

# Flipped Classroom Approach and Acquisition of Problem Solving Skills in Mathematics in Secondary Schools in Turkana County

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## Abstract

In a flipped classroom, learners study structured mathematics content prior to the lesson via watching relevant videos outside the lesson. This study initiated the use of flipped classroom approach in mathematics classrooms in order to strengthen learners' problem solving skills and impact performance. Reviewed literature shows a positive correlation between using flipped classroom approach and problem solving. The study design is quasi-experimental. One group of participants was instructed via flipped classroom approach and the other conventional methods. A comparison of problem solving ability between the groups was made. The form two students and their mathematics teachers were the target population. Data was collected by means of an achievement test and means calculated per group. The inferential statistic, t-test was used to determine if the difference in means between the experimental and control group in the achievement test was significant. The study found that where flipped classroom approach is used, learners performed better in mathematics problem solving than their counterparts instructed via conventional methods.

**Keywords:** Flipped Classroom Approach, Problem Solving in Mathematics

## 1. Introduction

The flipped classroom model is one in which, by using internet technology, learners watch teacher created/selected videos outside of class time (Overmeyr, 2014). This is done so that the teacher can spend more time attending to learning difficulties learners may have during class time. In this approach, students learn basic subject matter prior to in-class meetings, then, come to the classroom for collaborative learning experiences. The classroom is flipped in that what used to be 'class work' is done at home while what used to be 'assigned problem solving' is now done in class.

Long, Cummins & Waugh (2017) note that using a flipped classroom can motivate students towards active learning, improve their higher-order thinking skills, as well as their collaborative learning skills. The study however focused on instructors' perspectives and it reports improved teaching and learning when using the flipped classroom model. In a study examining the effect of the flipped classroom instructional strategy on student learning outcomes, Cheng, Ritzhaupt & Antonenco (2019) concluded that it was a good way to structure learning experiences in order to improve learning outcomes. Their research however cut across several subject areas and was not specific to mathematics only. According to Mattis (2015) flipped classrooms are meant to effectively blend traditional and online education by using both in and out of class time. While focusing on college level students, the study examined

accuracy and mental effort at three levels of mathematical complexity and holds that accuracy increased while mental effort decreased with flipped instruction.

In documenting how technology is changing education in Africa, Kubickova (2019) says the interactive approach of educational technology encourages students to acquire problem solving skills which will be vital in the job market. Although the focus was not mathematics, the flipped classroom, it says, usually involves using technology to access information and documents the advantages of students becoming familiar with technology at a young age. Furthermore, using flipped classrooms not only promotes problem solving but also helps students' access global education. Maurice et al. (2014) reports on the challenges of integrating ICTs in education in Africa. In a study underpinning the importance of ICTs, it observes that, the twenty-first century teacher in Africa needs to adopt new trends of teaching and learning using ICTs. This will encourage students to search for information, obtain opportunities to practice, analyze and develop new understanding in their areas of learning. While not restricting itself to mathematics instruction, the study roots for ICTs integration as it promotes student centered learning. This, it says, converts students from passive recipients to learning initiators which is the premise of a flipped classroom approach.

The rationale for the introduction of the competence based curriculum in Kenya, emphasizes the need to equip learners with technological skills (KICD,2019). In a study on transferring power from teachers to students, Owino (2020) details the use of flipped classroom in a marketing class. Success is reported in that the flipped classroom encouraged students to think through the content resulting in improved overall performance evidenced by better grades. The study recommends blending the flipped classroom with other pedagogies as it complements the students learning experiences. Kithinji (2020) investigated whether the flipped learning approach resulted in increased achievement amongst primary school children in science instruction in Meru County. Not only did achievement improve, but students' attitudes towards homework and independent learning were improved when using the flipped classroom.

### **Statement of the Problem**

A survey conducted by SMASE (2021), revealed that majority of teachers favored teacher centered modes of lesson delivery as they resulted in fast syllabus coverage and less preparation time. Teaching by telling, in mathematics may not contribute to acquisition of problem solving skills and may contribute to the dismal performance in mathematics.

### **Purpose of the Study**

The purpose of the study was to initiate, monitor and support the use of flipped classroom approach in mathematics instruction in secondary schools in order to determine its impact on problem solving.

### **Objectives**

The objective of the study was to find out the differences in problem solving ability between learners predominantly taught using flipped classroom approach and those taught by conventional methods. This was done by considering the null hypothesis;  $H_0$ : there is no significant difference in problem solving ability between learners predominantly taught using flipped classroom approach and those taught by conventional methods.

### **Significance and Justification for the Study**

The study contributes towards increased use of technology in mathematics instruction as flipped classroom activities necessitate reliance on technology for success. This lays ground for technological advancement by both learners and teachers. The study is also expected to impact acquisition of 21<sup>st</sup> century skills of creativity, critical thinking communication and collaboration which are necessary life

skills. In sifting through information for problem solving, learners sharpen their critical thinking skills and acquire effective communication etiquette for presentation during class. By prioritizing the flipped classroom in the study schools, the study increases awareness of this instruction innovation amongst mathematics teachers creating more opportunities for individualizing instruction.

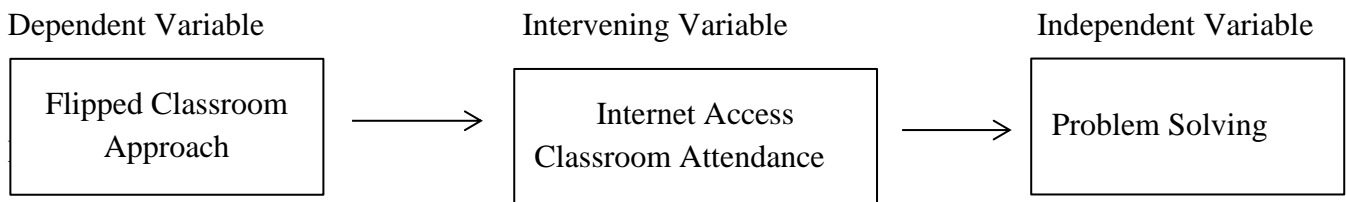
**Scope of the Study.**

The model for using flipped classroom approach is developed from a topic (linear inequalities) in the secondary school syllabus (KICD, 2012).The study involved only form two students in Turkana County and their teachers. A comparison of achievement in problem solving questions was made between learners instructed by the model and those by conventional methods.

**Conceptual Framework**

The study is hinged upon a constructivist foundation where understanding comes about as a result of building mental structures from preexisting pieces of information. Jaworski (2009) says, in constructivism the learner is not a passive recipient of knowledge rather an active participant in the construction of his understanding. Suffice to say, knowing is active, individual and personal hence in flipping the classroom the individual learner actively constructs meaning of mathematics concepts out of class and conversationally shares his findings in a class session in order to learn.

**Figure1: Relation between the Independent and Dependent Variables**



**Figure1:** Shows that the independent variable flipped classroom can be affected by internet access and learner classroom attendance. The dependent variable is achievement in problem solving tasks.

**2.0. Literature Review**

Teachers are entrusted with choosing the teaching method that best delivers the content to be learnt. According to Owino (2006) not much attention has been channeled towards adjusting teaching methods for effective delivery of skills required by students. This is so yet, learning outcomes depend upon the methods used by teachers (Johnson, 2019). Additionally, the method of teaching can create either an independent thinker and problem solver or a dependent knowledge seeker. Learner centered modes of teaching have been advocated over time for resulting in better learning outcomes (Ouko, 2016; Cheng,2019 ). Thus, propelling learners to discover knowledge using a flipped classroom serves the dual purpose of acquisition of knowledge and acquisition of problem solving skills. Johnson (2015) defines a flipped classroom as one in which the learner is active and relies on active techniques and modern technologies to engage in the learning process. While engaging with the learning materials students build their analytical abilities and become skilled in problem solving.

Not only do students take responsibility for their own learning when using this model, but it also frees up time for gainful engagement between teachers and students during the class sessions, thereby allowing teachers more time to address the unique learning needs of learners. Indeed a study comparing achievement between learners taught by the conventional classroom methods to those taught by the flipped classroom approach, Overmeyr (2016) reports that those in the flipped classroom outperformed

their regular class in an achievement test on algebra. This is not surprising given that the 21<sup>st</sup> century children are accustomed to information technology and would much rather spend an hour or two on you tube, a laptop or tablet than sitting in rows listening to the teacher's lecture. Instead of reading out of a textbook, the learners would prefer to surf the internet and, with advances in technology such as cloud computing, teacher tube and screen cast.com sharing of video resources becomes easier making them more accessible to both students and teachers.

### **3.0. Research Design**

This study adopted a quasi- experimental research design. This design is suitable because the researcher is attempting to test a causal hypothesis between instructional approach used and achievement in problem solving in mathematics. The flipped classroom approach is the 'intervention' being tested for how it impacts problem solving as measured by an achievement test. The study uses a comparison group –instructed via conventional methods to capture what would have been the outcomes had the status quo been maintained.

This study used two groups which were subjected to an achievement test at the start of the experiment. The purpose of this pre-test was to verify that the groups were matched in achievement at the beginning of the experiment and to be able to link any differences in achievement in the post test to the treatment. The control group was instructed via conventional methods and the treatment group via the flipped classroom approach. The two groups then were subjected to an achievement test which formed the basis for the hypothesis test.

#### **Study Location**

The study was conducted in Turkana south sub county of Turkana County which is in the north western part of Kenya. There are eleven public secondary schools in the sub county. The municipality is a cosmopolitan area within Turkana County with good internet connectivity. All schools in the study area have internet access.

#### **The Study Population**

The population of interest is the form two class, this is because the 'treatment' was developed on the topic linear inequalities usually taught at that level according to the KICD syllabus in use. The topic of interest was selected because of its wide application to problem solving in other topics within the same curriculum as well as after school. The mathematics teachers of each sampled class also participated in the study.

#### **The Sampling Procedure**

Data obtained from the sub-county education office indicated that there are approximately 2200 form two students in Turkana south sub-county at the time of the study. Taking a confidence level of 95% with a confidence interval of 5 yielded a sample size of 241 participants. A typical classroom in Turkana County sits about 40 students in a class therefore 6 schools participated in the study. Simple random sampling was used to pick the six schools. In each school, the mathematics teacher of the sampled class participated in the study. The six intact classes were randomly assigned to either the control or experimental group.

#### **Data Collection Instruments**

Data was collected by means of an achievement test developed by the researcher. The Secondary Students Achievement Test (SSAT) is a one hour written test measuring the problem solving ability of the respondents. The test required mastery of content in linear inequalities and its applications.

**The Treatment**

The study sequenced peer instruction videos to be watched and other instructional activities over the treatment period. The researcher prepared an instructional plan to be used to derive lesson plans in the topic linear inequalities. The subject teachers of the relevant classes were inducted in a workshop on how to integrate flipped classroom approach in their teaching schedules. Relevant video links were provided as well as other reference materials available online. Teachers participated in creating their own teaching videos to complement what is available online. The students interacted with the learning material via videos watched prior to each lesson and did the tasks outlined in each video. During the classroom session, the teacher then attended to any difficulties learners met while watching the videos and learners participated in problem solving.

**Data Analysis**

The t-test was used to compare the means of the experimental and the control groups. Both the pre-test and post-test were marked and scored out of a maximum score of 50. The score per student was used to obtain the mean for each group, control and experimental. The researcher used the statistical package for social scientists to generate an independent samples T-test which was used to test hypothesis at  $\alpha = 0.05$ . In the study, the control group was the one under conventional methods of instruction tagged  $\mu_1$  and the treatment group was the one instructed via flipped instruction and tagged  $\mu_2$ . The t-test involved determining whether the differences between the means  $\mu_1 - \mu_2$  was significant.

**Table 1: Pre-Test Results**

	Mean	S D	S E M	S E D
$\mu_1$ (N = 132 )	31.2	7.4	0.644	0.848
$\mu_2$ (N = 128)	32.7	6.2	0.548	

S D Standard Deviation

SEM Standard Error of Measurement

SED Standard error of the Differences

From the table, the estimate for the difference  $\mu_1 - \mu_2$  is -1.500, taking a 95% Confidence Interval for the difference yielded -3.170 to 0.170. The hypothesis test  $H_{01}: \mu_1 - \mu_2 = 0$  against  $\mu_1 - \mu_2 \neq 0$  yielded a t-value of 1.7689 with p-value 0.0781 at 258 degrees of freedom. This was a two tailed test which was compared to the pre-determined  $\alpha$  level of 0.05. By conventional standards the difference between the means is not statistically significant as  $0.0781 > 0.05$ . Hence the study concludes that the experimental and control groups were matched by achievement at the start of the experiment.

**Table 2: Post-Test Results**

	Mean	S D	S E M	S E D
$\mu_1$ (N = 132 )	34.02	7.2	0.6267	0.83
$\mu_2$ (N = 128)	38.7	6.12	0.5409	

S D = Standard Deviation

SEM = Standard Error of Measurement

SED = Standard error of the Differences

From the table, the standard deviations are close enough to assume equal variances hence the t-test of independent samples  $H_0: \mu_1 - \mu_2 = 0$  versus  $H_a: \mu_1 - \mu_2 \neq 0$  is valid. The estimate for the difference  $\mu_1 - \mu_2$  is -4.6800 and taking a 95% Confidence Interval for difference yielded -6.3143 to -3.0457. The SPSS



yielded a t-value of 5.6391 with p-value 0.0001 at 258 degrees of freedom. Thus the hypothesis test  $H_{01}: \mu_1 - \mu_2 = 0$  against  $\mu_1 - \mu_2 \neq 0$  was a two tailed test which was compared to the pre-determined  $\alpha$  level of 0.05. By conventional standards the difference between the means is statistically significant as  $0.0001 < 0.05$ . Hence we reject the null hypothesis and conclude that our sample data supports the claim that the population means are different. Suffice to say that because high scores are better, in this case using flipped classroom model yielded a higher mean than using conventional methods, then using flipped classroom approach in instruction is significantly better than teaching using conventional methods.

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### Authors Biography

The researcher is a lecturer of mathematics education in Turkana University College.

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