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RESEARCH ARTICLE

PROVISION OF LEARNING RESOURCES AND OTHER STRATEGIES TOWARDS IMPROVING SCIENCE EDUCATION IN SECONDARY SCHOOLS IN BARINGO CENTRAL, KENYA

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Abstract

Following the realization that standards were falling and interest of science among learners in many countries was waning, a good number of research studies and policy reviews have been commissioned internationally, regionally and even locally to avert the situation. The government of Kenya attaches a lot of importance to education as exemplified by a good proportion of the allotment of the Government's expenditure on learning and teaching resources and in particular to Science education. This paper examines instructional intervention strategies which affect the teaching and learning processes based on a study of science education in Baringo Central District in Kenya. It is also concerned with establishing whether teachers' intervention in learning can boost science performance given the adequate instructional resources. An empirical study design was adopted for this investigation. The research instrument used was the questionnaire which was categorized into two: one for the students and another for the teachers. Respondents were divided into homogenous subgroups and stratified random sampling was used to identify three schools where three science teachers and a total of 36 students, 12 from each school were involved. The findings were analyzed using a descriptive approach for quantitative data while interpretative approach was employed for the qualitative data respectively. It was established that efforts have been made to improve the state of science education in schools through the purchase of more science equipment, employment of more science teachers, purchase of more textbooks and organizing for retraining of teachers. There is need to organize for regular In-Service Education Trainings (INSETs) for teachers and curriculum implementers in order to enable participants to put in the necessary effort and time to ensure attainment. It is expected that, through the findings of the study and the discussions in this paper, the participants will be conversant with and be diligent practitioners of the Plan, Do, See, Improve (PDSI) and Activities, Students, Experiments and Improvisation (ASEI) ideals for quality teaching and learning.

Introduction

The education sector in Kenya has undergone a series of reforms since independence. At independence, the education system that was adopted was that left by the British Colonial government. The structure was: 7-4-2-3, that is, seven years of Primary Education, four in Junior Secondary, two in Senior Upper Secondary (Popularly known as "A" level), and three years at University (Mackay, 1981). Many commissions, committees and task forces were set up by the government to review the education system from time to time (MOEST, 2005). The Ominde report (1965) and Sessional paper no. 10 of 1965 addressed the need for production of human capital through Education for national development

(MOEST, 2005). The Gachathi report of 1976 provided further insights on redefining education policies to be in tandem with the country's social, economic and cultural needs. Specifically, the key area that education was to address was the elimination of poverty, disease and ignorance.

Close to two decades after independence, the solutions that were envisaged that education would offer for the country's immediate needs were far from being realised and this necessitated the restructuring of the whole education system. The Presidential Working Party on the Second University in Kenya (Mackay, 1981) made radical changes that overhauled the education system in the country. One year was added to the primary category to make eight years, two were dropped from the secondary sector and one was added to university, i.e. eight years of Primary education, four for Secondary and four for University. The new system, better known as 8-4-4, was implemented in 1985 (first standard eight class) and its full cycle was realised in 1994 when the first cohort completed University education.

Under the 8-4-4 system, students graduating at every stage were expected to have some scientific and technological knowledge for self employment or further education (MOEST, 1984; MOEST, 2005). In order to accomplish this objective, the curriculum was changed to suit the needs of the new system. Subjects were placed in groups as follows: the first being compulsory subjects (Core) which include Kiswahili, Mathematics and English. Group II comprised of Sciences: Physics, Chemistry and Biology. Group III: Humanities which comprised History, Religious Education and Geography. While group IV was Applied Science subjects like Agriculture, Woodwork, Metalwork, Home science, Electricity, Aviation, Building and Construction and Computer studies. The last group (Group 5) categorised as 'others' included Business studies, German and French. Science subjects were made compulsory for all students. This curriculum structure was revised in 2002 to allow a less burden-some number of compulsory subjects and content thereby creating more freedom for students to choose option subjects (Elimu Yetu Coalition, 2003).

In the new subject arrangement, there are thirty-two subjects being offered at Secondary school level, all are examinable at Form IV except Physical Education. A student is expected to take a minimum of seven subjects comprising the core subjects (Compulsory); English, Kiswahili and Mathematics, any two of the Science subjects (Physics, Chemistry and Biology) and at least one from the humanities (history, Geography and CRE) and at least one from either group four or five to qualify for certification at the end of Form IV (KNEC, 2006). The highest achiever attains grade A per subject and the lowest gets grade E in the Kenya Certificate of Secondary Education (KCSE) done at Form IV.

In the recent past, the Government has pursued a course to revamp the education sector in a bid to comply with the changing local and global trends. Many policy papers and strategic plans have been designed and disseminated to schools for the operations within the education sector. Sessional Paper No. 1 of 2005 is now the blue print for operations within the education sector in the country. The Kenya Education Sector Support Programme (KESSP) is the engine for infrastructural development funding, monitoring and evaluation of projects. Vision 2030 is an intersectoral supra framework which charts the path towards making Kenya a middle income country (MIC) by 2030. The Vision 2030 identifies education, Science, technology and innovation as important facets to help achieve the goal (Republic of Kenya [RoK], 2007a). Under this strategy, it is targeted that by 2012, a literacy rate of 80% and an enrolment rate of 95% will have been realised in schools. Performance in science and technology will also be at international ranking, as far as the plan is concerned (RoK, 2007).

The Ministry of Education manages education from pre-school to secondary level while the Ministry of Higher Education takes over all post secondary education. There are key agencies commonly termed as Semi-Autonomous Government Agencies (SAGAS) which support the ministry in offering specialized service. The services of these SAGAS are centralised except in some situations where satellite units are established at the district and provincial offices. The Teachers Service Commission (TSC) employs, deploys, remunerates, promotes and disciplines teachers. The Kenya Institute of Education (KIE) designs, revises and disseminates the curriculum to schools while at the same time vets and approves course books and reference books from various publishers before they are used in schools. The Kenya National Examinations council (KNEC) evaluates the curriculum through national examinations at the end of primary and secondary school level including teacher training colleges (MOEST, 2005). These examinations are done once in a year.

In 1985, Kenya changed her education system from 7-4-2-3 to the current 8-4-4 (Mackay, 1981). The change-over made science subjects compulsory in all Kenyan public schools. The new education policy found many schools ill-equipped to start science

classes. The new education system's high demand for science facilities and teachers hardly gave room for the teachers' professional development on how to implement the new curriculum. This has remained so for some time even whenever the curriculum was revised. However, students in Kenya sit for National Examinations that are centrally set, moderated, marked and graded (KNEC, 1998). According to KNEC (2008), students' overall performance in science subjects has been declining over the years. It has been argued that one way of addressing the difficulties learners experience in science classrooms is through appropriate teaching interventions that can be realized through professional development of science teachers for example in the Strengthening of Mathematics and Science in Secondary Education (SMASSE) Project. It is hoped that professional development programmes for science teachers will equip teachers with appropriate teaching skills and instruction strategies that are necessary to effectively implement science curricula in schools.

Statement of the Problem

Since the inception of the 8-4-4 system of education, the teaching of science subjects in Kenya has become a matter of debate due to poor performance in the national examinations by many candidates. This is an indication that the teaching and learning of these subjects in secondary schools has not been successful. It is important that teachers identify the teaching and learning problems in sciences and seek intervening solutions to this perennial problem. There is also need to establish a system of follow-up and monitoring to determine whether the resolutions arrived at in science seminars and workshops are actually used to improve the situation in the classroom. The science teachers should therefore make an effort to plan for what they are to teach well in advance.

However, it is not usual to see a science teacher relying almost entirely on a textbook for his/her teaching with no schemes of work, lesson plans and only occasional reference to the syllabus. It should be remembered that a course largely succeeds or fails due to the way it is taught. On the other hand, it should be noted that science teaching is such a personal art that it should be wrong to suggest any single, rigid approach to science teaching and learning. The effectiveness of what is taught depends to a large extent on the amount and quality of planning put in before the class.

This creates a dialectic scenario where questions can be raised about whether there is any correlation and continuity between the science done in primary and secondary given the fact that the examining body is the same. Some of the government strategies with regard to the improvement of science trickle down to the district and by end of 2008, a grant totalling Ksh10,439,487 had been disbursed to schools from the national laboratory equipment programme (MOEST, 2008). More strategies need to be identified and implemented to improve the teaching and learning of science in secondary schools in Kenya.

Efforts and Strategies to Improve Science Education

Following the realization that standards were falling and interest of science among learners in many countries was waning, a good number of research studies and policy reviews were commissioned internationally, regionally and even locally to avert the situation. Initiatives such as 'Science for ALL' (Fensham, 1985) and 'Science for the 21st Century' are shaping the debates at global levels on recent trends in Science Education. The evaluation of science under the Trends in International Mathematics and Science Study (TIMSS) programme started in 1995 looks at Science progress in developed countries at grade 4 to 8. Many countries have come up with their own national initiatives, for example in Africa, there is the Science Education In-service Teacher Training Programme (SEITT) in Zimbabwe, Science Education in Secondary Schools (SESS) in Tanzania, Female Education in Mathematics and Science (FEMSA); in Namibia, there is the Mathematics and Science Teachers Extension Programme (MASTEP) which upgrades junior secondary schools by further training (World Bank, 2007).

The Strengthening of Mathematics and Science in Secondary Education in Kenya (SMASSE), gives teachers in-service training in Science and Mathematics. The programme emphasises the student-centred approach to teaching through ten-day training during holidays for three years. Vision 2030, a government strategic plan for the economic and industrial development of the country, identifies Science and Technology as key to its realisation (RoK, 2007). The government provides grants to ten schools per district in the country for the purchase of science equipment. However, there is little or no information from the literature reviewed here that examines initiatives at the school level, hence this is what this study was set to address.

The SMASSE Project

The need to induct teachers through an in-service programme was occasioned by the declining performance in science subjects. The government of Kenya in cooperation with the Japanese government and working through the Japan International

Cooperation Agency (JICA) developed the SMASSE (INSET) programme for science teachers in secondary schools. The main purpose was to upgrade the capability of secondary school science teachers in Kenya (Sifuna & Kaime, 2007). This operates using a cascading system targeting all the science teachers in the country for induction using learner-centred approach. The programme is an offshoot of the findings of a baseline survey that was conducted to ascertain the state of science education in Kenya (Sifuna & Kaime, 2007). The findings indicated that there were gaps in the process of curriculum implementation in secondary schools.

As a way of reinforcing the pedagogical skills that enhances student involvement in learning, the project coined an acronym summarizing the approaches as ASEI (Activity, Student, Experiment and Improvisation) and PDSI for, Plan, Do, See and Improve. The SMASSE programme is organized in four cycles, each cycle taking ten days during August holidays. The project started in 1998 and has since been rolled out to the whole country. SMASSE has its internal evaluation unit called SPIAS (SMASSE Project Impact Assessment Survey). This is meant to assess the impact of ASEI movement and, PDSI approach on the teaching of science in schools (SPIAS, 2005). In most of its findings, the impression is that SMASSE has succeeded in changing the teaching strategies that teachers use. However, according to a research conducted by Sifuna and Kaime (2007), SMASSE has not brought about any serious changes in classroom practices in science learning in Kenyan secondary schools. Teachers acknowledged the fact that SMASSE has helped orientate them to be student focused and adapt a pupil-centred teaching approach. When students were asked about the classroom practices, they contradicted the teachers' position on the teaching methodology.

Limitations of the Study

This study was carried out within a span of two months. The duration was too short considering the level of the expected work. The author feels that the work was not exhaustive enough in terms of identifying situations that require more interventions to improve science education in Kenya. However, the data presented and discussed in this paper sheds light on the intervening efforts to improve science education in the region. In addition, the teachers who filled the questionnaire knew the researcher who is a deputy principal of a secondary school within the district. There is therefore a possibility of distortion in reporting information with regard to the state of science education in the region. The sample could be further widened in future in order to capture a bigger number of schools and respondents in order to improve on generalization. The research instrument could be triangulated using other research methods like interview and observation in order to improve on validity of the information given.

MATERIALS AND METHODS

The study used an empirical mixed method research design. In this research, both qualitative and quantitative methods were utilized, thus necessitating the use of mixed methods. Baringo Central District is within the North Rift region of the Rift Valley Province and has 47 secondary schools and 120 primary schools (RoK, 2007b). Performance in Science education in the District has been below average. The marked contradiction between the performance in primary and secondary schools nationally is reflected, especially in national examinations.

The population that was targeted for the research was science students and teachers in secondary schools in the District. There were a total of 9,052 students and teachers in the 47 secondary schools in the district. Out of these, a sample of three schools, thirty-six students and nine teachers were sampled for the study. A stratified random sampling technique was selected. This method was used to identify schools according to their categories. The Kenyan secondary schools are classified into three main categories: national schools, which are endowed with facilities and select the best performing students, provincial schools which are moderately equipped and which admit students of average and above abilities. The third category is the district schools; most of these are under-equipped and admit average students. In order to get fair distributions of respondents, using a purposive sampling technique; one school was selected to represent national schools. Because there was no national school within the District, the best performing school was selected using purposive sampling. The selected school was a boys' school. A second school, to represent the provincial category, was a girls' school and the third school to represent district school was also selected using the stratified random sampling technique. Other factors such as their geographical distribution across the three divisions in the District were also considered.

The normal secondary school establishment in Kenya is that there are four levels: Forms 1, 2, 3, and 4. In order to guarantee fair distribution of respondents, three chances were allocated to each level per school and the individual respondents were chosen through random sampling. The selection of teachers was done mainly through a purposive approach, that is, subject teachers majoring on science. It was only science

teachers who were allowed to participate. In schools with many science teachers like in the boy's school, random sampling was employed. A total of 45 respondents participated in the research; 36 students, 12 per school and9 teachers, 3 per school.

The tool that was used to collect data was a questionnaire. A coding scheme was devised which made it easy to compare, collate and contrast responses. Initially, pre-processing was done to iron out cases of unanswered questions, repetitions and any discrepancy that arose during the answering of the questionnaire which could in a way interfere with the process of analysis. Missing data was given its own code (D/A). Each school was given an initial: the boys' school became P, the provincial girls' school became Q and the district mixed school became R. All quantitative data were analysed through a descriptive method, put in frequency tables, converted into percentages and represented in tables and figures. The qualitative data was analysed using an interpretative approach, arranged according to themes, and classified in form of the most common themes in line with the research questions.

RESULTS AND DISCUSSION

Learning Resources

Pupil Textbook Ratio (PTR) in the Sciences

Physics

The text book ratio in Physics is mainly one between 1 and 3, according to thirty respondents (83.3%). A small proportion of the learners, 5(13.9%), felt that the text book ratio ranges between one text per 4-6 students, as shown in Table 1. Further in Table 1 it seen that there are more Physics text books than Biology and Chemistry. Comparatively, the text books ratio in Physics in the boys' school is good, whereas in the girls' school more students share one copy. The mixed school was relatively well stocked with Physics text books; 10 of the respondents from that school said the text book ratio was between one and three students per book. However, there seemed to be a small proportion, 2, who felt that the text ratio was between 4 and 6.

Table 1 Pupil Textbook Ratio in Physics

Pupils	Boys' school	Girls' school	Mixed school	TOTAL	%
1-3 pupils	11	9	10	**30**	**83.3**
4-6 pupils	1	2	2	**5**	**13.9**
7-10 pupils	0	1	0	**1**	**2.8**
10 and above	0	0	0	**0**	**00**
Total	**12**	**12**	**12**	**36**	**100**

Table 2 Pupil Textbook Ratio in Biology

PUPILS	Boys' school	Girls' school	Mixed school	TOTAL	%
1-3 pupils	10	9	10	**29**	**80.5**
4-6 pupils	1	0	0	**1**	**2.8**
7-10 pupils	1	3	2	**6**	**16.7**
10 and above	0	0	0	**0**	**0**
Total	**12**	**12**	**12**	**36**	**100**

Table 3 Pupil Textbook Ratio in Chemistry

PUPILS	Boys' school	Girls' school	Mixed school	TOTAL	%
1-3 pupils	10	10	9	**29**	**80.5**
4-6 pupils	1	0	1	**2**	**5.6**
7-10 pupils	0	1	2	**3**	**8.3**
10 and above	1	1	0	**2**	**5.6**
Total	**12**	**12**	**12**	**36**	**100**

Table 4: The Frequency of Performing Practical per Week

No. of times	Boys' school	Girls' school	Mixed school	TOTAL	%
Once	11	5	6	**22**	**61.1**
Twice	0	3	4	**7**	**19.4**
Thrice	1	1	0	**2**	**5.6**
Four times	0	3	2	**5**	**13.9**
Total	**12**	**12**	**12**	**36**	**100**

Table 5: Strategies that have been put in Place to Improve Science Education

Strategies	Boys' school	Girls' school	Mixed school	TOTAL	%
Yes	10	4	4	**21**	**58.3**
No	0	6	7	**10**	**27.8**
D/A	2	2	1	**5**	**13.9**
Total	**12**	**12**	**12**	**36**	**100**

Biology

The majority of the students, 29(80.5%), stated that the text book ratio in Biology was one textbook between 1 and 3. Some, 6(16.7%), students felt that the textbook ratio was one between 7 and 10. A small proportion felt that the text book ratio was between 4 and 6 pupils. Like in Physics, the boys' school had the best (10 of respondents in that school) pupil-text book ratio while the mixed schools had the same pupil text book ratio. The mixed schools had the lowest pupil text book ratio in Biology with 3 students stating that the pupil-text book ratio was between 7 and 10. This means there are many students sharing one text book. The results are as analysed in Table 2.

Chemistry

Pupil textbook ratio statistics for Chemistry, Table 3, indicated that all the three subjects had a good textbook ratio (one between 1 and3). This is mainly attributed to the free secondary education funding from the government. With adequate textbooks in science classroom, it is expected that curriculum delivery will improve and performance enhanced. The big challenge rests on how effectively teachers supervise the utility of these textbooks. The second challenge which requires further investigation is how far the books go in providing the students with relevant and approved content. The Kenya Institute of Education which vets textbooks that are used in schools, have an obligation to the teachers in order to get facts on the ground on what the approved books are contributing to the successful implementation of the curriculum. The textbook ratio improvement can be attributed to the government's grant under free secondary education programme.

The Frequency of Performing Practical per Week

Most students, 22(61.1%), as shown in Table 4, said that they performed practical once per week as opposed to 5(13.9%) who said they performed many times. Teachers cited once per subject per week. Most students rated themselves as average and above. There was almost a unanimous acknowledgement that they were optimistic that they would improve in the science subjects with only one case who did not answer. The improvement, as most of them responded, would be possible if they would be exposed to more practical lessons, more discussions and increased time be allocated to science subjects. The clear fact here is that students require pupil-centred teaching approach where they can actively participate in constructing their own knowledge.

Adequacy of Science Teachers in School

Majority of the students, 22(61.1%), found the number of science teachers to be adequate in their schools. This was more pronounced in the boys' schools where 9 out of the 12 respondents from the school felt that they had enough teachers. However, in the mixed school, half of the students, 6, felt that they had enough teachers. The staffing position is understood more by students in the boys' school where all of them had an answer as opposed to the mixed school where 2 of the respondents had no answer on staffing position.

Strategies put in Place to Improve Science Education in Schools

Twenty one (58.3%) students felt that their schools had made efforts to improve science education. There is a clear indication as shown by Table 5 that the boys' school had made a lot of efforts to improve science as 10 of the respondents in the school responded to the affirmative. Only 4 in the girls'

school felt that the school had made efforts to improve Science education. Teachers from all the three schools felt that efforts had been made to improve Science education.

Some of the efforts/strategies put in place to improve science education in the region included:

i) More science teachers employed
ii) More science equipment bought
iii) Remedial teaching time for weak students availed

There was a general feeling among students that their schools had taken steps to improve science education 21(58%) as shown in Table 5. These strategies included: more science teachers employed to reduce workload, in the boys' school; remedial teaching had been introduced to help weak students. In all the schools, an improvement in purchase of science equipment had been noted. This is also likely to be because of the government grant under the free secondary education programme and the laboratory grant facility where selected schools per district benefit from a government grant meant specifically for science equipment (MOEST, 2007).

Some of the suggestions on other strategies that can be used to improve science education if more funds were availed include provision of adequate textbooks, more trained personnel and construction and equipment of more laboratories, among others.

CONCLUSION AND RECOMMENDATIONS

It is clear that efforts to improve the teaching and learning of science in secondary schools have been enhanced. The science curriculum has been continuously considered for review and developed so that it is able to recognize the abilities and the conceptual world view of the students.

In order to compensate for any pedagogical lapses (known or unknown to teachers), it is imperative that science teaching be presented through the e-learning mode. This will help to make the subjects interesting and update the learners on the latest trends globally (World Bank, 2007; Newton & Rogers, 2001). E-learning will also fill gaps caused by lack of laboratory equipment and teacher shortage or absence. There is also a need to organize for regular INSETs for teachers and curriculum implementers in order to enable participants to put in the necessary effort and time to ensure attainment. It is expected that the participants will be conversant with and be diligent practitioners if the PDSI and ASEI ideals for quality teaching and learning.

More strategies to improve science can also come from extensive and intensive research in the field. Most studies on Science education in Kenya have looked at the discrete subjects and little is known about science education in general. Literature on science education in Kenya is hard to come by, what is available is simply the textbooks that are being used by students in schools. This situation limits science education to the field of academia. There is need to conduct more research on combined/integrated science in order to get a more coherent science policy.

In addition, the areas covered by most science research in Kenya are confined to urban centres e.g. Nairobi and its close environs leaving the rural areas which is a greater part of the country with little or no researched information at all. More research should be done in the rural areas. Moreover the INSET training for teachers should be upgraded to offer meaningful certificates that can be used by teachers to acquire promotion. The design of such in service training should be sourced directly from the practicing teachers. Principals of schools should also undergo basic training on enhancement of science in schools in order to assist the teachers while implementing new strategies (Khamis & Sammons, 2004).

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