EFFECTS OF CONSTRUCTIVIST TEACHING APPROACH ON ACHIEVEMENT, SELF-CONCEPT AND DISPOSITION IN MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS IN NAKURU COUNTY, KENYA

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ABSTRACT
Mathematics is a universal utilitarian tool for Social, Cultural and Personal goals that every member of society aspires to achieve. In Kenya mathematics is a compulsory subject in Primary and Secondary schools and is examinable by Kenya National Examinations Council. Worldwide and particularly in Kenya students’ mathematics performance has been dismal. Most studies attribute the students’ dismal mathematics performance to the teacher centered teaching methods, practiced by mathematics teachers, in mathematics classrooms. The study investigated the effects of Constructivist Teaching Approach (CTA) on students’ achievement, self-concept and disposition in mathematics, among secondary school students. It was carried out in Rongai Sub-county of Nakuru County, where there has been persistent low learners’ achievement in the subject. The Solomon Four Non-equivalent Control Group Research Design was used in the study. Four co-educational schools were purposively selected from the sub-county and randomly assigned to serve as Experimental groups (E₁ & E₂) and Control groups (C₁ & C₂). Each school provided one Form Two class for study giving a sample population of 165 students. The Instruments, Students’ Mathematics Achievement Test (SMAT), Students’ Mathematics Self-concept Questionnaire (SMSQ) and Students’ Mathematical Disposition Questionnaire (SMDQ) were used for data collection. The data collected was analyzed by use of t-Test and Analysis of Variance (ANOVA). Results indicated that students in the experimental groups E₁ and E₂ had better performance than the students in the control groups C₁ and C₂ in the SMAT. This showed that CTA enhanced student learning better than the conventional methods. In addition experimental group E₁ had a rise in Students’ Mathematics Self-concept and relatively increased Students’ Mathematical Disposition, compared to Control group C₁ which had been taught using conventional method. The curriculum developers and mathematics teachers are encouraged to use CTA, in improving students’ mathematics achievement, mathematics self- concept and mathematical disposition among secondary school students.

Key Word: Constructivist Teaching Approach, Mathematics Achievement, Mathematics Self-Concept, Mathematical Disposition
Introduction

Mathematics is a requirement in which people globally need, to analyze data that is necessary for solving many challenges facing the world today (Armold, 2012). Such challenges include; population statistics, world diseases analysis, children mortality rate among others. Mathematics in itself has all the ingredients that make it a universal language, shared by all human-beings irrespective of culture, religion or gender (Celia, 2008). Prakash (2011) noted that mathematics is a way of thinking, a way of organizing a logical proof and gives an insight into the power of the human mind.

The Kenya National goal of education number two is to, ‘promote the social, economic, technological and industrial needs for national development,’ (Ministry of Education, 2006). The goal aims at producing citizens with skills, knowledge, expertise and personal qualities that are required to support a growing economy and Kenya’s needs for her adequate domestic manpower. This can only be realized by strengthening of mathematics and sciences in our education system. This is the reason why mathematics is one of the core subjects in Kenyan secondary school curriculum and a critical filter for career choices (Sulunga, Toili & Amadola, 2011). One objective of secondary school mathematics curriculum is to provide the learners with opportunities to develop ability for enquiry and critical thinking, which help them to solve their problems (Kenya Institute of Education, 2002).

According to Trends in International Mathematics and Science Study, TIMSS (2007), Singapore was consistently in the top ranking countries in learners’ mathematics performance for the years 1995, 1999, 2003, and again in 2007 grade 4 and grade 8 international students’ mathematics achievements. Though the study was based on lower grade 4 and grade 8, the TIMSS is a clear reflection of mathematics performance on higher grades and in secondary schools. The Curriculum Planning and Development Division, (CPDD) of Singapore developed the Model Teaching Method which advocates the Concrete- Pictorial- Abstract approach. In this teaching/learning approach students are provided with the necessary learning experiences and meaningful context, using concrete manipulative and pictorial representations to help them learn abstract mathematics (Whetstone, 2009). Though Kenya has never participated in TIMSS, the quality of mathematics and science achievement of students in Kenya has been a major concern for the last ten years. Over that time, the Kenya government launched Strengthening Mathematics and Science in Secondary Education Project, in an attempt to promote mathematics and science education (SMASSE, 2004). In addition the Ministry of Education Science and Technology (MOEST) in Kenya has made mathematics subject compulsory for all pupils in primary and secondary schools. This has also been enhanced by National Education Sector Plan (NESP) in its goals, Educate, Empower, Elevate, has set out mathematics and languages to be emphasized in free compulsory basic education for all Kenyan school age children. Despite the huge effort by the government students’ mathematics performance in the KCSE has been dismal over
the years, as supported by KNEC mathematics examination results analysis for the years 2010-2014 in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Paper</th>
<th>Candidate</th>
<th>Maximum Score</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1</td>
<td>356,072</td>
<td>100</td>
<td>18.21</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>100</td>
<td>19.92</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>409,887</td>
<td>100</td>
<td>21.36</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>100</td>
<td>23.22</td>
</tr>
<tr>
<td>2012</td>
<td>1</td>
<td>433,017</td>
<td>100</td>
<td>24.46</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>100</td>
<td>20.86</td>
</tr>
<tr>
<td>2013</td>
<td>1</td>
<td>446,696</td>
<td>100</td>
<td>21.34</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>100</td>
<td>19.69</td>
</tr>
<tr>
<td>2014</td>
<td>1</td>
<td>457,043</td>
<td>100</td>
<td>23.53</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>100</td>
<td>22.36</td>
</tr>
</tbody>
</table>


According to Sarita and Akdemir (2009), a good Instruction method is an effective way to alleviate problems related to the quality of teaching and learning mathematics. The conventional classroom teaching approach utilizes teacher centered methods, commonly used in our mathematics classroom. According to Mondoh (2002), the teacher prepares his/her work based on the syllabus and the schemes of work, the teacher explains the various concepts to be learnt while the class listens and carries out the activities as directed. The class moves at the teacher’s pace, topic to topic. This results into rote learning and therefore students have problems in conceptualization of the learned knowledge and skills. Moreover students’ achievement and self-concept are affected by the way the teacher handles the teaching and learning process (McAleese, 2010).

Constructivist Teaching Approach (CTA) view learning as an activity which involves constructing meaning through a social process, whereby learners interact with each other, as well as their facilitator (Herrman, 2007). William (2010) found that the CTA consist of four key constructivist elements; knowledge construction, collaborative learning, authentic learning and self-regulation learning. On
knowledge construction, individual ‘construct’ knowledge by filtering new information through their own past experiences and presently held knowledge, to derive a personal understanding of the world. In collaborative learning, students work in a team. Andrew (quoted in William, 2010) state authentic learning to involve structuring class work to direct the students to continually reflect on how knowledge gained in the class could be applied in a practical setting.

Statement of the Problem

Strengthening mathematics education, would contribute to Kenya’s prosperity by spurring economic growth and generating a more highly skilled workforce, to enable her achieve Vision 2030. It would also offer greater foundation for students to pursue post-secondary education and training. Despite the importance of mathematics to an individual and society, students’ performance in mathematics has over the years been persistently poor (KNEC, 2009). Among factors contributing to learners’ dismal performance in mathematics is the teacher centered teaching methods, practiced by mathematics teachers. This study attempted to seek an effective teaching method, to improve learners’ mathematics output in secondary schools. It tried to find out whether there were effects of CTA on achievement, self-concept and disposition in mathematics among secondary school students, of Rongai Sub-county in Nakuru County. It was based on Form Two Mathematics Class, topic linear Inequalities.

Objectives of the Study

i. Investigate the effects of Constructivist Teaching Approach on students’ mathematics achievement.

ii. Determine the effects of Constructivist Teaching Approach on students’ mathematics self-concept.

iii. Evaluate the effects of Constructivist Teaching Approach on students’ mathematical disposition.

Literature Review

Importance of Mathematics in Society

Mathematics provides a powerful universal language and intellectual toolkit for Science and technology; it disciplines the mind, develops logical and critical reasoning, and besides it also develops analytical and problem solving skills (Adrian, 2011). Thomaskutty (2009) argues that mathematics cannot be considered as a classroom discipline only, but every man may need it at any time. As Marrion (2007) noted, not only academician; not only a scientist; not only an engineer; but a shopkeeper needs it; a grocer needs it; a housewife needs it; a sportsman needs it; an employee needs it and just like a language we all need mathematics to communicate. According to Wojciech (2009), mathematical competence has been identified by the European Parliament and the Council of the
European Union as one of the key competence necessary for personal fulfillment, active citizenship, social inclusion and employability in modern society. Mathematics is of central importance to modern society, it is essential in business, financial services, many areas of ICT, and it forms the basis of most scientific and industrial research and development (Celia, 2008). Kenya Society has not been left behind as Mondoh (2002) observed, that officially participation in Mathematics lessons at school is compulsory for both gender and Kenya National Curriculum make this statutory.

Problems Facing Mathematics Education in Kenyan Secondary Schools

Education stakeholders continue to invest heavily in education system with hope that there will be good performances in the National examination. Nevertheless Mathematics performances at Kenya Certificate of Secondary Education have been quite dismal as indicated by national mean scores (KNEC, 2012, 2013, 2014). The dismal performance in the subject has been attributed to several factors like, symbolism and specialized mathematics language structure, condensed meaning that make mathematics difficult to understand, terminology that is uncommon in ordinary English, specialized language in mathematics tests and examinations, and negative attitudes toward mathematics among others (Githua, 2006).

According to Woodward (2004), students’ anxiety toward the learning of mathematics makes them to lose interest in the subject. In many mathematic classrooms the level of anxiety and stress while learning mathematics was noted to be all time high. This finding was similar to Njoroge (2006), who noted that beside negative attitudes toward mathematics, Kenyan students in the classroom show a very high level of anxiety and stress while learning mathematics.

Mathematics Teaching Methods used in Secondary Schools

Many teaching methods are used in combination to optimize learning. When used effectively teaching methods should facilitate in learners the development of critical consciousness and reflection on issues (Macharia, Githua & Guantai, 2009). When teaching Mathematics, the instructional strategies ideally should be tailored to the aptitudes of the learners. Instructional strategies can be represented on a continuum, one end of which is teacher-centered, with the teacher being active and the learner being less active, and the other end being student-centered. The teaching methods are also classified under two broad categories namely; facilitation teaching strategy and the transmission teaching strategy (Macharia, Githua & Guantai, 2009).

Transmission Teaching Strategy
The transmission strategy is more conventional teacher centered where the teacher is authoritative and the expert of the subject matter to be taught. As Rawlinson (2006) observed, teacher centered teaching methods have demerits such as, students are passive receivers of transmitted information and it involves surface learning of concepts, principles and skills, resulting to mechanically ingesting knowledge from the teacher. The transmission teaching strategy includes several methods such as.

**Lecture Method:** This is a didactic method of teaching in which an active teacher, communicate information to more or less passive learners, who listen and make notes with limited or no time to ask questions. According to Brownstein (2006), lecture method is a one-way communication approach, a process of delivering knowledge to students verbally using a pre-organized outline.

**Demonstration Method:** Demonstration method is step by step performance or operation which is accompanied by explanation and often in slow motion. The method mainly utilizes real objects and audio-visual technology to enhance learners’ ability to conceptualize facts (Cheboi, 2013), The teacher uses this approach to explain, emphasize or specify a topic or subject. In mathematics demonstration is often used in tackling topics like, three dimensions, differentiation and trigonometry ratios.

**Drill and Practice:** Drill refers to instructions about some skill or operation and repeating the skill by a lot of exercise. In mathematics, drill and practice is used for example when learning multiplication of numbers, learning long division of whole numbers or subtraction of integers. Walkin (2007), noted that for the drill and practice to be effective the teacher must make the learner aware of the purpose of the practice. The purpose of the practice is to; Promote retention, accuracy and efficiency.

**Facilitation Teaching Strategy**
Facilitation teaching strategy is student- centered and seeks to develop abilities of the learner critical thinking, creativity, interpersonal and social skills, which is all in line with Constructivist Teaching Approach. The facilitation teaching strategy includes methods like:

**Discussion Method:** The discussion method is a learner centered teaching technique that involves active student participation and provides an environment in which learners may develop social skills and result to positive self-concept. The major value of a discussion in a classroom lies in the fact that it focuses attention on interest of the learners.

**Inquiry-Based Method:** Inquiry-Based Method is an approach that teach learners to handle situations which they encounter dealing with the physical world by using techniques which are applied by research scientists (Clark, 2008). When using the inquiry-based approach the learners are guided to employ procedures research scientists use to recognize problems, to ask questions, and to apply step by step procedure to provide consistent descriptions and explanations.
**Guided Investigations:** Investigating learning arouses students’ curiosity and motivates the learners to work out problems until they find answers (Rawlinson, 2006). This work well on several mathematics topics like Pythagoras theorem, area, perimeter, use of Pascal’s triangle and others. When investigating the relationships between diameter and circumference of a circle and the value of \( \pi \), where students measure the dimension of various cylinders using strings and rulers the method is very useful (Walkin, 2007).

**Discovery Method:** Discovery Method is a student-centered approach that seeks to develop the abilities of the learners, refine their processes and attitudes required for critical thinking, creativity, interpersonal and social skills. In science world, the concept behind the discovery approach is that the motivation of learners to learn science is increased if they experience the feelings scientist obtains from ”discovering” scientific knowledge (Walkin, 2007).

**Out-of-Class Mathematical activities:** To stimulate learners’ interest and activate their curiosity, it is important to have some lessons outside the normal classroom set up (Marrion, 2007). Outside the classroom, the students’ are more alert, active, cooperative and more self-reliant. According to Githua (2002), this approach stimulates student’ interest and creativity. This approach provides the learners with a hand on activities; promote self-confidence, satisfaction and competence. Learning by doing has more advantage for it promote retention.

**Problem Solving Method:** Problem solving is the ability to identify and solve a problem by applying appropriate skills systematically (Linda, 2009). According to Clark (2008), problem solving is a higher order cognitive process that requires the modulation and ability to understand what the problem is, what rule could be applied through abstract thinking and coming up with a creative solution.

**Constructivist Teaching and Learning Approach in Mathematics**

William (2010), explain the constructivist model of learning as the one that emphasizes learners’ development of knowledge through active discussion processes that link new knowledge to prior knowledge. Derny (2007), observed that learners are observers, participants and agents who actively generate and transform the patterns through which they construct the realities that fit them. According to Clark (2008), discovery, hands-on, experiential, project and task based learning are a number of applications that base teaching and learning on constructivism. Constructivist Teaching Approach foster critical thinking and creates motivated and independent learner, since learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively (Taber, 2011). Audrey (2005), noted that as much as we would like to, we cannot fix ideas in students’ heads they should and must construct their
own meanings, and to find truth they should construct viable explanations of their experiences. The teacher teaches by giving the learners the training to take initiative for their own learning experiences and encourages them become actively involved with activities that are interactive and student centered (Gray, 2010). According to Constructivist Teaching Approach the instructor guide learners in construction, organization and restructuring of the conceptions and frameworks which they already have (Rawlinson, 2006). The instructor’s role is to mentor the learner and enable quested learning that may modify existing knowledge and allow for creating of new knowledge (Linda, 2009). Kim (2005) pointed that constructivism learning experience should be open and free enough, to allow for the learners to discover, enjoy, interact and arrive at their own verified version of truth. Through interaction Social Constructivism is promoted, as the classroom environment emphasize collaboration and exchange of ideas, increasing learners’ social and communication skills (Powell, 2008). As Rawlinson (2006) noted, through exchange of ideas, the students learn to ‘negotiate’ with others and to evaluate their contribution in socially acceptable manner, in which they have to cooperate and navigate among the ideas of others. Njoroge (2006), noted that Constructivist teaching approach typically make extensive use of cooperative learning. He explains the students will more easily discover and comprehend difficult concepts if they can talk to each other about their problems.

**Conceptual Framework**

Diagrammatic representation of the interaction of the various variables in the study is illustrated in Figure 1 below.

![Conceptual Framework Diagram](image-url)

**Figure 2:** Conceptual framework showing the Effects of Constructivist Teaching Approach On Students’ Achievement, Self-Concept and Disposition in Mathematics.
Research Methodology
The research design used for the study was Solomon Four Non-Equivalent control group design. This is a quasi experimental study design and hence intact classes were used without random assignment to each of the four groups. The design was appropriate for the study because, random assignment of the classes was not being done since the classes existed as intact groups. The study was carried out in Rongai sub-county in Nakuru County. Rongai sub-county consists of nine locations. There were 43 Secondary schools in the sub-county with 39 of them registered for KCSE 2013 Examinations. The target population was all form two students in Rongai Sub-County. Mathematics being a compulsory subject, the accessible population was all Form two students in co-educational Sub-county secondary schools, of Rongai sub-county. The researcher used Purposive sampling technique to sample the schools. The Solomon Four Non-Equivalent Control Group Research design that was used required a sample size of 4 schools. A list of 25 co-educational Sub-county secondary schools in Rongai sub-county formed the sampling frame. The Instruments used in the research were Students’ Mathematics Achievement Test (SMAT), Students’ Mathematics Self-concept Questionnaire (SMSQ), and Students’ Mathematical Disposition Questionnaire (SMDQ). A t-Test was adopted by the study to test for differences between two means and a one way Analysis of Variances (ANOVA), was used to find out for any statistically significant difference between the variables. ANOVA was preferred since ANOVAs are useful in comparing (testing) three or more means for statistical significance (Mwangi & Nassimua, 2004). SPSS version 20 was used in data analysis. Hypotheses of the study were tested at alpha (α) equals 0.05 level of significance.

RESULTS

Pre-test Analysis
Pre-test was administered in Students’ Mathematics Achievement Test (SMAT), to Experimental Group (E1) and Control Group (C1) to determine the students’ entry behavior before the teaching started. The t-Test was used to determine whether there was significant difference between the mean scores of the two groups. Table 2 shows the Pre-test results.

<table>
<thead>
<tr>
<th>TEST</th>
<th>GROUP</th>
<th>N</th>
<th>MEAN</th>
<th>SD</th>
<th>t-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAT</td>
<td>Experimental Group (E1)</td>
<td>43</td>
<td>19.209</td>
<td>7.149</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Group (C1)</td>
<td>41</td>
<td>19.951</td>
<td>6.572</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Critical Values (t 0.05 =1.645, P> 0.05), Calculated Values (t 0.05 =1.284, P=0.311)
The results in the Table 6 indicate that the differences in students’ scores in the SMAT between Experimental Group (E₁) and Control Group (C₁) were not statistically significant, since t-value=1.284 while P> 0.05, an indication that the groups that were used in the study, showed comparable characteristics towards the Mathematics topic Linear Inequalities, and therefore suitable for the study.

Effect of Constructivist Teaching Approach on Students’ Achievement on Mathematics Topic Linear Inequalities

The study sought to determine the relative effect of Constructivist Teaching Approach on students’ mathematics achievement in the topic Linear Inequalities. To assess the effect, the First hypothesis (H₀₁) of the study that sought to find out whether there was any statistically significant difference in students’ mathematics achievement, between those that are exposed to Constructivist Teaching Approach (CTA) and those that are not exposed to it, was formulated. Both the analysis of the students’ Post-test SMAT mean scores and ANOVA were carried out. Table 3 shows the mean scores of the four groups.

Table 3: SMAT Post-test Mean Scores of the Students in the Four Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>E₁</td>
<td>43</td>
<td>25.605</td>
</tr>
<tr>
<td>E₂</td>
<td>39</td>
<td>24.821</td>
</tr>
<tr>
<td>C₁</td>
<td>41</td>
<td>20.342</td>
</tr>
<tr>
<td>C₂</td>
<td>42</td>
<td>20.095</td>
</tr>
<tr>
<td>TOTAL</td>
<td>165</td>
<td>22.709</td>
</tr>
</tbody>
</table>

The results in Table 3 indicate that Experimental Group E₁ and E₂ had higher mean scores than Control Groups C₁ and C₂ respectively. The mean scores are also represented in the graph, figure 4

![Bar Chart](http://www.ijsse.org)

**Figure 2 : SMAT Post-test Mean Scores of the Students in the Four Groups**

These results indicated that the pre-test SMAT did not affect the students in the learning of the mathematics contents. If it did, students who sat for the pre-test would have had different results from the others. Pre-test was therefore suitable for the study. It also showed that the pre-test SMAT did not
interact with the treatment conditions. If they did the difference between Groups E₁ and E₂ would have been higher than that between Group C₁ and C₂ (Gall et al., 1996). It further shows that the Constructivist Teaching Approach had an effect of improving achievement as compared to the conventional teaching method. Constructivist Teaching Approach provides learners with an opportunity to engage actively in the learning process.

**Analysis of Variance for Post-test Scores on SMAT**

An Analysis of Variance (ANOVA) was carried out to determine whether the mean scores on SMAT were significantly different for the groups. Table 4 shows the ANOVA results.

<table>
<thead>
<tr>
<th>Test</th>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAT</td>
<td>Between groups</td>
<td>1051.175</td>
<td>3</td>
<td>350.392</td>
<td>8.273</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>6818.861</td>
<td>161</td>
<td>42.353</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total 7870.036 164

**Critical Values (F₀.₀₅ =2.6049, df = 3, P< 0.05), Calculated Values (F₀.₀₅ =8.273, P=0.00)**

Results in Table 4 revealed that statistically significant difference between the Post-test mean scores exists, F (3,161) = 8.273, P < 0.05. To establish the mean scores which were statistically different, a Post-hoc Least Significant Difference (LSD) test was carried out. Table 4 shows the results of the LSD.

**Table 5 : Post-Hoc LSD Summary for the SMAT Post-Test Mean Scores for the Four Groups**

<table>
<thead>
<tr>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean Difference (I-J)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental E₁</td>
<td>Control C₁</td>
<td>5.263*</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Control C₂</td>
<td>5.510*</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>Experimental E₂</td>
<td>0.784</td>
<td>0.324 (NS)</td>
</tr>
<tr>
<td>Experimental E₂</td>
<td>Control C₁</td>
<td>4.479*</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>Control C₂</td>
<td>4.726*</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>Experimental E₁</td>
<td>-0.784</td>
<td>0.324 (NS)</td>
</tr>
<tr>
<td>Control C₁</td>
<td>Control C₂</td>
<td>0.247</td>
<td>0.082 (NS)</td>
</tr>
<tr>
<td></td>
<td>Experimental E₁</td>
<td>-5.263*</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Experimental E₂</td>
<td>-4.479*</td>
<td>0.043</td>
</tr>
</tbody>
</table>
Table 5 shows that the mean differences in the SMAT scores between Experimental E₁ and Control C₁, Experimental E₁ and Control C₂, Experimental E₂ and Control C₁ and Experimental E₂ and Control C₂ were statistically significant at 0.05 α level. But there were no statistically significant differences in the SMAT mean scores between Experimental E₁ and Experimental E₂ who were both taught using Constructivist Teaching Approach, and likewise there were no statistically significant differences in the SMAT mean scores between Control C₁ and Control C₂ who were both taught using Conventional Teaching Methods. From these results the students in the Experimental groups E₁ and E₂ had better performance than the students in the Control groups C₁ and C₂. This implies that the treatment Constructivist Teaching Approach had similar effects on experimental groups E₁ and E₂, enhancing their performance in the SMAT and thus outperforming the control groups C₁ and C₂, which did not receive the treatment. The results of Analysis of Variance (ANOVA) show that there is a statistically significant difference in the scores of the experimental and control groups. The Null Hypothesis (H₀) that sought to find out whether there was any statistically significant difference in students’ mathematics achievement, between those that are exposed to Constructivist Teaching Approach (CTA) and those that are not exposed to it, was therefore rejected.

This means that, the Constructivist Teaching Approach is effective in improving learners’ achievements in Mathematics. These results are in consistent with finding of similar studies on Constructivist Based Learning. Kim (2005), investigated the effects of Constructivist Teaching Approach on students’ academic achievement, and established that the approach resulted to higher achievement of students in a Physical Science class. Further analysis was carried out based on students’ mean score in the pre-test and post-test SMAT, where comparison was done to determine their relative gain. Table 10 gives the summary of the comparison

Table 6: Comparison of the Mean Score Gain Obtained in the SMAT

<table>
<thead>
<tr>
<th></th>
<th>Group E₁ N=43</th>
<th>Group C₁ N=41</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test Mean</td>
<td>19.209</td>
<td>19.951</td>
</tr>
<tr>
<td>Post-test Mean</td>
<td>25.605</td>
<td>20.342</td>
</tr>
<tr>
<td>Mean Gain</td>
<td>6.396</td>
<td>0.391</td>
</tr>
</tbody>
</table>
Mean Gain = Post-test Mean - Pre-test Mean

As indicated on Table 10, both groups E₁ and C₁ gained from the teaching but despite the gain, it is significantly clear that group E₁ had a higher mean gain in the SMAT than group C₁. The experimental group thus gained more than the control group. This emphasizes the position that the Constructivist Teaching Approach resulted to higher achievement than the conventional teaching methods.

Effect of Constructivist Teaching Approach on Students’ Mathematics Self-concept

The second objective of the study, sought to determine the effect of Constructivist Teaching Approach on students’ Mathematics Self-concept on the Topic Linear Inequalities among secondary school students. To assess the effect, the Second hypothesis (H₀2) of the study that sought to find out whether there was any statistically significant difference in students’ mathematics self-concept, between those that are exposed to CTA and those that are not exposed to it, was formulated. The Students’ Mathematics Self-concept Questionnaire (SMSQ) was used to measure the students’ mathematics self-concept. The SMSQ was administered to two groups, Experimental group E₁ and Control group C₁. The comparison of Pre-test and Post-test means and Standard Deviations are presented under this section. The T-test to determine whether the mean scores of the two groups are statistically significant is also presented.

Comparisons of the SMSQ Pre-test and Post-test mean Scores

The mean scores of the Pre-test and Post-test for both Experimental group E₁ and Control group C₁ were computed and compared to determine whether there was any statistically significant difference in students’ mathematics self-concept, between those that were exposed to Constructivist Teaching Approach and those that were not exposed to it. Table 10 shows the SMSQs Pre-test and Post-test mean scores.
Table 7: Comparison of the SMSQ Pre-test and Post-test Mean Scores of Experimental Groups \( E_1 \) and Control group \( C_1 \)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Mean Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E_1 )</td>
<td>3.209</td>
<td>4.317</td>
<td>1.108</td>
</tr>
<tr>
<td>( C_1 )</td>
<td>3.186</td>
<td>3.275</td>
<td>0.089</td>
</tr>
</tbody>
</table>

**Mean Gain = Post-test Mean - Pre-test Mean**

Table 7 shows that the SMSQ Pre-test mean scores for both Experimental Group \( E_1 \) and Control group \( C_1 \) had almost an equal score of 3.209 and 3.186 respectively. At the end of the study, the SMSQ Post-test mean scores indicated that the Experimental group \( E_1 \) registered a relatively higher mean score of 4.317 compared with 3.275 of Control group \( C_1 \) and with a mean gain of 1.108 as opposed to the mean gain of 0.089 of Control group \( C_1 \).

**Independent Samples T-test of the Post-test Mean Scores on SMSQ**

To establish whether the differences in the Post-test mean scores, of the SMSQ between the two groups \( E_1 \) and \( C_1 \) were statistically significant or not, a t-Test was carried out at 0.05 level of significance. The table 8 shows the results.

**Table 8 Independent Samples t-Test of the Post-test Mean Scores on SMSQ**

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMSQ</td>
<td>( E_1 )</td>
<td>43</td>
<td>4.317</td>
<td>0.385</td>
<td>1.915</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>( C_1 )</td>
<td>41</td>
<td>3.275</td>
<td>0.648</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Critical Values** \( t_{0.05} = 1.645, P < 0.05 \), **Calculated Values** \( t = 1.915, P = 0.00 \)

The results in table 8 revealed that, statistically significant differences existed between the Post-test mean scores, on SMSQ of the two groups, Experimental group \( E_1 \) and Control group \( C_1 \), t-value = 1.915, \( P < 0.05 \). This implied that the Students’ Mathematics Self-concept in the Experimental group \( E_1 \) had risen, and was statistically different from that of Control group \( C_1 \). The researcher concluded
that the Constructivist Teaching Approach had a significant Positive effect on Students’ Mathematics Self-concept and thus the null hypothesis (H₀2) that stated that, there is no statistically significant difference in students’ mathematics self-concept, between those that are exposed to constructivist teaching approach and those that are not exposed to it, was therefore rejected. Majda and Branka (2008), on their study on Self-Concept of Student in Inclusive Setting, points out that students develops positive self-concept and self –esteem, when taught using a method that encouraged group interaction and collaboration, a concept embedded on Constructivist Teaching Approach. The CTA emphasized collaboration and group discussions in mathematics which resulted to an increased students’ mathematics self-concept.

**Effect of Constructivist Teaching Approach on Students’ Mathematical Disposition**

The third objective of the study, sought to evaluate the effect of Constructivist Teaching Approach on students’ Mathematical disposition, on the Topic Linear Inequalities among secondary school students. To assess the effect, the Third hypothesis (H₀3) of the study that sought to find out whether there was any statistically significant difference in students’ mathematical disposition, between those that are exposed to CTA and those that are not exposed to it, was formulated. The Students’ Mathematical Disposition Questionnaire (SMDQ) was used to measure the students’ mathematical disposition. The SMDQ was administered to two groups, Experimental group E₁ and Control group C₁. This section therefore present the comparison of the Pre-test and Post-test mean scores, on SMDQ of the two groups. The T-test to determine whether the mean scores on SMDQ of the two groups is statistically significant is also presented.

**Comparisons of the Pre-test and Post-test mean Scores on SMDQ**

To determine whether there was any statistically significant difference in students’ mathematical disposition, between those that were exposed to Constructivist Teaching Approach and those that were not exposed to it, the comparison of the Pre-test and Post-test mean scores, on SMDQ of the two groups, Experimental group E₁ and Control group C₁ was carried out. Table 15 shows the results of the comparison.

**Table 9 Comparison of SMDQ Pre-test and Post-test Mean Scores for E₁ and C₁**

<table>
<thead>
<tr>
<th>Test</th>
<th>E₁</th>
<th>C₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>3.305</td>
<td>3.437</td>
</tr>
<tr>
<td>Post-test</td>
<td>4.427</td>
<td>3.332</td>
</tr>
</tbody>
</table>
Table 9 shows that both Experimental Group E1 and Control group C1, the Pre-test mean had almost an equal score of 3.305 and 3.437 respectively. At the end of the study, the SMDQ Post-test mean scores for Experimental group E1 was relatively higher, with a means score of 4.427 compared with mean score of 3.332 registered by Control group C1 Experimental Group E1 indicated a mean gain of 1.122 while Control group C1, indicated a mean gain of –0.105.

**Independent Samples t-Test of the Post-test Mean Scores on SMDQ**

A t-Test was done to determine whether the differences in the Post-test mean scores on the SMDQ, between the two groups E1 and C1 were statistically significant or not, at 0.05 level of significance. The table 10 shows the results.

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMDQ</td>
<td>E1</td>
<td>43</td>
<td>4.427</td>
<td>0.308</td>
<td>2.843</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>C1</td>
<td>41</td>
<td>3.332</td>
<td>0.843</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Critical Values (t 0.05 =1.645, P< 0.05), Calculated Values (t 0.05 =2.843, P=0.001)**

The result in Table 10 indicated that the differences in students’ Post-test mean score in the SMDQ, between Experimental Group E1 and Control group C1 were statistically significant t-value=2.843, P-value<0.05. This indicated that, the Students’ Mathematical Disposition in the Experimental group E1 had relatively increased, and was statistically different from that of Control group C1. It was therefore concluded that the Constructivist Teaching Approach had a significant Positive effect on Students’ Mathematical Disposition, and thus the null hypothesis (H₀3) that stated that, there is no statistically significant difference in students’ mathematical disposition, between those that are exposed to constructivist teaching approach and those that are not exposed to it, was therefore rejected. Enyonam (2004), on his study Fostering Students’ Disposition towards Mathematics, established that students
who were self-directed, creative and task based, developed a positive disposition in mathematics. This is consistent with findings of this study since CTA emphasized on creative, critical thinking and perseverance in challenging problems, the result was an increased students’ mathematical disposition.

**Discussion of Results**

Based on the study, the researcher established that, the SMAT mean scores of Experimental groups $E_1$ and $E_2$, who were taught using constructivist teaching approach were superior and statistically different from those of Control group $C_1$ and $C_2$, who were taught through the conventional teaching methods. This implied that the use of CTA is effective in enhancing students’ achievements in the SMAT, thus improving performance as compared to the conventional teaching methods. Experimental groups $E_1$ and $E_2$, therefore outperformed the Control group $C_1$ and $C_2$, who were taught using conventional teaching methods. These results are in line with Audrey (2005) who found that the learners in constructivist mathematics classroom, are actively involved, the environment are democratic, the activities are interactive, student centered and the teacher facilitates the process of learning in which students are encouraged to be responsible and autonomous, resulting to improved performance. McAleese (2010), who investigated the effect of teaching science by use of constructivist model of learning, found that learners developed knowledge through active discussions that linked new knowledge to prior knowledge leading to higher science achievement. This is in line with Constructivist Teaching Approach in this study that emphasized the learners’ use of discussion, interaction and construction of knowledge from prior experiences.

In this study, the differences in students’ mathematics self-concept mean scores, between the Experimental group $E_1$ and Control group $C_1$ were established to be statistically significant at $P <0.05$. This indicated that, the Constructivist Teaching Approach had a significant positive effect on the Students’ Mathematics Self-concept. The CTA encouraged the learner’s to be reflective and inquisitive by asking thoughtful questions. Rawlinson (2006) found that, through exchange of ideas, the learners learned to ‘negotiate’ with others and to evaluate their contribution in socially acceptable manner. With social approval, the learner resulted to increased self-concept. The Constructivist Teaching Approach social dimension, promoted a classroom environment that emphasized collaboration and exchange of ideas, which increased learners’ social and communication skills, and with it increased self-concept. Marsh and Martin (2011), found that increase in positive self-concept leads to increase in subsequent academic achievement and other desirable educational outcome in mathematics. This study support this as use of CTA was found to result in an increased students’ mathematics self-concept.
The researcher also found that the differences in students’ mathematical disposition mean scores, between the Experimental group E₁ and Control group C₁ were statistically significant at P <0.05. This implied that, the Constructivist Teaching Approach was significant in increasing students’ mathematical disposition. Glenda (2009), in his study on Affective Influence in the Knowledge of Mathematics, point out that those students with positive disposition towards mathematics performed better than those with negative disposition. Douglaus (2007), found that positive disposition enabled learners to persevere in more challenging problems and to develop good working habits. In this study the use of Constructivist Teaching Approach encouraged learners to be creative, critical thinkers, discoverers, hands-on and task based a component of positive disposition. This resulted in the increase of students’ mathematical disposition.

Conclusion

Based on the finding of this study, the researcher concluded that; Students who were taught using the Constructivist Teaching Approach achieved higher scores than those taught using the conventional teaching method. This implies that the Constructivist Teaching Approach facilitates students learning in Mathematics better than the conventional teaching. The study also concludes that students taught using Constructivist Teaching Approach recorded a higher Students’ Mathematics Self-concept scores, indicating that the CTA enhanced a positive students’ mathematics self-concept, which can improve student performance in mathematics. Another conclusion by the study is that the Constructivist Teaching Approach facilitated in rising of students’ mathematical disposition, which is likely to improve the performance and hence better achievement in mathematics.

Recommendations

Based on the finding and conclusions, the following suggestions are recommended; The Constructivist Teaching Approach should be more emphasized in Mathematics teaching in secondary schools. Achievement is likely to improve and performance in KCSE examinations would be better; Mathematics teachers should be more encouraged to incorporate this approach in their teaching. CTA should be used in regular in-serving of teachers and that Curriculum developer to incorporate CTA in the Mathematics curriculum development.

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