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Composite Instructional Method and Its Effect on Secondary School Students' Academic Achievement in Fluid Flow Physics in Mt Elgon Sub-county, Kenya

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Abstract Physics is one of the sciences that are applicable in day to day life activities. Physics ideas are also required in other science subjects such as biology and chemistry. It is evident that Physics related courses from tertiary level are very marketable. Despite of this importance and value of Physics, performance at Kenya Certificate of Secondary Examination has remain dismal, hindering students from doing Physics related courses at tertiary level. This paper reports findings of a study that investigated the effect of Composite Instructional Method in comparison with Conventional Instructional Method on students' academic achievement in fluid flow physics. The study was done in Mt Elgon Sub-county of Bungoma County. A sample of 300 participants was selected through simple random sampling The adopted a Pre-test, Post-test non Equivalent Quasi experimental design. Achievement tests were used to collect data of students' academic achievement. Reliability of the instruments was determined using the test and retest method while their validity was established from experts' comments and advice. The collected data were analyzed using independent samples-t-test to determine the effect of Composite Instructional Method on students' academic achievement in fluid flow physics. The research finding has implications on physics curriculum reforms by the Ministry of Education.

Keywords: *attitude, academic performance, fluid flow*

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1. Introduction

Physics is one of the science subjects taught at secondary school level. It deals with the study of matter, energy and their interaction. According to the report from International Technical school of academic (2010), the study of physics in schools and universities is undoubtedly relevant to the students and society today. Physics students usually possess excellent analytical, quantitative and problem solving skills. They have the ability to synthesize and analyze large quantities of data and present their analysis in an easily understandable form.

When faced with particular problem, learners are taught to systematically identify all factors contributing to the problem and work out how those factors interact in order to solve the problem. These are valuable skills that can be applied in range of careers. Perhaps the greatest skill a Physics student develops is a sense of how things work. For students with ambitions in other areas such as business management or finance, the study of Physics during senior school is also important even if those students don't intend to study Physics or science at university. Physics sharpens observation skills and instills problem solving skills. Physics demands respect from many employers and university administration officers since it provides students with analytical, problem solving and quantitative skills. Physics is a driver of economic growth. From energy generation to novel medicines, Physics and physics based business plays crucial role in driving innovation and development of new technologies. Physics laws of optics describing the way light behaves have led to development of the optical fiber networks that are beginning to crawl over the entire globe drawing the world closer together. Students taking physics at secondary school level have a wide range of careers that they can take at university level and middle colleges. These include: Engineering, Medicine, Nursing, Agricultural, Teaching, Survey, Food technology, Architecture, Agricultural Education, Computer Science, Range Management and Fisheries. In addition we have physics teachers and university lecturers.

At higher level, the braches of Physics include particle Physics, quantum mechanics, fluid dynamics and plasma Physics. According to [1] fluid flow is a sub discipline of fluid mechanics that deals with flow of fluids (liquids and gases) in motion. It has several sub topics itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion). Fluid flow has a wide range of applications, including calculating forces and moments on aircraft, determining the mass flow rate of petroleum through pipelines, predicting weather patterns, understanding nebulae in interstellar space and modeling fission weapon detonation. Some of its principles are even used in traffic engineering, where traffic is treated as a continuous fluid flow. Fluid flow is the study of fluid i.e. liquids and gases in motion. It is studied in form two syllabuses. The solution to a fluid dynamics problem typically involves calculating various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time.

Referencev [6] shows that Physics is amongst the subjects performed poorly. In addition Physics has constantly registered the lowest enrolment. The content of physics at secondary school level was revised so as to reduce its difficulty. Despite this, performance in the subject has not changed. Fluid flow physics is feared by most of learners because of it being too mathematical in content. The approach that teachers in secondary school use to teach this topic of fluid flow is lecture method and laboratory work. The teachers provide the students with apparatus and students perform experiment themselves following given instructions. This approach has continuously registered poor performance and negative attitude in Physics classes. Due to poor performance in Physics in KCSE examination, the current study was to find out how composite instructional method affected the performance of student in fluid flow physics. Composite Instructional Method was a new method that comprised of demonstration by teacher, student to student involvement in practical work and class discussion. Refeence [13] have presented a conception of factors affecting teaching and learning process in any behavioral setting for effective learning. Some of the main factors include: learner entry behavior and their ability and teacher contacts his classes, group entry behavior and abilities, Physical setting and outside forces. The composite instructional method has considered all these factors in order to motivate students.

The Composite instructional method utilizes the following steps; prediction step, experience step and reflection step. In prediction step, it connects the class demonstration with students' prior experience. Reference [11] found that carefully prepared demonstration helps students to generate the type of knowledge that are likely to help them learn from subsequent lessons. Individually and then with a partner, students explain to each other a set of possible outcomes that is likely to occur. In experience step, students work in small groups, conduct experiment, and analyze data to determine whether their initial predictions were confirmed or not. The reflection step students internalizes and critically thinks of outcomes and relates with prior knowledge, this enhances students' achievement and develops in students the ability to learn independently. Reference [10] suggests that lecture without such preparation often causes students to fall back on memorization rather than understanding.

The main objective of the study was to find out if there is any mean difference in academic achievement between students taught fluid flow physics using composite instructional method and those taught using Conventional Instructional Method. To achieve this objective the following null hypothesis was tested at a significance level of $\alpha = 0.05$.

$H_{o\ 1}$: There is no mean difference in performance in fluid flow physics by treatment groups.

The alternative hypothesis was; H_a: There is a difference in group means.

2. Materials and Methods

2.1. Research Design

The study adopted a quasi experimental, Pre-test, Post-test nonequivalent design was. The reason for making use of this design is because random assignment of participants in the study is not possible. Most school administrations would not accept to re-organize the classes because of the study which will only take short period of time to affect the whole school program [12]. Quasi experimental Designs are widely used in the evaluation of teaching intervention because it is not practical to justify assigning students to experimental and control groups by random assignment [1]. The Pre-test, Post-test nonequivalent design can be conceptualized as follows.

Table 1. Pre-test, Post-test Nonequivalent Design

E	0_1	X	0_2
C	0_3	-	0_4

Where,
E- Experimental group
C- Control group
X – Treatment condition (Composite Instructional method)
0_1 and 0_3- Pre-test,
While 0_2 and 0_4 – Post-test.

2.2. Participants

Stratified random sampling was used to classify Mt. Elgon sub-county into four strata (divisions) i.e. Kaptama, Kapsokwony, Kopsiro, and Cheptais strata. This is because schools in region were not homogeneous. Purposive sampling was used to select eight (8) schools. This was because the study was targeting only average performing schools, i.e schools having mean score of between 4 and 7, while simple random sampling was used to assign four (4) schools to experimental group and four control group. A Form two class was randomly selected from each sampled school. A total of 300 hundred students participated in the study, selecting a minimum of 37 students from each school. This is according to [3], who recommended that at least 30 subject per group be selected.

2.3. Instruments

Two Student Achievement Tests (SAT) were used to measure academic achievement of the respondents. SAT 1 was administered to the two groups as pre-test to determine the entry behavior of the students in form two classes. SAT 2 was administered to the two groups as post-test to find out the effect of treatment in fluid flow physics.

2.3.1. Student Achievement Tests, SAT 1.

The Student Achievement Test, SAT 1 was set and moderated by researcher with assistance of physics teachers in the physics department. SAT 1 had ten Questions and the total marks were 30 comprising of recall questions, application and experimental questions. SAT 1 was designed to measure performance in the basics of the fluid flow Physics of the two groups of students after Composite Instructional Method and Conventional Instructional Method was used at initial stage as the pre-tests. This was administered after students were introduced to fluid flow physics within the first week of the study to test the students' entry behavior in form two classes.

2.3.2. Student Achievement Tests, SAT 2.

The Student Achievement Test, SAT 2 was also set and moderated by researchers with assistance of physics teachers in the physics department. SAT 2 had eleven Questions of fluid flow physics which were extracted from past KCSE papers and KLB physics book two and the total marks were 30 comprising of recall questions, application and experimental questions. SAT 2 was designed to measure performance of students in fluid flow physics after using the Composite Instructional Method and Conventional Instructional Method.

2.4. Validity of Instruments

This is an extent to which the research instruments measure what is intended to be measured. According to [7], there are three types of validity i.e. Content Validity, criterion validity and Face Validity. This paper assessed Content and Face Validity. Content Validity is the extent to which measuring instrument provides adequate coverage of the topic of study. Face validity which is related to how measuring instrument appears, how it is designed and if there is enough space for provision of answers. Thus, the researchers sought expert opinion concerning the research instruments from supervisors and other one expert from the Department of Mathematics and Science Education. The researchers therefore relied on supervisors on content and face validity to ensure that they measure what they were intended to measure. The experts rated the validity of the instruments out of 10 marks and average of each expert was done and also average rating of content and face validity was done.

Table 2. Expert opinion on Face and Content Validity of the Research Instruments

Expert	Content Validity mark(10)	Face Validity mark(10)	Average Validity Mark (10)	Remark
1	7	8	7.5	Above average
2	7	6	6.5	Above average
3	6	8	7	Above average
Total(average)	6.667	7.333	7.000	Valid

From the above information, instruments were adopted after changes were made on Student Achievement Questionnaire, SAT 1. Based on the comments that were given by the experts, the rating was above average i.e., content validity average score was 6.667 while face validity had average score of 7.333 and overall average of all experts were found to be 7.000.

2.5. Reliability of Instruments

The reliability of the achievement tests were established through the use of split half technique. This was used to establish consistency of the instruments after administering. The completed tests were randomly selected and then divided into two equal halves then all the items in the instruments were then scored and the scores correlated by Pearson's Coefficient Correlation(r). The reliability correlation coefficient of the instruments was found to above 0.7. This confirms that the instruments were reliable to be used to measure performance [3].

2.6. Data Collection Procedures

The research permit was obtained from National Commission for Science, Technology and Innovation (NACOSTI) through the Dean of the School of Graduate Studies (DSGS) of MMUST to collect data. After obtaining the research permit, researcher requested permission from the county commissioner of Bungoma and County Director of Education to carry out research from the area. After obtaining permission, researcher contacted the principals of sampled schools about intention of collecting data from their schools. Finally teachers from the sampled schools were invited for a workshop of two days about the two methods that was used. Thereafter the SAT1, SAT2 and SAQ were administered to the students in experimental and control group of the study. During the period of study experimental group was taught using Composite Instructional method while the control group was taught using Conventional Instructional methods.

2.7. Data Analysis

Descriptive analyses were conducted to examine the measures of central tendency (mean) and dispersion (standard deviation) while independent samples t-test was conducted to assess the group mean differences.

3. Results

3.1. Descriptive Statistics

Results of descriptive statistics for pre-test are reported in Table 3.

Table 3. Mean Scores and Standard Deviations of SAT 1 by Treatment Groups

	Treatment Group	*N*	*M*	*SD*
Pre-test	Experimental Group	150	16.10	3.858
	Control Group	150	15.43	3.494

Examination of academic achievement for fluid flow physics test (SAT1) demonstrates that the groups were homogeneous. The mean of pre-test of control group was slightly lower than the mean of experimental group. The pre-test mean for control group was slightly lower (M=15.43, SD = 3.494) than that of experimental group (M= 16.10, SD = 3.858).

Table 4. Mean Scores and Standard Deviations of SAT 2 by Treatment Groups

	Treatment Group	*N*	*M*	*SD*
Post Test	Control Group	150	16.75	3.818
	Experimental Group	150	21.22	4.689

Similarly, examination of academic achievement for fluid flow physics test (SAT2) demonstrates group mean differences. The post-test mean for control group was much lower (M=16.75, SD = 3.818) than that of experimental group (M= 21.22, SD = 4.689).

To determine whether the mean differences revealed by descriptive statistics were significant, an independent samples t-test was conducted for both pre-test and post test. Results are reported in the subsequent sections.

3.2. Primary Results

To examine the significance of the mean differences in both pre-test and post-test, two independent samples t-tests were conducted. .Results are reported in Table 5.

Table 5. Results of Independent Samples t-test

	Df	*t*	*p-value*
Pre-test	298	1.584	0.114
Post-Test	298	11.633	0.01

For the pre-test, results of independent samples t-test indicates that there was no significant difference between treatment groups on achievement test in fluid flow physics (t_{298}=1.584, p=0.114). This implies that the groups were equivalent at the start of the treatment

Similarly, for the post-test, results of the independent sample of t-test indicates a significant difference between treatment groups (t_{298}= 11. 633, P=0.01). The null hypothesis is thus rejected in favor of the alternative. This shows that composite instructional method is superior to Conventional Instructional method.

4. Discussion

Basing on the findings and the literature reviewed it is clear that Composite Instructional Method is influential on students' performance as compared to Conventional Instructional methods [9]. This Findings from the study showed that students taught by composite method of instruction performed better than those taught by conventional method on fluid flow test (SAT2). This implies that composite method of teaching is superior to conventional method. This finding is consistent with findings of previous studies [5]. When Composite Instructional method is used it makes students to be active allowing application of new information in problem solving. First hand use of new materials enhances understanding of physics concepts [4]. Composite Instructional method heightens understanding in students and sticks in their mind longer. The finding is also consistent with [8] who concluded that activity-based environment coupled with interactive discussion and homework are superior to traditional methods for enhancing conceptual development, experimental techniques and scientific literacy. The advantage of Composite Instructional is that it forces students to articulate and defend their understanding of the problem or mathematical concepts. Explaining to each other in such way that they make sense of it is a good way of testing the coherence of one's own understanding and may itself lead to deeper processing of the material and more abstraction in thinking [5].

5. Conclusions

The main objective of the study was to find out if there was difference on student achievement in fluid flow physics when taught using Composite Instructional Method and Conventional instructional method. Results indicated that students taught by composite instructional method outperformed their counterparts taught conventionally. Therefore composite instructional method is superior to conventional method. It improves performance in fluid flow physics.

6. Recommendations

Following the findings of the current study it is recommended that Composite Instructional method be adopted in all schools in teaching physics. This is because the new method led to improvement in students' achievement. In addition, middle-level colleges and higher learning institutions of learning should incorporate Composite Instructional method in curriculum instruction technology to enhance conceptual understanding.

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Statement of Competing Interests

The authors have no competing interests.

List of Abbreviations/Acronyms

KNEC:	Kenya National Examination Council
KCSE:	Kenya Certificate of Secondary Education.
SMASSE:	Strengthening of Mathematics and Science in Secondary Education.
SAT:	Student Achievement Test
KLB:	Kenya Literature Bureau
NACOSTI:	National Commission for Science, Technology and Innovation
DSGS:	Dean School of Graduate Studies
MMUST:	Masinde Muliro University of Science and Technology.

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