems Model of the Teaching| Learning Process*. *Educational Psychology Interactive*. Valdosta. G.A: College of Education, Valdosta State University Retrieved in <http://www.Edpsycinteractive.Org.Materias|tchlrnmd>. Html. 20/10/2016 at 12:00 p.m.
- [105] Justman, M., and Teubal, M. (1991). A Structuralist Perspective on the role of technology in Economic growth and Development, *World Development*, Elsevier, vol 19(9), pages 1167-1183 September. In S.A-CDUC Journal volume 10 Number 1, of March 2013.
- [106] Jacob, B.A. & Lefgren, L. (2004). Remedial Education and Student Achievement: A Reggression-Discontinuity Analysis. Retrieved from <https://www.jstor.org>stable> on the 08/12/2019 at 04:47 am.
- [107] Jarrar (2014). The Impact of Remedial Classes on the Performance of Students. Retrieved from <https://scholar.najah.edu>files> on the 08/12/2019 at 04:42 am.
- [108] Kara, M.W. (2012). The Effects of an Instructional Model Utilizing Hands-on Learning and Manipulatives on Maths Achievement of Middle Schools Students in Georgia Digital Commons Liberty.edu|cgi|view content.cgi? Article, 1653 and Content, doctoral.17/10/2016 at 13:58 p.m
- [109] Kazempour, E. (2013). The Effects of Inquiry-Based Teaching on Critical Thinking of Students. *Journal of Social Issues and Humanities*, 1(3), pp. 23-27. In, Ford, W. (2014). *Students Inquiry and Critical Thinking*. <http://www.nwmissouriedu/library/research/papers/2015/ford,%20William>. Pdf 12/08/2018 at 11:15am

- [110] Kim, J. (2005). The Effects of Constructivists Teaching Approach on Students Academic Achievement, Self Concept and Learning Strategies. Asian Pacific Education Review. 6(1).7-19. In www.libo.org/globalassets/Publications/lib-research/approachestolearning.Pdf. on 17/10/2016 at 19:08pm.
- [111] Kozma, R. (1991). Learning with Media. Review of Educational Research 61(2): 179-211 <http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodelQAiT>.
- [112] Kreizberg, A.P, and Kreizberg, C.B. (2009). Higher Order Thinking: A Business Survival Skill of the 21st Century, In Endeley M.N. & Kintati R.S (2017).
- [113] Land, M.L (1987). Vagueness and Clarity. In International Encyclopedia of Teaching and Teacher Education, ed. M.J. Dunkin. New York: Pergamon. <http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodelQAiT>.
- [114] Lyman, F. (1981). Think-pair-share-EL Education. <https://el-leducation.org/...../9DBK2W4oi489SSLmtc1ytpgF4eDLxju608HBrex.JXIZ>. 13/08/2018 at 07:19am.
- [115] Lynn, S.F., (2016). Criterion- Referenced Assessment without Measurement. How accurate for Special Education? rse. Sage pub.com | content |5/ 4|29|. Abstract. 18|10|16 at 05:22a.m.
- [116] Maddox, H. and Hoole, E. (1975). Performance Decrement in the Lecture. Educational Review 28: 17-30. <http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodelQAiT>.
- [117] Maynard, T. (2001). The Student Teacher and the Community of Practice: A Consideration of Learning as Participation. Cambridge Journal of Education, 31, 39-52 in Santrock, J.W (2004). Educational Psychology. New York: McGraw Hill.
- [118] Madhavan, B.G; Oakley, B. & Kun, L. (2009). Career Development in Biotechnology & Bioengineering. Retrieved from <https://books.google.cm>books> on the 07/12/2019 at 04:02 am.
- [119] Martin, R.W; Elliott, S; & Mumford, M.D. (2019). Errors in Creative Problem Solving: Identify, Deliberate and Remediate, Creativity research Journal. Retrieved <https://www.researchgate.net>3> on the 08/12/2019 at 04:00 am.
- [120] Marx, B.W., Blumerfield, P.C., Krajcik, J.S., Fishman, B., Soloway, E., Geier, R. and Tal, R.T. (2004). Inquiry based Science in the middle grades: Assessment of Learning in Urban Systematic reforms. Journal of Research in Science Teaching, 41(10).Pp 1063-1080. In www.ibo.org/globalassets/Publicatcion|lib-research|approachestolearning.pdf
- [121] Marzano, R.J. (2001). A Resource Book for Teaching Thinking (3rd ed). Audio book publishing, USA <https://www.amazon.com/Robert-J.-Marzano/e/B001HPO054>. on the 16\01\2017 at 23:11 pm.
- [122] Melton, R.F. (1978) Resolution of Conflicting Claims Concerning the Effect of Behavioural Objectives on Students Learning. Review of Educational Research <http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodelQAiT>.
- [123] Michalipoulou, A. (2014). Inquiry Based Learning through Creative Thinking and Expression in Early Years Education. Journal of Scientific Research vol 5 no 6, April 2014. Retrieved <https://www.scrip.org/journal/paper.08/08/2018at3.27Pm>.
- [124] Michalipoulou, A. (2014). Inquiry Based Learning through Creative Thinking and Expression in Early Years Education. Journal of Scientific Research vol 5 no 6, April 2014. Retrieved from <https://www.scrip.org/journal/paper.08/08/2018at3:27pm>.
- [125] Michaelsen, LK; Knight, A; and Fink L.D. (1997). Designing Effective Group Activities: Lessons for Classroom Teaching and Faculty Development. In D. Dezure (Ed). To Improve the Academy, vol. 16 (pp.373-398). Skillwater ok: New forums press. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/2331113/08/2018at08:55am>.
- [126] Mosk, C., (2001). Japanese Industrial History: Technology, Urbanization and Economic Growth. Armonk, New York: M.E. Sharpe. In <https|eh.net\encyclopedia\japaneseindustrialization-and-economic-growth.26-12-2016at19:27>.
- [127] Munyaradzi, E.G., (2014). Factors Affecting Academic Achievements in Quantitative Courses among Business Students of Private Higher Education Institutions. Journal of Education and Practices. ISSN 2222-1737 (paper). ISSN 2222-288x(online N^o15,2013. In <https://www.research.net./publication/264124450-Factors-Influencing/Academic-Achievement-Quantitative-Courses- among Business Students of Private higher education Institutions>.
- [128] Mwamadzingo, M. (1995). The Impact of University Research on Industrial Innovations: Empirical Evidence from Kenya Technology and policy practice in Africa IDRC: Ottawa.
- [129] Nafees, M., Farooq, G., Tahirkheli, S.A., and Akhtar, M., (2012). Effects of Instructional Strategies on Academic Achievement in a High School General Science Class. International Journal of Business and Social Science, vol. 3 N^o 5. March 2012. In ijbssnet.Com\Journal\vol-3-No5-March-2012\12:28pm
- [130] Nami, Y.V (2014). The Relationship between Creativity and Academic Achievement. Procedia-Social and Behavioural Sciences vol. 144, pp 36-39. <http://doi.org/10.1016/j.sbspro.2013.12.652>. Published by Elsevier Ltd. Retrieved at 6:00pm on 06/08/2018.
- [131] Nami, W. (2014). Nami Undertakes and Funds Market – Driven Research in Nanotechnology and Advanced Materials. www.nami.org.hk,nami>otherVideos, 13/08/2018 at 13:32pm.
- [132] Natadiwijaya, I.F. (2014). How to Practice Creative Thinking Skills through Scaffolding on biotechnology Content. Retrieved from iopscience.iop.org>articlepdf.

- Retrieved on the 07/12/2019 at 03:54 am. from Journal of Physics: conference Series. Volume 1063.
- [133] Natadiwijaya, I.F.; Rhamat, A., Redjeki, S. & Anggraeni, S. (2018). How to Practice Creative Thinking Skills through Scaffolding on Biotechnology Content. Journal of Physics: Conference Series. Retrieved from <https://iopscience.iop.org> on the 07/12/2019 at 05:16 am.
- [134] Nozari, A.Y. & Siamian, H. (2014). The Effects of Problem Solving Teaching on Creative Thinking Among District 2 High School Students in Saricity.. Academy of Medical Sciences of Bosnia and Herzegovina. Retrieved from <https://www.ncbi.nlm.nih.gov>>pmc.
- [135] Okoro, O.M. (1993). Principles and methods in vocational and technical Education. Logos: Orowalu Obosi pacific publishers (Nigeria). Ltd in Akon, E.O. curriculum and teaching, in Nigeria. Calabar. The CERN press Limited.
- [136] Olsen, R.C., (1973). A Comparative Study of the Effects of Behavioural Objectives on Class Performance and Retention in Physical Science. In onlinelibrary.wiley.com/doi/10.1002/sce.3730590205abstract.on 18|10|2016 at 06>13 a.m.
- [137] Ottley, E. (1968). The Effect of Remedial Instruction on Mathematical Achievement. The American Mathematical Monthly Vol. 75, NO 9(Nov, 1968), Pp 1004. Retrieved from <https://www.jstor.org>> Stable at 08/12/2019 at 04:50 am
- [138] Pace, C. N. (1995) How to Measure and Predict the Molar Absorption Coefficient. Retrieved from <http://onlinelibrary.wiley.com/doi/abs/10.1002/pro.5560041120>. 13/08/2018.
- [139] Padidar, J., (2013). Experimental Research Design. In www.drjayeshpatidar.blogspot.com. on 13|01|2017 at 02:30 a.m.
- [140] Paratoo, K. (1997). Nursing Research: Principles, Process and Issues: Amazon. Co. UK. Audio book Publishing in <https://www.amazon.co.uk/Nursing-Research-Principles-Process> |dp| 0333987276. On 13|01|2017 at 02:13
- [141] Pascarella, E.T. & Terenzini, P., (1997). How College Affects Students. San-Francisco. Jossey-Bass <http://www.ujcontent.ujac.za/vital/access/services.uj/content/1>. 10/08/18 at 12:41pm
- [142] Pascarella, E.T. And Terenzini, R. T (1991) How College Affects Students: A Third Decade of Research Volume. Retrieved from <http://edocs.uis.edu/.../how-college-effects-students-534-545-pdf> 13/08/2018
- [143] Pascarella, E.T. and Terenzini, R. T. (2005). How College Affects Students Vol 2. Research Gate. <http://edocs.uis.edu/.../how-college-effects-students-534-545-> 13/08/2018
- [144] Piper, C. (2016). How Collaboration Can Foster Creativity and Innovative Thinking. Retrieved from <https://projectdelivery.autodesk.com>. 08/08/2018 at 3:40pm.
- [145] Pushkin, D., (2007) Critical Thinking and Problem Solving. The Theory behind Flexible Thinking Skills Development. Journal of Science Education, 8(1), pp 13-19.
- Retrieved <https://www.ujcontent.ujac.za/vital/access/services.10/08/2018>
- [146] Ringenberg, M.A. (2006). Scaffolding Problem Solving with Annotated Work-out Examples to Promote Deep Learning/Springerlink. <https://link.springer.com>chapter>. Retrieved on the 07/12/2019 at 03:06 am.
- [147] Rodriguez, G.L; Florez, E.E.R; & Barreto, A.M.R. (2014) Increasing Critical and Thinking Awareness through the Use of Task Based Learning Approach. Retrieved from <https://www.scielo.org/corscielo.php?script=sciarttextandpid=s1794> 12/08/2018 at 17:01pm.
- [148] Reed, J.H. (1998). Effect of a Model for Critical Thinking on Student Achievement in Primary Source Document Analysis and Interpretation Argumentative Reasoning, Critical Thinking Dispositions and History Content in a Community College History Course. Retrieved at 22.15 pm from <http://www.criticalthinking.org/resources/> Reed-dessertation. Pdf, 11/08/2018
- [149] Research Gate (2015). The Role of Scaffolding in Problem Solving Skills Among Children. <https://www.researchgate.net>2840>
- [150] Research Gate (2018). How to Practice Creative Thinking Skills through Scaffolding on biotechnology Content. Retrieved from <https://www.researchgate.net>3251> on the 07/12/2019 at 04:04 am
- [151] Research Gate (2019). The Impact of Scaffolding on Student Achievement Levels Influence Inquiry and Performance. Retrieved from <https://www.researchgate.net>2> on the 07/12/2019 at 05:30 am.
- [152] Robbins, D. (2001). Vygotsky's Psychology- Philosophy: A metaphor for Language Theory and Learning. New York: Plenum in Santrock, J.W (2004). Educational Psychology. New York: McGraw Hill.
- [153] Rowntree, D. (1981). Developing Courses for students. MCG raw- Hill: Uk. In Dr Neil Haign, (1980) updated by Harris, T. (2009). WWW waika-to.ac.nz/tdu/pdf/booklets /12- labs and pracs pdf. 15/10/2016 at 21:44p.m.
- [154] Rudibyani, R.B. (2019). Improving Students' Creative Thinking Ability through Problem Based Learning Models on Stoichiometric Materials- iopscience. Retrieved from <https://www.iopscience.iop.org>pdf>. On the 10/12/2019 at 10:46 am.
- [155] Rudina, V. (2011). Effects of Group Learning on the Academic Performance of University Students. Problems of Education in the 21 Century, vol. 33, 2011. Oaji. Net|articles|2014| 457-1406576474. Pdf. on 17|10|2016 at 13:03 p.m.
- [156] Runco, M.A. et al (2012). Divergent Thinking as an Indicator of Creative Potential in Divergent Thinking, Intelligence and Expertise: A Test of Alternative Models by Vincent, A.S; Decker, B.P. & Mumford, M.D. (2002). <https://doi.org/10.1207/S15326934CRJ1402-4>.

- [157] Russo, C.F. (2004). A Comparative Study of Creativity and Cognitive Problem Solving Strategies of High IQ and Average Students. SAGE Journals. Retrieved from <https://journals.sagepub.com>.>doi. <https://doi.org/10.1177/001698620404800303> on the 10/12/2019 at 12:12 pm.
- [158] Samson, P.L. (2015). Fostering Student Engagement: Creative Problem Solving in Small Group Facilitations-Eric. Retrieved from <https://files.eric.ed.gov/fulltext/pdf> on the 10/12/2019 at 10:50 am.
- [159] Schwartz. (2012). For Students Why the Question is More Important than the Answer. in Ford, W.(2014), <http://www.nwmissouriedu/library/research/papers/2015/ford,%20William.pdf> 12/08/2018 at 11:15am.
- [160] Sharma, P. & Hannafin (2004).Scaffolding Critical Thinking in an Online Course: An Exploratory Study.Journals. Retrieved from Sage pub.com on the 06/12/2019 at 02:47 am.
- [161] Shymansky, J.A., Hedges, L.V., & Woodworth, G. (1990). A Reassessment of the Effects of Inquiry Based Science Curricular of the 60's on Student Performance. Journal of Research in Science Teaching. 27(2), 127-144. <https://doi.org/10.1002/tea.3660270205> on the 23/01/2020 at 03:22 am
- [162] Simmons, K. (2007). The Impact of Scaffolding and Student Achievement Levels. Retrieved from <https://www.semanticscholar.org> on the 07/12/2019 at 05:36 am.
- [163] Slavin, R.E (1994). A Model of Effective Instruction. Retrieved from [http://www.tanfoline.com/doi/abs/ip,10/080/00/3/72950936387/journal Code=utef20](http://www.tanfoline.com/doi/abs/ip,10/080/00/3/72950936387/journal%20Code=utef20). At 22:30 on 27/07/2018.
- [164] Slavin, R.E (1994). A Model of Effective Instruction in QAIT.<http://model.umons.ac.be/plungifile.php/168300/mod-folder/intro/slavinmodel>.
- [165] Smith, J. (2018). Scaffolding Primary School Teachers in Designing and enacting Language-Oriented Science Lessons: [https://www.sciencedirect.com>pii](https://www.sciencedirect.com/pii). Retrieved on the 07/12/2019 at 03:41 am.
- [166] Sofroniou, A & Poutos, K. (2016). Investigating the effects of group work in Mathematics. Retrieved from <https://ir.uiowa.edu/cgi/viewcontent.cgi?article=5478&context=etd> 12/08/2018 at 15:05pm.
- [167] Spektor Levy O. (2004). High Order Learning Skills in Science Studies. Development of an Instructional Model and Research on Implementation and Students' Learning.
- [168] Springer, L; Stanne, M.E. and Donovan. S.S. (1999). Effects of Small-Group Learning on Undergraduate in Science, Mathematics, Engineering and Technology: A Meta-Analysis. American Educational Research Association. Retrieved from <http://www.jstar.org/stable/1170643>. 13/08/2018 at 09:06am.
- [169] Sternberg, R. J, Kaufman, J. C. and Pretz, J. E. (2001). The Propulsion Model of Creative Contributions applied to the Arts and Letters. Journal of Creative Behaviour, 35(2), 75-101.
- <http://www.robertsternberg.com/inv>. On 13/08/2018 at 22:33pm
- [170] Sternberg, R.J and Lubart, T.L (1992). Buy low and sell high: An investment approach to creativity. Current Directions in Psychology Sciences, 1(1, 1-5). <http://www.Robertsternberg.com/inv> on 13/08/2018 at 22:34 pm.
- [171] Sternberg, R.J. (1998). Handbook of Creativity. Cambridge: Cambridge University Press. [http://online library.Wiley.com/doi/abs/10.../j21626057](http://online.library.Wiley.com/doi/abs/10.../j21626057).
- [172] Sternberg, R.J and Lubart, T.L (1999). The Concept of Creativity: Prospects and Paradigms. In Handbook of Creativity, Edited by Sternbergs, R. J., Editor, Cambridge University Press, Cambridge, UK. Pp 3-15. In Foster, J. S and Lemus, J.D (2015) <http://www.ncbi.nlm.nih.gov/PMC/article/PMC4290794/>. 12/08/18 at 09:36am.
- [173] Stevenson, H.W and Stigler, J.W (1992) The Learning Gap: Why Are Schools Failing and What We Can Learn from Japanese Chinese Education: New York: summit books. <http://people.uncw.edu/kozloff/scaffolding.pdf> on 29/07/2018 at 15:20pm.
- [174] Tambo, L. I. (2012). Principles and Methods of Teaching. (2nd edition). Limbe: ANUCAM.
- [175] Tanyi, M. E. (2016). The Student's Adjustment Inventory Manual: A Counsellor's Psychological Working Guide. Retrieved from [https://www.amazon.com>students adjustment inventory](https://www.amazon.com>students%20adjustment%20inventory). On the 22/12/2019 at 03:15 pm.
- [176] Tiruneh, D.T. Verburch, A. & Elen, J. (2014). Effectiveness of Critical Thinking Instruction in Higher Education: A Systematic Review of Intervention Studies.<https://www.sciencedirect.com/science/article/pii/S24523151163094>. 11/08/2018 at 21:16pm
- [177] Todd, M; Higgs, C.A & Mumford, M.D. (2019). Bias and Bias in Creative Problem Solving: Managing Biases Through Forecasting. Creativity Research Journal. Volume 31, 2019 issue 1. Retrieved from <https://www.tandfonline.com>abs> on 08/12/2019 at 03:46 am.
- [178] Ukeje, O.B. (1966). Education for Social Reconstruction. London: MacMillan. In Tambo, L.V. (2012). Principles and Methods of Teaching (2nd edition). Limbe: ANUCAM.
- [179] Valiant, G, Olachan, M. and Euler, N. (1982). of Cognitive Development through Cooperative tasks Performance. London; British Journal of Educational Psychology 523. In Akon, E.O. Curriculum and Teaching in Nigeria. Calabar. The CIBN Press Limited.
- [180] Van de Pol, J. (2015). The Effects of Scaffolding in Classroom: Support Contingency. Retrieved from <https://link.springer.com>article> on the 07/12/2019 at 05:38 am.
- [181] Vijayaratnam, P (2012) Effect of Cooperative Learning Strategy on Students' Acquisition and Practice of Science. <http://www.researchgate.net/publication/316967778>. On 06/08/2018 at 10:56 pm.

- [182] Vong, S. A. & Kaewurai, W. (2017). Instructional Model Development to Enhance Critical Thinking and Critical Thinking Teaching Ability of Trainee Students at Regional Teaching Training Centre in Takeo Province, Cambodia. <https://doi.org/10.1016/J.Kjss.2016.05.002> on the 10/12/2019 at 09:54 am.
- [183] Vonk, J. (2016). Operational definition of Target Population in www.jennifer_vonk.com/aploads. Retrieved on 15/01/2017 at 12:51
- [184] Walker, S. (2003). Active Learning Strategies to Promote Critical Thinking. *Journal of Athletic Training* 38(3), jul-sept 2003.12/08/2018 at 06:24 am
- [185] Wass, R; Harland, T; & Mercer (2011). Scaffolding critical thinking in the zone of proximal development. Retrieved from ajet.au on the 06/12/2019 at 1:30 am.
- [186] Wenger, E. (1998). *Communities of Practice: Learning, Meaning and identity*: Cambridge University Press. In *South African Journal for Open and Distance Learning and Practice (Progression)*. Vol. 35 No 2, 2013. UNISA, University of South Africa).
- [187] Wilson, K. (2016). *Critical Reading: Critical Thinking: DELICATE Scaffolding in English For Academic Purposes (EAP)* – Elsevier on 06/12/2019 at 03:06 am
- [188] Xun, G. E. (2014). A Conceptual Framework for Scaffolding IL-Structured Problem Solving Processes using question prompts and Peer Support. <https://link.springer.com/p/article>. Retrieved on the 12/12/2019 at 03:57 am.
- [189] Yi Lin, C. (2017). Threshold Effects of Creative Problem Solving Attributes on Creativity in Maths Abilities of Taiwanese Upper Elementary Students. Retrieved from <https://doi.org/10.1155/2017/4571383> on the 10/12/2019 at 12:26 pm.
- [190] Yusuf, A.S., Nuradeen, M. (2013). Effects of Integrating Instructional Models with Lecture Method on academic performance and Retention of students of small class size in Zaria Educational Zone Kaduna State Nigeria in *ATBU Journal of Science, Technology and Education*. WWW. atbujostel.com/index.php/kjostel/article/view/53.
- [191] Zion, M. & Sadeh, I. (2007). Curiosity and Open Inquiry Learning. *J Biol Edu* 41: 162-16 in Foster, J. S. and Lemus, J. D. (2015) <http://www.ncbi.nlm.nih.gov/PMC/article/PMC42900794>.12/08/18 AT 09:34am

