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Impact of smasse programme on gender difference in the achievement of physics by secondary school students in Bomet County, Kenya

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Abstract
Science subjects are the backbone of the scientific and technological advancements in the world. Achievement in science subjects in secondary schools in Kenya has been below average. The low achievement in the national examinations has been attributed mainly to teacher centered teaching approaches used by teachers. In an attempt to address the low achievement in Physics, the Strengthening of Mathematics and Science in Secondary Education (SMASSE) teaching program was introduced through In-service Education and Training INSET) in the whole of Kenya in 2004.Therefore, this study was an attempt to fill this gap. The objectives of the study were; to find out whether SMASSE approach had impacted the achievement in physics and whether there was a gender difference in the achievement in Physics among secondary school students in Konoin sub-county. The study used expost-facto research design as well as a survey research design. Stratified and systematic sampling was employed to select schools for this study. The population was the KCSE candidates in Konoin Sub- County and the accessible populations were the 2000-2003 candidates before SMASSE was introduced and 2012-2015 KCSE candidates immediately after. There was a total of 5017 candidates in this target class in 24 secondary schools in Konoin Sub-County in period 2000-03 and 5204 in the period 2012-15. The schools were in 3 categories, these were extra-County, county, and sub-county schools and both stratified, systematic sampling and purposive sampling were used to select 12 schools with a total of 1013(685 boys and 328 girls) students for the period 2000-2003 and 1390 (1009 boys and 381 girls) in the same 12 schools for the period 2012-2015 took part in this study. The research instruments used for the study were a Document analysis tools. Descriptive and inferential statistics were used in the analysis of data, a one-way ANOVA was used as inferential statistic to test the null hypothesis. All statistical tests were subjected to a test of significance at coefficient alpha (α) of 0.05. The study found out that there was no statistically significant difference between those students who were exposed to SMASSE and those who were not. The findings may inform decisions and action towards improving teaching and learning of Physics in Kenya. The study also may help to sensitize teachers, curriculum planners, policy makers and other education stake holders as far as SMASSE program is concerned on the areas that require improvement.

Keywords: SMASSE approach, Physics students' achievement

1. Introduction
Science education is crucial in human lives and in the development of nations around the world, as it contributes much towards economic empowerment of nations (Aoki, 2001) [1]. Science knowledge has been utilized in scientific inventions in medicine, engineering and technology towards solving most of the human problems (Das, 1985) [6]. Over the years, science has contributed to the improvement of quality of human life (Mori, 2017). Most basic Human needs have also been met through scientific inventions. Furthermore, Science education yields a new knowledge, new skills and new desirable attitudes for the learners (Kerich, 2004).

Teaching science would therefore equip students with the established body of scientific knowledge appropriate to their needs, interests and capacities (Millar, 2004) [16].

There have been several changes in science teaching approaches and methods. A number of innovations came into being with far reaching effects across many parts of the world. In the United Kingdom, Nuffield Science Project (NSP) was launched in 1962.This project was sponsored by the Nuffield Foundation. In Kenya, Science subjects were included in school curriculum through the School Science Project (Kenya Institute of Education, 1969). The School Science Project (SSP) was designed especially for those schools with well-equipped laboratories. The SSP required students to carry out investigations and discuss their findings and finally draw conclusions with the help of their teacher. Wachanga (2005) [24] pointed out that in 1984 the 8-4-4 education system was introduced in Kenya with the aim of making education more relevant to the needs of Kenyan society. The 8-4-4 education system revised syllabi of Biology, Physics and Chemistry in all secondary schools in Kenya was done by Kenya Institute of Education (KIE,1992), currently called Kenya Institute of Curriculum Development (KICD). These science syllabi emphasized on science content and methods which could be directly applicable to the immediate environment of the students.

Physics curriculum has also undergone several changes starting from 1958 when physical Science Curriculum Study (PSCS) was established in the United States with the following objectives; to examine classroom Physics materials available before 1960, produce a Physics curriculum which encourages creative and imaginative approach to the study of Physics, and the teaching and learning of Physics through inquiry and use of leaner's environment as the starting point in Physics education. PSCS influenced the launch of Nuffield Science Project (NSP) in United Kingdom in 1962.In Kenya, the development of Physics curriculum was initiated by the Kenya Institute of Education, United Nations Educational Scientific and Cultural Organization (UNESCO) through the African Curriculum Development Centre (ACDC) in 1963.There was the Nuffield Science Project of 1969 which adopted the learning of the natural science (Biology, Physics and Chemistry) in selected secondary schools in Kenya. The introduction of the 8-4-4 secondary school Physics syllabi followed a recommendation of the Presidential Working Party in 1981 that stipulated the 4-year Physics course. The importance of studying Physics is; relate and apply relevant Physics knowledge and understanding to social and economic development in rural and urban settings, demonstrate resourcefulness, technical skills and scientific thinking necessary for economic development, acquire firm foundation of relevant knowledge, skills and attitudes for further education and training in related scientific fields (Majani, Kelemba&Maina,2003).

A national assessment survey carried out in 1999 by the Ministry of Education (MOE), resulted in the revision of secondary education Physics curriculum in Kenya. The revised curriculum was to address aspects necessary for industrial transformation by the year 2030 (MOE, 2002). The revised syllabus has many practical activities unlike the previous one that had small scale practical activities; this is still the syllabus in use to date. The consistently low performance in the science subjects in the KCSE is what prompted the ministry of education in Kenya to introduce SMASSE as an intervention measure.

Students' achievement in Physics in Kenyan secondary schools was and is still below average. In an attempt to address this poor achievement, the Government of Kenya introduced SMASSE program. It is not clear how this program has impacted on the students' achievement in Physics in Konoin Sub-County of Bomet County. The study therefore aimed at examining whether SMASSE program has had any impact on students' achievement in secondary school Physics in Konoin Sub-County. The teaching of physics by teachers requires the use of a lesson plan which normally has three sections namely; a short introduction, a body of content and a brief conclusion. The SMASSE approach introduced Activity, Student-centered, Experiment and Improvisation (ASEI) in the body of the conventional lesson plan for the students and the Plan, Do, See and Improve (PDSI) for the teacher. There is always an activity for the learners in the lesson before the summary by the teacher.

1.1 Purpose of the Study

The purpose of the study was to assess the impact of SMASSE program on students' achievement in Physics in Konoin Sub-County secondary schools. The study was also to assess the impact of the program on the students' achievement by gender in Physics.

1.2 Objectives of the study

The study was guided by the following objective;

To find out whether there was a difference in students' Physics achievement before the introduction SMASSE program (2000-2003) and after the introduction of the SMASSE program (2012-2015) in Konoin sub-county in terms of gender.

1.3 Hypothesis of the Study

To achieve the objective of the study, the following the following hypothesis was tested:

Ho: There was no statistically significant difference in students' achievement in physics in Konoin sub-county before (2000-2003) and after (2012-15) the introduction of SMASSE program in terms of gender.

2. Research Design and Methodology

This study employed expost-facto research design using comparative research method. The expost facto research design utilized the document analysis tool to review and evaluate documents. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge (Corbin & Strauss, 2008).In this particular study it looked at the Physics achievement in KCSE before the inception of SMASSE (2000-2003) and after (2012-2015) in terms of gender For this study it was hypothesized that any improvement in Physics achievement would be due to the students' exposure to SMASSE approach after its inception in 2004 employed by the individual schools.

3. Data analysis

Data collected using the document analysis tool was analyzed in order to obtain the information required in the study. Data analysis was based on the objectives and the hypothesis of the study. These data were analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0. A one-way ANOVA was used to analyze scores on achievement in Physics at a

significance alpha level of 0.05 which determined whether to accept or reject the null hypotheses of the study. The hypothesis was tested at 95 % level of significance and the data presented in form of tables. The-test in this study was used to test if there was any statistically significant difference in the means before and after exposure to SMASSE while the ANOVA was to test if there was any significant difference in the means of the two groups i.e., Boys schools and Girls schools before the exposure to SMASSE and after.

4. Demographic characteristics of the population

The population under study consisted of both boys and girls from extra-county, county and sub-county schools in the sub-county. The extra county and county were single gender while sub-county schools were mixed gender.

5. Results from the study

This section presents the results of the analysis of the collected from the 12 sampled schools and the discussion of the analyzed results.

The overall students' achievement in physics is as shown in Table 1 and Table 2, the Mean scores of the two periods were used to asses the overall achievement.

Table 1: KCSE Physics results before SMASSE was introduced for the sampled schools 2000-03

Year	Gender	Entry	Mean Score
2000	Boys	242	6.02
	Girls	118	4.33
2001	Boys	272	6.03
	Girls	97	4.77
2002	Boys	148	6.01
	Girls	109	5.22
2003	Boys	299	5.23
	Girls	152	4.07

Average mean Boys = 5.22 Girls = 4.88

From table 1, results show that four years before SMASSE approach was introduced the boys and girls mean score was 5.24 and 4.88 respectively

Table 2 shows achievement in KCSE four years (2012-2015) in the sub-county after SMASSE was introduced; the mean grades of the schools were 5.22 and 4.46 for boys and girls respectively.

Table 2: KCSE Physics results after SMASSE was introduced in the sampled schools 2012-2015

Year	Gender	Entry	Mean Score
2012	Boys	329	5.78
	Girls	123	5.05
2013	Boys	318	4.07
	Girls	129	3.83
2014	Boys	298	5.80
	Girls	101	5.13
2015	Boys	367	4.83
	Girls	125	3.83

The tables above clearly show the means in physics achievement in schools with the introduction of SMASSE approach. The results show that four years before SMASSE approach was introduced; the achievement mean were 5.24 and 4.88 respectively. Four years after SMASSE approach was introduced the achievement was 5.13 and 4.76.

Table 3 shows the entries from the 12 schools, the entries are the overall mean grade of the school regardless of the gender. These entries were obtained from school records from the sampled schools in the sub-county.

6. Results analysis

This section presents the results of the analysis of the collected data from the 12 sampled schools and the discussion of the analyzed results. Table 3 shows the entries from the 12 schools. The entries are the overall mean grade of the school regardless of the gender.

Table 3: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
2000	239	2.83	8.81	5.705	1.832
2001	278	2.87	8.08	5.464	1.611
2002	187	3.24	6.65	4.490	1.196
2003	309	2.23	7.56	4.462	1.621
2012	349	3.77	7.59	5.235	1.116
2013	261	2.78	7.82	4.879	1.385
2014	306	4.11	7.18	5.544	0.894
2015	384	1.7	7.95	4.599	1.636
No of student (Entry number)	2403	23	273	90.750	68.484
Average grade before SMASSE	1009	2.79	7.395	5.0302	1.560
Average grade after SMASSE	1009	3.99	7.96	5.064	1.487
Valid N (list wise)	1390				

Table 4 shows the entries from the 12 schools. The entries are the overall mean grade of the school in terms of the gender.

Table 4: Means per school in terms of gender

Year		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
2000	Boys	180	5.5912	1.43428	4.3921	6.7903	4.02	8.06
	Girls	59	4.9861	1.29270	3.9054	6.0668	3.11	7.11
	Total	239	5.2886	1.35554	4.5663	6.0110	3.11	8.06
2001	Boys	208	5.2018	1.61251	3.8537	6.5499	2.78	8.21
	Girls	70	4.8283	1.45308	3.6135	6.0431	2.92	7.42
	Total	278	5.0151	1.49531	4.2183	5.8119	2.78	8.21

2002	Boys	102	5.7554	.96457	4.9490	6.5618	4.78	7.44
	Girls	85	5.3721	.89300	4.6255	6.1187	4.11	7.18
	Total	187	5.5638	.91951	5.0738	6.0537	4.11	7.44
2003	Boys	195	4.9940	2.26466	3.1007	6.8873	1.70	8.80
	Girls	114	4.4199	1.20721	3.4106	5.4291	3.11	7.09
	Total	309	4.7069	1.77802	3.7595	5.6544	1.70	8.80
2012	Boys	253	6.0833	2.04817	4.3709	7.7956	3.22	9.52
	Girls	96	5.2767	1.91405	3.6765	6.8769	2.44	8.11
	Total	349	5.6800	1.95980	4.6357	6.7243	2.44	9.52
2013	Boys	248	5.6654	1.77772	4.1792	7.1517	3.18	8.51
	Girls	103	5.2615	1.73285	3.8128	6.7102	2.55	7.64
	Total	261	5.4635	1.70868	4.5530	6.3740	2.55	8.51
2014	Boys	225	4.6874	1.03362	3.8233	5.5515	3.63	6.24
	Girls	81	4.1774	1.35210	3.0470	5.3078	2.84	6.65
	Total	306	4.4324	1.19209	3.7972	5.0676	2.84	6.65
2015	Boys	283	4.4504	1.58435	3.1259	5.7750	2.58	7.37
	Girls	101	4.4263	1.86402	2.8679	5.9846	1.88	7.56
	Total	384	4.4383	1.67123	3.5478	5.3289	1.88	7.56

The mean of mixed schools was separated into the two entries of boys and girls for the two periods from (2000-2003) and (2012-2015). The table shows the standard deviation as indicated for each year in both periods before and after.

Table 5 shows the one-way ANOVA test for the two periods before the exposure (2000- 2003) and after (2012-2015) and their associated F-Values.

Table 5: ANOVA sum of squares

ANOVA						
		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
2000	Between Groups	1.465	1	1.465	.786	.390
	Within Groups	26.098	14	1.864		
	Total	27.562	15			
2001	Between Groups	.558	1	.558	.237	.634
	Within Groups	32.982	14	2.356		
	Total	33.539	15			
2002	Between Groups	.588	1	.588	.680	.423
	Within Groups	12.095	14	.864		
	Total	12.683	15			
2003	Between Groups	1.318	1	1.318	.400	.537
	Within Groups	46.102	14	3.293		
	Total	47.421	15			
2012	Between Groups	2.602	1	2.602	.662	.429
	Within Groups	55.010	14	3.929		
	Total	57.612	15			
2013	Between Groups	.653	1	.653	.212	.652
	Within Groups	43.141	14	3.082		
	Total	43.794	15			
2014	Between Groups	1.041	1	1.041	.718	.411
	Within Groups	20.276	14	1.448		
	Total	21.316	15			
2015	Between Groups	.002	1	.002	.001	.978
	Within Groups	41.893	14	2.992		
	Total	41.895	15			

Tale 6: One-way ANOVA of the means of Gender

		N	**Mean**	**Std. Deviation**	**95% Confidence Interval for Mean**		**Min**	**Max**
					Lower Bound	**Upper Bound**		
Average before SMASSE	Boys	685	5.386	1.251	4.340	6.431	3.99	8.13
	Girls	328	4.902	1.004	4.062	5.741	4.00	6.79
	Total	1009	5.144	1.124	4.545	5.743	3.99	8.13
Average after SMASSE	Boys	1013	5.222	1.534	3.939	6.504	3.15	7.91
	Girls	381	4.785	1.556	3.485	6.086	2.43	6.93
	Total	1390	5.004	1.510	4.199	5.808	2.43	7.91

Table 6 shows a comparison of the average means of the boys and girls in the two periods Analysis of variance (ANOVA) was used to test for statistical differences in the means as shown in table 7 below.

Table 7: Comparison of students' physics achievement by gender before and after the introduction of SMASSE ANOVA

Anova						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Average before SMASSE	Between Groups	.937	1	.937	.728	.408
	Within Groups	18.014	14	1.287		
	Total	18.951	15			
Average after SMASSE	Between Groups	0.761	1	.761	.319	.581*
	Within Groups	33.427	14	2.388		
	Total	34.188	15			

Critical values (F =4.60,α=0.05) calculated values (F= 0.319, P=0.581)

Table 6 shows a comparison of the average means of the boys and girls in the two periods. The standard deviation in the above study for the boys achievement was 1.251 while that for the girls was 1.004 which shows that the spread of the means of the boys is higher than that of the girls before the introduction of SMASSE .The standard deviations for boys and girls was 1.543 and 1.556 respectively before and after the exposure to SMASSE .This could be explained by that only girls who had a higher academic ability selected physics while boys of varying academic abilities selected the subject before the exposure to the SMASSE .It could also mean that teachers were no longer discouraging weak students from taking up the subject after undergoing the SMASSE training.

7. Discussion of the Results

The hypothesis of the study sought to find out if there was a statistically significant difference in students' achievement in physics in Konoin sub-county before (2000-2003) and after (2012-15) the introduction of SMASSE program in terms of gender.

The alternative hypothesis H_A stated that there was a statistically significant difference in students' achievement in physics in Koinon sub-county before (2000-2003) and after (2012-15) the introduction of SMASSE program in terms of gender.

The significance level α=0.05, the computed value of the test F = 0.319 statistic as shown in table 14 and the critical value $F_{0.05(1,14)} = 4.60$.

Since 0.319 <4.60 we therefore fail to reject the null hypothesis. At α=0.05 of significance, there is not enough evidence to conclude that there is a statistically significant difference in achievement by physics students before (2000-2003) and after exposure (2012-2015) to SMASSE in terms of gender in Koinon sub-county.

The findings of this study agree with findings of Langat (2009) [15], Ndiku (2011) and Sifuna & Kaime (2007) who established that the SMASSE INSET had not improved student's performance in mathematics in some secondary schools in Kenya. Similarly, Keitany K (2014) [12] in his study on the impact of SMASSE INSET on student's performance in Physics, teaching approaches and methodologies and teachers and student's attitude towards Physics found out that despite improvements in the student's attitude and teacher's teaching instructional practices, performance was still poor.

However these findings disagree with findings of Kwamboka (2012) [14] who in her study on the application of the principles of Activity-Student-Experiment Improvisation/Plan-Do-See Improve (ASEI/PDSI) by mathematics teachers in secondary schools of Nakuru District, found that schools had adequate, professional and SMASSE trained teachers, school facilities and teaching-learning resources were adequate while mathematics instructional sessions were teacher-dominated with little or no active involvement of students. Prevalent during lessons was the use of text books and the chalkboard, lessons lacked extensive student activities. Application of ASEI/PDSI principles was invisible, teachers' and students' attitude towards mathematics and ASEI/PDSI principles was relatively positive albeit factors that hinder their application. Similar findings were also found by Kisangi (2009), who investigated the extent to which lessons in Japanese schools were interactive and student-centered for purposes of adaptation in the Kenyan situation. Findings revealed that learning at senior high school level was less interactive. Similarly, in his study, Yara & Otieno (2010) postulates that student achievement in physics depends on the way it is presented to learners, the way learners actively interact with the learning experiences presented and the environment within which these interactions are taking place.

8. Conclusion and Recommendations

From the findings, it is evident that SMASSE teaching approach has had a negligible impact on the difference on gender achievement in physics in the sub-county. The approach should therefore be should be modified for the teaching of physics in the secondary schools to try and close the gap in achievement of physics between boys and girls. The physics curriculum developers should also design the teaching-learning materials in line with the SMASSE teaching approach to encourage more girls to take up the subject and improve their achievement in physics.

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