

Influence of Self-Instruction on Mathematics Achievement among Students in Secondary Schools in Kenya

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Abstract

Achievement in Mathematics is a challenge to many students at secondary school level in Kenya, for instance students in Vihiga Sub County. Despite the government's effort in strengthening the subject, its performance is still wanting. The main objective of the study was to examine the influence of self-instruction on Mathematics achievement among students in secondary schools in Vihiga Sub-county. 'Self-instruction' was defined as a deliberate long-term learning project instigated, planned, and learned out by the learner alone, without teacher intervention. The Self-determination theory and Achievement Goal theory informed the study. The study adopted Mixed Methods approach and the Sequential Explanatory Design was used. The study targeted 1483 form four students, 35 Mathematics teachers, and 27 teacher counsellors. A sample size of 445 students, 11 Mathematics teachers, and 9 teacher counsellors were selected using stratified random, purposive and purposive sampling techniques respectively. Quantitative data was collected using a Students' Questionnaire while qualitative data was collected using interviews from students, teacher counsellors and Mathematics teachers. Students' achievement was assessed using K.C.S.E Exam results of the year 2017. Reliability of the questionnaire was ensured by Cronbach's alpha and a coefficient of alpha >0.7 was reported. Normality of data was tested by using Kolmogorov-Smirnov and Shapiro-Wilk (W) tests. Descriptive statistics such as frequencies and percentages were used to analyze quantitative data from questionnaires, while inferential statistics such as Regression Analysis and Pearson correlation coefficient were used to analyze quantitative data. On the other hand, thematic framework was used to analyze Qualitative data. The study found that there was statistically significant between self-instruction and Mathematics achievement ($r = .192, n=396, p < .05$). The findings showed that self-instruction predicted the achievement in Mathematics among secondary school students. The study recommended that the government in conjunction with the Ministry of Education should provide seminars and conferences for Mathematics teachers as a platform for constant reminder to teachers to avoid traditional modes of Mathematics teaching and embrace self-instruction strategy. This would enable Mathematic teachers to instruct their students in such a way as to enable them to take charge, control and evaluate their learning through self-instruction, hence enabling students to become autonomous learners in Mathematics. This is because the study reported that self-instruction has positive influence on Mathematics achievement among students in secondary schools.

Key words: Self-instruction, Mathematics achievement, Secondary schools.

1. Introduction

Formal education is a means of imparting and acquiring knowledge. This is done through teaching and learning within the school. The school system empowers the students with necessary knowledge and skills for an effective living in the society. It is expected that classroom learning be translated into solving problems in real life situation. UNESCO (2006) stated that the worldwide drive for “Education for all” lays emphasis on literacy in science and mathematics. Mathematics comes out clearly as a core subject to be learned. Atherton (2010) observed that Mathematics knowledge plays a crucial role in understanding contents of other subjects such as Chemistry, Physics, Biology and Geography, and related the importance of mathematics to the scientific, industrial, technological and social progress of a society. Despite its usefulness, students' achievement in Mathematics has been poor (Reddy, Van der Bergs, Jansey Van Rensburg & Taylor, 2012). According to Kurgat and Tanui (2013), performance in Mathematics has generally been poor in Kenyan schools yet it's a core subject in the curriculum, a good performance in it implies good performance in secondary education. Mathematics is an important school subject that is associated with more academic and career opportunities (Kosgey, 2013). According to Korir and Kemboi (2013), students' personal effort made significant contribution to the students' Mathematics achievement. Poor academic achievement in Mathematics has been reported in Kenya (KNEC, 2016).

2. Theoretical Framework and Literature Review

2.1 Theoretical Framework

This study was guided by self-determination theory (SDT) developed by Deci and Ryan in 1971 (Harakiewicz, Barron, Elliot & Thrash, 2002). SDT is an approach to human motivation and personality that uses traditional empirical methods while employing an organismic metatheory that highlights the importance of humans' evolved inner resources for personality development and behavioral self-regulation (Ryan, Kuhl & Deci, 1997). It deals with peoples' inherent growth tendencies and innate psychological needs that are the basis of their self-motivation and personality integration as well as conditions that foster those positive processes. Inductively using the empirical process, three needs are identified: the needs of competence (Harter, 1978), relatedness (Baumeister and Leary, 1995) and lastly autonomy (Deci, 1975). Self-determination theory addresses the energization issues as well as the direction issue. The theory informed the present study in that when applied to the realm of education is concerned with promoting in students, an interest in learning, a valuing of education and a confidence in their own capacities and attributes.

This study was also guided by Achievement Goal Theory developed by Ames in 1992 (Wolters, 2004). Achievement goals refer to the purposes or reasons for a person's pursuit in an achievement situation. Different purposes result in different patterns of cognition, affect, and behavior (Urduan & Midgley, 2003). To date, a full 2x2 crossing of the performance-mastery and approach-avoidance distinctions has been proposed by achievement goal theorists to account for the broad spectrum of competence-based strivings (Elliot & McGregor, 2001).

2.2 Literature Review

For self- instructed learning to occur, two conditions must be satisfied; firstly, the learner must take care of his learning by making decisions concerning all aspects of learning including determining the objective, defining progressions, selecting techniques used and

evaluating what has been acquired (Kan'an & Osman, 2015). To do this, the learner is trained in certain learning strategies like planning and organizing, evaluating, practicing, timed practicing, developing and using memory aids, getting help, asking for correction and peer-learning. Secondly, there must be a learning structure in which the learner can exercise control over the learning process. Therefore, for learners to succeed in self-instruction, they must have the skills to manage their own learning (Areepattamannil, 2012, Kan'an & Osman, 2015). According to Gitome, Katola, and Nyabwari (2013) the student who is self-instructed is disciplined. According to Gitome, Katola, & Nyabwari (2013), where there is good discipline, there is self-instruction and hence, there is improved academic performance.

Self-instructional strategy, in the context of this work, is a cognitive and metacognitive learning instructional strategy. It involves the use of designed instructional package so that students can learn either without a teacher's intervention or with minimum guidance while applying different learning skills and strategies. It is, therefore, a student centered learning strategy that focuses on the monitoring of cognitive processes of an individual's problem solving. Application of self-instructional learning strategy has been linked to student's performance improvement in solving word problems in Mathematics.

Montague, Enders, and Dietz (2011) engaged in a study to improve solving mathematical word problem for middle school students with learning problems by implementing Montague's Cognitive-Metacognitive instructional strategy in inclusive general education Mathematics classes. The findings were positive and support the efficacy of the intervention when implemented by general education math teachers in inclusive classrooms. Moreover, it can be asserted that Montague's model used to teach self-instructional strategy was a practical and useful one. The model was applied on learners in inclusive classrooms but present study looked at self-instruction among normal students in regular public schools in Vihiga sub County.

Another qualitative study was done in Iran by Haddadian, Alipour, Majidi, and Maleki (2012) which examined the effect of self-instruction technique on improvement of reading performance and reduction of anxiety symptoms in primary school students with dyslexia in city of Arak. The sample consisted of 32 primary school students with dyslexia and anxiety symptoms; they were selected via cluster random sampling and then were placed in two equal size groups of 16 in the experimental and control groups. This was an experimental research with pre-test, post-test, and a five month follow up test along with a control group. The experimental group received 12 sessions (each 45 minutes) of self-instruction technique. The instruments used in the design were Dyslexia Test, Wechsler Intelligence Scale for Children (WISC-R), and Ratter Behavioural Questionnaire. Results from the covariate analysis showed ($p < .0001$) that self-instruction technique had significant effect on improvement of reading performance and on reduction of anxiety symptoms in students. The reviewed study was done in primary schools with lower age while the current study was done on adolescents to fill the gap in age.

A study which was done by Narges (2015) investigated the effects of teaching the cognitive and meta-cognitive strategies (self-instruction procedure) on verbal math problem-solving (VMPS) performance of primary school students with VMPS difficulties. The experimental design using pre-test, post-test with control group was applied. The students were selected randomly from primary school and examined with VMPS test (pre-test). 60 of the students with VMPS difficulties were purpose fully matched in experimental and control groups (30

girls and 30 boys). During treatment experimental students received strategies instruction of 16 weeks of 45 min in 2 months during the school hours. The VMPS performances in each group are measured with post-test. The results of repeated measures analysis showed that teaching of cognitive and meta-cognitive strategies (self-instructional procedure) significantly improved performance of experimental group in both genders ($F=44.86$, $P<0.0001$). The reviewed study used the experimental design, hence the environment caused low realism, while the current study used sequential explanatory design which enabled high realism. Similarly participants aware of the experiment may have changed their behavior to suit the study hence affecting the study findings.

Another study done in Malaysia by Ashraf & Kamisah (2015) investigated the relationship between students' self-instructed learning readiness and their science achievement. 83 students were randomly selected from a secondary school in Qatar. The students' self-instructed learning readiness was measured by the Self-Directed Learning Readiness Scale (SDLRS) and their science achievement was determined by the science subject National Exam (NE) scores. The findings of the study showed that Students self-instructed learning readiness and their science achievement (SDLRS) total score significantly predicted the National Exam science subject score ($p = .049$). It was suggested that self-instructed learning is essential for students to be academically successful to their fullest potential. The reviewed study focused on science subjects but not Mathematics as was the case of present study.

A quasi-experimental study was done by Adani, Eskay, and Onu, (2012) about Effect of Self-instruction Strategy on the Achievement in Algebra of Students with Learning Difficulty in Mathematics in secondary schools in Nigeria. Two research questions and one null hypothesis were formulated to guide the study. The study adopted a non-randomized pre-test and post-test control group design with one experimental group using self-instruction strategy and a control group, learning through the "normal" conventional way of "teacher-directed" instruction. Two secondary schools in Nsukka education zone were used for the study. The population of the study comprised 855 students with learning difficulty in Mathematics in SSI (senior secondary school I) in secondary schools in Nsukka education zone. The sample for the study was 40 students with learning difficulty in Mathematics in community secondary school Isienu and community secondary school Umabor. Using the teacher's class achievement record, 40 students with learning difficulty in Mathematics were identified, 20 from each school. The result of the study showed that self-instruction was effective in improving the achievement in algebra of students with learning difficulty in Mathematics. The reviewed study was done in Nigeria and not in Kenya like the present study.

Anyichie and Onyedike (2012) carried out a study in Nigeria to investigate the effects of self-instructional learning strategy on students' achievement in solving Mathematical word problems. The research determined whether self-instructional learning strategy has significant effect on the learning achievement of senior secondary school students. The study utilized the non-randomized control group pre-test post-test experimental design. The sample consisted of 131 subjects with mean age of 16 years. The experimental group were instructed in four units of Mathematics syllabus using self-instructional method. On the other hand, the control group was taught the same topics in Mathematics using the conventional teaching method. Mathematics Achievement Test instrument developed and duly validated by experts was used to collect data. Data collected were analysed using mean for the research questions and Two-way Analysis of co-variance was used to test the hypotheses at 0.05 level of significant. The study found out that there was significant effect of self-instructional learning strategy on the

student's mathematical word problem achievement. The reviewed study was done in Nigeria and not in Kenya.

Ikwumelu, Oyibe and Ogene (2014) in their study which was done in Nigeria determined the effects of self-directed instructional method on secondary school achievement in Social studies. The study adopted quasi-experimental research design using JSSII students randomly selected into one experimental and one control groups. Data was collected using 34 items test and was analyzed using mean and standard deviation for research question while ANCOVA was used for the null hypothesis. The study revealed that students who learned Social studies using self-instructional method performed better than the students taught Social studies with conventional instructional method. Thus there is a significant difference between the mean achievement of students who learnt Social studies using self-instructional method and those who learnt with traditional methods of teaching. The reviewed study considered research in achievement in social studies, while the current study considered achievement in Mathematics to fill the gaps in literature. The reviewed study was done in Nigeria and not in Kenya.

2.3 Goal of the Study

The study sought to measure the Influence of Self-instruction on Mathematics Achievement among Students in Secondary Schools in Vihiga Sub County- Kenya.

3.0 Research Methodology

3.1 Research Design

The study was anchored on Mixed Methods Approach. According to Creswell (2014), in mixed method the researcher collects and analyses data, integrates findings and draws inferences using both quantitative and qualitative methods in a single study.

This study adopted the Sequential Explanatory Research design. This design lays priority on to the quantitative data, and the findings are integrated during the interpretation phase of the study. It is an important design that help explain, interpret or contextualize quantitative findings and help examine in more detail unexpected results from a quantitative study (Creswell, 2014). The current study involved collecting and analyzing quantitative and then qualitative data in two consecutive phases within one study. Priority was given first to the quantitative data collection and analysis in the study, after which the researcher went back to the field to collect qualitative data and analyzed hence, (QUAN-qual) notation (Creswell, 2014). The sequence of the data collection and analysis, and the stages in the research process for both the quantitative and qualitative data was connected and the results were integrated.

3.2 Research Participants

A study population is a collective term used to describe total quantity of cases of the type subjected to the study (Creswell, 2014). If this population is broadly defined, generalizability is maximized and confidence level is easily obtained because the sample is distributed in the same way as the population. Vihiga Sub-County has 27 public secondary schools with 1 boys' school, 3 girls' schools and 23 mixed schools (Vihiga sub county academic committee, 2015). A total of 1483 registered form four students who sat KCSE of the year 2017 comprised the study target population. The study population also comprised of 35 Mathematics teachers, 27 teacher counsellors and the 1483 form four students. The

Quantitative information about self-instruction was obtained through questionnaires from students, while qualitative data about the same was obtained through interviews from students, Mathematics teachers, and teacher counselors.

3.3 Research Instruments.

Reliable data depends on the precision of research instruments to be used. Therefore to have reliable data, suitable instruments necessary to provide high accuracy for generalization was used. This research employed the use of questionnaires and interview schedules to collect information from the respondents. Quantitative data was collected using a Students' Questionnaire while qualitative data was collected using interviews from students, teacher counsellors and Mathematics teachers. Students' achievement was assessed using K.C.S.E Exam results of the year 2017. A pilot study was carried out in three of the schools in Emuhaya sub-county. Reliability of the questionnaire was ensured by Cronbach's alpha and a coefficient of alpha >0.7 was reported. The efficacy expectation scale questionnaire which composed of 10 items had internal consistency of $\alpha = .782$; an indication that the instruments had adequate reliability for the study. In-depth interview schedules were administered to students, teacher counsellors, and Mathematics teachers in every school.

3.4 Data Collection Procedures.

The researcher visited the sampled schools personally. Quantitative data was rigorously collected from students using questionnaires. Creswell & Plano (2010) notes that "Respondents can be helped to overcome difficulties with questions, and that personal persuasion and reminders by the researcher can ensure high response rate." The researcher introduced herself to the school's head teachers before seeking further permission to meet and administer the questionnaires to the various respondents. The researcher then organized, analyzed the data collected, drew valid conclusions from it and presented the findings. The researcher thereafter went back to the field and collected qualitative data by administering interviews to students, teacher counsellors, and Mathematics teachers in every school. Ethical considerations protect the rights of participants by ensuring that participants are treated with respect and sensitivity beyond what may be required by law (Patton 2002, Radnor, 2005). To adhere to ethical issues permission was sought from the university in writing to conduct research with which the researcher sought for the permit to do the same before conducting the research. Again permission was sought from the Vihiga sub-county education office, and respective schools within the sub-county. The researcher identified herself to the students and gave them clear information of what the study was all about. Learners were given time to decide whether they would take part in the study or not by agreeing to sign consent forms. After their consent, data gathering tool was administered. The respondents were encouraged of their cooperation in participating in the study and that their responses were to be treated with utmost confidentiality. The respondents were assured of anonymity by concealing their identities.

3.5 Data Analysis

Researchers have asserted that data analysis involves the ordering, structuring and giving meaning to the mass of data collected (Cresswell, 2014). In this study, data analysis was done in two parts namely; Quantitative data analysis and Qualitative data analysis. Data gathered was loaded into the statistical package for social science (SPSS) Version 22 software for statistical analysis. Data file was created in SPSS to compile data from students'

questionnaire on Internal Locus of Control as well as students' achievement from their respective achievement tests scores. The quantitative data was analyzed by both descriptive and inferential statistics. Statistical techniques such as percentages, frequencies, Mean, Pearson's product-moment Correlation coefficient, and regression analysis were used. Confirmation of study findings were further done using ANOVA and scatter plot. Qualitative data was analyzed thematically depending on the themes arising from respondents' responses to interview schedules.

4.0 Findings

The study objective was investigated by use of descriptive and inferential statistics. Descriptive statistics was used to explore the level of self-instruction while inferential statistics helped to investigate the influence of student self-instruction on Mathematics achievement. To investigate whether there was any statistical significant influence of self-instruction on Mathematics achievement among students in secondary schools in Vihiga Sub County, the null hypothesis was tested. The null hypothesis tested was: *There is no Statistical significant influence of self-instruction on Mathematics achievement among students in secondary schools in Vihiga Sub County.* To do this, a Pearson Product Moment Correlation Coefficient was computed, with scores on self-instruction as independent variable and student Mathematics achievement as dependent variable. The scores of the independent variables were computed from frequency of responses and converted into continuous scaled data by computing mean responses per respondents, where high scale ratings implied high perceived student self-instruction. However, the dependent variable was the 2017 KSCE student scores in Mathematics. The p-value was set at .05, the null hypothesis was rejected when the p-value was less than .05 but it was accepted when the p-value obtained was greater than .05. Table 4.1., shows the correlation analysis results in SPSS output.

Table 4.1.

Influence of Student Level of Self-Instruction on Mathematics Achievement

		Self-instruction	Mathematics achievement
Self-instruction	Pearson Correlation	1	.192**
	Sig. (2-tailed)		.000
	N	396	396
Mathematics achievement	Pearson Correlation	.192**	1
	Sig. (2-tailed)	.000	
	N	396	396

** . Correlation is significant at the 0.01 level (2-tailed).

Table 4.1 shows that there was statistically significant, though weak, positive correlation [n= (396), $r = .192$, $p < .05$] between student level of self-instruction and Mathematics achievement, with high level of student self-instruction concomitant to high student Mathematics achievement and vice-versa. Given that the relationship was established to be statistically significant ($p < .05$), the hypothesis that, "*there is no statistical significant influence student level of self-instruction on Mathematics achievement*" was rejected. Consequently, it was concluded that student level of self-instruction has significant positive influence on Mathematics achievement among secondary school students.

In addition, to estimate the level of influence of self-instruction on Mathematics achievement, a coefficient of determination was computed. This was done using of regression analysis and the result was as shown in Table 4.2. *Model Summary on Regression Analysis of Influence of Student Level of Self-Instruction on Mathematics Achievement*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.192 ^a	.037	.034	.72838

a. Predictors: (Constant), Self-instruction

The model in Table 4.2 shows that student level of self-instruction accounted for 3.7% ($R^2 = .037$) of the variation in Mathematics achievement among the students in public secondary schools. However, to determine whether self-expectancy was a significant predictor of Mathematics achievement, Analysis of Variance (ANOVA) was computed as Table 4.3.

Table 4.3. ANOVA –*Influence of Student Level of Self-Instruction on Mathematics Achievement*

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8.007	1	8.007	15.092	.000 ^b
	Residual	209.033	394	.531		
	Total	217.040	395			

a. Dependent Variable: Mathematics achievement

b. Predictors: (Constant), Self-instruction

From Table 4.3, it is clear that the level of self-instruction was a significant predictor of Mathematics achievement among the secondary school students [$F(1, 394) = 15.092, p < .05; R^2 = .037$]. This further proves that level of student self-instruction significantly influences student's Mathematics achievements among the secondary school students.

However some respondents during interview expressed their opinion contrary in the sense that, even though there are some students in their school who performed poorly, the teacher remained key determinant in students' achievement in Mathematics.

“Although our Students who have low level of self-instruction perform poorly in Mathematics and vice versa, my opinion is that the teacher remains the key factor in students' achievement in Mathematics. [Mathematics Teacher 8]

The qualitative data finding indicated that self- instruction is effective generally for influencing Mathematics achievement. Application of self-instruction significantly improved Mathematics performance of students with difficulties in solving Mathematics problems. Although from the qualitative data, most students with Mathematics difficulties tend to attract special attention from their teachers who feel that these kind of students are helpless without them. From the current findings, such students can be assisted by Mathematics teachers and Teacher counsellors to gain a better attitude toward Mathematics problem solving and be successful, rather than fully relying on their teachers as the main source of instruction. Absence of Mathematics teacher control can enable personalization of Mathematical tasks hence, basing them on the learner's own interests, and this may also increase retention of input throughout learning.

5.0 Discussion

Based on the objective of the study, learners are aware that self-instruction has an influence on their Mathematics achievement as supported by qualitative data. However, from quantitative study findings, there is a correlation between students' achievement and self-instruction. The findings agree with study done in Iran by Haddadian, Alipour, Majidi, and Maleki (2012) which showed that self-instruction technique had significant effect on improvement in students' achievement.

6.0 Concluding Remarks

From the findings of the study, the researcher recommended that the government in conjunction with the Ministry of Education should provide seminars and conferences for Mathematics teachers as a platform for constant reminder to teachers to avoid traditional modes of Mathematics teaching and embrace self-instruction strategy. This would enable Mathematics teachers to instruct their students in such a way as to enable them to take charge, control and evaluate their learning through self-instruction, hence enabling students to become autonomous learners in Mathematics. This is because the study proved that student self-instruction significantly influenced student's Mathematics achievements among the secondary school students.

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