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Determinants of Implementing Chemistry Curriculum in Arid and Semi-Arid Lands: A Case of Secondary Schools in Garissa, Kenya

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Abstract. As a science subject, chemistry occupies a dominant position in the contemporary society. Its knowledge underpins almost every existing aspect of life. As such, thorough implementation of the subject's curriculum is of absolute significance. However, this is yet to be fulfilled as plainly exemplified in the subject's low performance as compared to other science subjects; biology and physics. Execution of chemistry curriculum proves even more difficult in marginalised regions such as the arid and semi-arid ones. The two main objectives of the study were; to determine the influences of teaching/learning materials and facilities (TLMFs), and teacher's workload on the implementation of chemistry curriculum in public secondary schools in Garissa Sub County, Kenya. The study adopted the descriptive survey research design. The target population comprised of eight principals, 27 chemistry teachers, and 940 students. The sample size consisted of eight principals, 27 chemistry teachers and 94 students. Data for the study was collected by using questionnaires and observation checklists. Main findings of the study revealed that all the schools had laboratories in which, the key teaching and learning materials were fairly available and adequate as follows; apparatus 73.7%, while chemicals 77.2%. Concerning teacher's workload and implementation of chemistry curriculum, it was revealed that 72.7% of the chemistry teachers taught another practical based science subject; either biology or physics. Furthermore 68.2% of the teachers held positions of responsibility in addition to chemistry teaching. It was thus concluded that, both shortage of some essential TLMFs and augmented teacher's workload hinder perfect implementation of chemistry subject's curriculum. The study recommended that, chemistry teachers should greatly emphasize on the use of experimentation pedagogical approach in which, their learners must directly engage in practical work by using the available TLMFs. Also, additional staff should be hired to science departments of schools in which the practical based science subject teachers are holding other positions of responsibility.

Keywords: Chemistry curriculum; implementation; teaching/learning materials; work load.

Introduction

Education is remarkably credited for national growth and development globally. According to Otu and Avaa (2011) scientific knowledge in particular, contributes extensively towards economic, industrial and technological prosperity. As such, proper implementation of all science subjects' curricular at any educational level is absolutely critical. This is based on the anticipated catalytic impact that it might create in simplifying the attainment of the desired learning outcomes and consequently the global educational goals.

As a science subject, chemistry incontrovertibly occupies a central locus in the contemporary society (American Chemical Society, n.d.). It underpins almost every aspect of modern life. Essentially, the ultimate goal of studying chemistry is to enhance peoples' understanding of the composition, structure, properties and changes of matter while under varied conditions. Generally, matter is anything that has mass and also takes up space. Matter commonly exists in solid, liquid or gaseous states. According to Ituma (2012) knowledge of chemistry is required in the provision of services and production of quality goods. The subject is also a prerequisite for enrolment into scientifically inclined careers such as medicine, engineering, pharmacy, biotechnology, agriculture and the like, in postsecondary educational institutions (Njagi & Silas, 2015; Mwangi, 2016). In addition, chemistry knowledge somehow blends compatibly with some content of other science subjects such as agriculture, biology and physics hence contributing notably towards a more desirable comprehension of those subjects.

Seemingly, effective chemistry education is yet to be attained even in other countries, for instance; In Sweden, Broman, Ekborg & Johnels (2011) noted that many students regard chemistry as an irrelevant and meaningless subject; this arises from their perception of the subject as a teacher-centred one. Accordingly, this misperception induced a drastic fall in the number of students pursuing chemistry based courses at higher levels thus substantiating the need for raising chemistry relevance by aligning its content to daily life and placing more emphasis on laboratory work.

In Ireland, Childs (2014) indicated that effective implementation of chemistry education is threatened by factors such as transition between levels of education, science background of students, diversity of the student body, problem of science language, and cognitive level of students. In addition, scientific misconceptions among students, impact of Information Technology (IT) on instruction, and ignorance of chemistry education research amongst most lecturers also affect the implementation of chemistry curriculum.

In china, the main problem facing implementation chemistry curriculum is adaptation of curriculum materials by the teachers. In particular, factors such as a chemistry teacher's pedagogical content knowledge, external examinations, time constraints, instructional resources, size of class, belief concerning science, and peer coaching have a significant influence on the adaptation of curriculum materials by the teachers (Chen & Wei, 2015)

In South Africa, implementation of chemistry curriculum is influenced by: inadequacy of practical lessons, shortage of both laboratory facilities and relevant textbooks. Others are: teacher unprofessionalism while on the job, poor attendance of teachers to in-service training courses, workshops and seminars, lack of laboratory attendants or presence of unqualified ones in schools, and absence of laboratory safety equipment for first aid interventions in case of accidents (Ijidike & Oyelana, 2015)

In Nigeria, ineffective implementation of the subject's curriculum is as a result of inadequate funding, poor teacher motivation, partial curriculum coverage and lack of laboratories (Achimugu, 2016). In addition, Neji, Okwetang & Njaa (2014) reported that laboratory facilities in most Nigerian secondary schools were inadequate for effective teaching of chemistry.

In Kenya, the education system is structured in such a manner that chemistry subject is first presented to all learners at the secondary school level of the basic education curriculum (Ituma, 2012). Although, some basic aspects of chemistry are taught at the primary school level, during this stage, those concepts are presented integratedly in science subject. At the secondary school level, the subject becomes autonomous. Its concepts, principals and skills are taught by experimental investigations; practical approach. This requires subject specific teaching, learning materials and facilities (TLMFs) such as the laboratory, apparatus, chemicals, safety equipment, record keeping books and personnel; laboratory assistant.

Garissa Sub County is one of the seven sub counties of Garissa County which is one of the three counties of the North eastern region of Kenya. The region lies within Kenya's vast Arid and Semi-Arid Lands (ASALs). Such areas are often regarded as marginalised and are generally sparsely populated owing to the usual harsh climatic conditions that prevail. According to Ombati & Mokua (2015) ASALs lack adequate basic foundations of development such as access to education, health services, adequate water, various food sources, Information Communication and Technology (ICT), energy, and infrastructure. Undersupply of the listed enablers of growth and development disadvantage such locales greatly. This makes provision of education more difficult and implementation of high resource dependant subjects such as chemistry even harder.

An intimate scrutiny of science subject's performance statistics in Kenya depicts chemistry as a low performing subject compared to fellow science subjects namely biology and physics. These results are based on a comparison of Kenya's national examinations; Kenya Certificate of Secondary Education (KCSE), nationally and for Garissa Sub County for the past five years. Considering that, the achievement of learners can serve as a crucial insight into the state of implementation of a subject's curriculum, these low performance results openly signify the presence of hurdles towards effective implementation of chemistry subject's curriculum. The computation of the average student achievement in biology, chemistry and physics (expressed as mean scores and mean grades) is presented in Table 1.

Table 1: Comparison of science subjects' performances (mean scores and grades) from the year 2012 to 2016 for National and Garissa Sub County

Level	National			Garissa Sub County		
Subject	Biology	Physics	Chemistry	Biology	Physics	Chemistry
2012	4.63 C-	5.44 C-	4.28 D+	3.09 D	3.69 D+	2.78 D
2013	4.89 C-	5.47 C-	3.93 D+	3.22 D	4.76 C-	2.47 D-
2014	4.96 C-	5.37 C-	4.38 D+	4.52 C-	4.95 C-	3.69 D+
2015	5.07 C-	5.52 C	4.54 C-	5.60 C	6.01 C	4.29 D+
2016	3.32 D	4.94 C-	2.68 D	3.27 D	6.33 C	2.29 D-
Average	4.57 C-	5.35 C-	3.96 D+	3.94 D+	5.15 C-	3.10 D

Source: Kenya National Examinations Council (2017)

As contemplated within table 1, the following twin facts are disclosed. Firstly, chemistry subject consistently trails fellow science subjects namely biology and physics. Secondly, the subject's mean grade rarely ascends beyond the low quality grade D bracket. This undermines the effectiveness of modalities put in place by the government to discontinue the subject's low performance. Bearing in mind the centrality of the subject's knowledge in the contemporary society, the results are also conveying a clear and unmistakable message concerning the need of investigating the factors which are likely to be responsible for the outgrowth of the problem. The overriding expectation being, to utilise the outcome obtained in seeking for appropriate strategies of mitigating the challenge before chemistry subject plunges into academic uncertainty.

Objectives of the study

The study was guided by the following objectives:

i) To determine the influence of teaching and learning materials on the implementation of chemistry curriculum in public secondary schools.
ii) To determine the influence of chemistry teachers' workload on the implementation of chemistry curriculum in public secondary schools.

Literature review

The study was guided by the constructivist theory that was postulated by Jerome Brunner in 1966. According to the theory, learning is an active process during which the learners construct new ideas based on their current or past knowledge. The theory advocates for active participation of learners in the learning process rather than being passive receivers of knowledge. The learners should be involved in physical action; hands-on experience that engages their mind as well as their brain (Bruner, 1966). The theory has limitations in that; some concepts require direct instruction rather than being constructed from past experiences. In addition, some learners may unknowingly misrelate some of the new knowledge to unrelated past experience(s) thereby misunderstanding the newly encountered content altogether.

Literature review of the study will cover an overview of chemistry curriculum implementation. Also, teaching/learning materials and teachers' workload as relates to the implementation of chemistry curriculum will be addressed.

Overview of chemistry curriculum implementation

Implementation of chemistry curriculum means putting the prescribed chemistry syllabus into actual practice. This entails, use of experimental investigations to develop in learners the scientific concepts, principles and skills meant for learning. Acquisition of knowledge by discovery is highly encouraged. In addition, Kyalo (2016) indicated that learning experiences in chemistry are: content, practical work, projects, group discussions, excursions and field work. The subject also has the application element of its knowledge. This enables learners to utilise the acquired knowledge in everyday life within the contemporary society.

Just like the other science subjects, chemistry has both theoretical and practical aspects which complement each other during the teaching and learning process (Mwangi, 2016). Whereas the subject's theoretical aspects can be studied by traditional methods, the study of its practical content entails conducting experiments. According to Okono, Sati & Awuor (2015) teaching of chemistry by experimentation pedagogical approach contributes to effective instruction by the teacher and improves mastery of scientific concepts by the learners. The approach also aids ascertainment of scientific facts, concepts and principles and help in nurturing the learners' scientific process skills (Kapting'ei and Rutto, 2014). Experiments can be done in two main ways, that is, class experiments and demonstrations. Whereas class experiments are learner centred and entail the students performing the experiments, recording observations made, by themselves either individually or in groups, demonstration experiments are carried out by the teacher as the students observe.

Teaching/learning materials & implementation of chemistry curriculum

The practical nature of chemistry singles it out as a resource intensive subject. Its curriculum implementation therefore demands for the variation of pedagogical approaches and use of subject specific teaching/learning materials and facilities (TLMFs) such as the laboratory, chemicals, apparatus, safety equipment and laboratory fittings. It also requires a laboratory assistant. This is in addition to the regular instructional resources used in teaching of other subjects. According to Orado (2009) the implementation of chemistry curriculum consumes a little more revenue.

While acknowledging the position given in Mwangi (2016) that some chemistry practicals can as well be performed in classrooms and or just outside, it is important to reiterate that the laboratory remains the most convenient venue for carrying out any chemistry experiment. This is because; the facility has a special design and possesses the appropriate infrastructure for this purpose, as such it is a mandatory requirement for effective implementation of chemistry curriculum. According to Ijidike and Oyelana (2015) shortage of laboratories contributes to ineffective chemistry teaching in schools. To enhance the conduciveness of the laboratory for teaching and learning, the facility should have adequate water supply, a good power supply system, enough furniture, good ventilation, and a clean environment. In addition the facility should be supplied with adequate stock of instructional materials such as chemicals, apparatus, operational equipment, charts and models. According to Gatana (2011) inadequacy of chemical materials and apparatus in the school laboratories contribute to low performance in chemistry. Additionally, Chepkorir, Cheptonui & Chemutai (2014) concur that for students to master chemical reactions, they need to mix the chemicals and observe subsequent reactions. The laboratory safety measures should also be in place through the supply of first aid kits, lab coats, gloves, and charts showing laboratory rules.

According to Makori and Onderi (2014) inadequacy of TLMFs may compel the teacher to depend on text books alone thereby resulting in poor syllabus coverage. In another but related perspective, Kimeu et al (2015) investigated the influence of resources on academic achievement in Makueni County. The study revealed that teachers' use or disuse of TLMFs while teaching affected academic achievement. Therefore, the available chemistry TLMFs should be made use of and proof of utilization kept for accountability purposes. Contrastingly, other past studies dispute the perceived correlation between provision of TLMFs and chemistry curriculum implementation. For example Neji, Okwetang and Nja (2014), investigated whether adequacy of laboratory facilities for chemistry teaching influenced academic performance in secondary schools of Calabar, Cross River State, Nigeria. Surprisingly, the study revealed that adequacy of laboratory facilities does not significantly contribute to improvement in students' academic performance in chemistry. In addition, Njagi and Silas (2015), when investigating the relevance of secondary school chemistry in preparation of students pursuing chemistry-based courses in Kenyan universities observed that some students still defied expectations, excelled in chemistry and qualified for enrolment in chemistry related disciplines offered in universities despite having hailed from secondary schools in which the laboratories were ill equipped with chemistry TLMFs. This suggests that, there exist other aspects pertaining to the available chemistry TLMFs which affect their effectiveness and thus need investigation too.

Teachers' workload and implementation of chemistry curriculum

The steady rise in population of students in secondary schools as a result of the introduction of free primary and secondary education in part has piled pressure on schools to add more classrooms so as to accommodate more students. This addition of more classrooms without corresponding recruitment of more teachers has consequently increased the workload of the existing teachers; more so the lesson allocation. According to Okono et al (2015) the number of lessons which a teacher handles affects their preparedness for each class and between classes daily. This is because teachers have other duties apart from teaching which also require time in order to be accomplished. Such duties include; managing behaviour of students, planning for lessons, assessment of learning, counselling students, marking assignments, resource improvisation etc. High lesson load can affect syllabus coverage and curriculum implementation in the sense that, teachers with more lessons may resort to carrying out only a few experiments as compared to their colleagues with fewer lessons. Ndirangu, Nyagah and Kimani (2017) established that, there was a partial level of implementation of learner-centred practical activities in teaching science subjects despite the teachers having attended to an in-service training programme about the same. This was largely blamed on the heavy teaching loads shouldered by the science teachers. In principle, teaching chemistry by using learner-centred experiments demands prior preparation and even trial of the experiment by the teacher prior to actual execution of the lesson. High number of lessons amounts to heavy workload and may compel the teacher against will to keep away from experimentation based teaching while deliberately opting for lecture method during implementation of chemistry curriculum. Also, length of a lesson, time between lessons, teacher's second subject and position of responsibility may impact on chemistry curriculum implementation. The recommended allocation in terms of lessons for Kenyan teachers is 27 (Okono et al, 2015).

Atieno (2014) investigated the influence of adequacy of human resources on student performance in Embakasi, Nairobi and revealed that most teachers had full lesson load as expected by the employer. A full teaching load is already quite high for a chemistry teacher to adequately prepare for all lessons and also handle other duties. In addition, the chemistry teachers with administrative roles such as principals, their deputies, and Heads of departments (HOD's) bear a heavy burden; this limits their effectiveness in implementation of curriculum. Mudulia (2012) reported that more high performing schools had laboratory assistants compared to the low performing schools. This implies that, in the highly performing schools, the frequency of carrying out laboratory practical experiments is higher than in low performing schools. This can be attributed to that support which the science teachers receive from the laboratory technicians. In incidences where a laboratory assistant is lacking, the chemistry teacher may abandon the use of experimentation pedagogical approach of instruction.

Methodology

In the study, descriptive survey design was used. The target population consisted of eight principals, 27 chemistry teachers and 940 students of the public secondary schools in Garissa Sub County, Kenya. The principals were randomly selected while the chemistry teachers were purposively targeted primarily because role which they play in actual curriculum implementation of the subject. The data for the study was collected using questionnaires and observation checklists.

A pilot study was carried out in two schools. Precisely, two principals, four chemistry teachers and twenty students were involved in the pilot study. Test-retest method was used to establish the reliability of the research instruments. The coefficient of reliability between the two sets of results was determined by using Pearson's Product Moment Correlation Coefficient formula. The obtained correlation coefficient for the principals' questionnaire was 0.86, that of the chemistry teachers' questionnaire was 0.87 while that of the students' questionnaire was 0.91. The coefficient of reliability values obtained were significant implying that the instruments were reliable. Both quantitative and qualitative data obtained from the study was analysed using descriptive statistics such as frequencies, percentages and mean presented in table format.

Findings of the study

This section presents the background information of the respondents. Also, the analysis of findings on the how the implementation of chemistry curriculum is influenced by teaching, learning materials and facilities on one side and chemistry teachers' workload on the other side is also presented.

Demographic information of the respondents

In order to understand the respondents who participated in the study, each respondent was asked to provide their personal data. Principals and chemistry teachers were asked to indicate their gender, age, highest education level attained, and lengths of service in their current schools. The students were asked to indicate their gender and frequency of attending chemistry lessons. The gender of the principals, chemistry teachers and students involved in the study was as shown in Table 2.

Table 2: Respondents by gender

	Principals		Chemistry teachers		Students	
Gender	(f)	(%)	(f)	(%)	(f)	(%)
Male	4	66.7	20	90.9	40	46.5
Female	2	33.3	2	9.1	46	53.5
Total	6	100.0	22	100.0	86	100.0

From the findings in Table 2, it was revealed that 66.7% of the principals were male while 33.3% were female. This implies that efforts towards eradicating gender-based inequality in education within marginalised areas are gradually yielding the expected fruits. Occupation of leadership positions by women is essential in giving hope to the female students as it motivates them against surrendering in their quest for self-actualisation.

The findings also reveal that 90.9% of the chemistry teachers were male while 9.1% were female. This indicates that the sub county's chemistry teaching force was male dominated in that for every ten chemistry teachers, only one is female. The prevailing male dominance in chemistry teaching staff needs deconstruction as it portrays the subject as masculine. This may silently promote emergence and rise of disaffection towards the subject by some female learners due the shortage of role models. However according to Owolabi and Adedayo (2012) a teacher's gender has no impact on their ability to impart knowledge to students provided s/he is knowledgeable and skilful in the subject area.

The findings also show that 53.5% of the students were female while 46.5% were male. The slightly higher number of female students than male ones signifies a rise in access to science educational opportunities by the girl child in marginalised areas. In order to realise education for all, both male and female students must be educated indiscriminately. The results presented in Table 3 show the highest level of education attained by both the principals and chemistry teachers.

Table 3: Principals and chemistry teachers by education level

	Principals		Chemistry teachers	
Highest education level	(f)	(%)	(f)	(%)
M Ed.	3	50.0	- -	- -
B Ed.	3	50.0	20	91.0
B Sc.	- -	- -	1	4.5
Dip Ed	- -	- -	1	4.5
Total	6	100.0	22	100.0

The data in Table 3 show that 50.0% of the principals held Master's degree while the other 50.0% held Bachelor's degree. This implies that all the heads of the public secondary schools had at least university education. Heads of learning institutions need to possess requisite competencies for satisfactory supervision of curricular implementation. According to Kigwilu & Githinji (2015) hiring of highly qualified teachers guarantees effective implementation of curricular.

The findings also reveal that 91.0% of the chemistry teachers were holders of a Bachelor of education degree, 4.5% had a Bachelor of science degree while 4.5% had a Diploma in education. As such, all the chemistry teachers satisfied the required professional competence for teaching the subject. According to Orado (2009) qualified chemistry teachers possess an in depth understanding of subject matter. This is required for a clear and convincing explanation of chemistry facts, concepts, principles and theories to the learners. Table 4 presents results of the findings on whether principals were chemistry teachers.

Table 4: Principals responses on whether they were chemistry teachers

Principals who also taught chemistry	(f)	(%)
Were chemistry teachers	1	16.7
Were not chemistry teachers	5	83.3
Total	6	100.0

The findings in Table 4 reveal that 83.3% of the school principals were not chemistry teachers while 16.7% were chemistry teachers. Since most of the principals teach non-practical based subjects, whose content presentation can be done without conducting experiments, it implies that they have enough time to supervise curriculum implementation and ensure that it is done effectively. According to Achimugu (2016) ineffective supervision and monitoring of the teaching and learning process by ones responsible affect proper implementation chemistry curriculum. The results presented in table 5 show the findings concerning the frequency of attending to chemistry lessons by the students.

Table 5: Students' frequency of attending to chemistry lessons

Students frequency of attending chemistry lessons	(f)	(%)
Attended to chemistry lessons always	82	95.3
Attended to chemistry lessons sometimes	4	4.7
Total	86	100.0

The findings in Table 5 show that 95.3% of the students always attended to chemistry lessons while 4.7% attended sometimes. Therefore, the students rarely missed chemistry lessons. According to Tuwei (2013) student absenteeism affects teaching and learning of mathematics. In the same way, learners' failure to attend to chemistry lessons may distort content flow thereby significantly affecting their comprehension of chemistry concepts as desired. This is because chemistry concepts are related to each other in such a way that previously learnt content is foundational thus required for understanding of subsequent concepts.

Teaching, learning materials and implementation chemistry curriculum

After establishing that all the schools had a science laboratory, the study sought to determine whether some items of interest were available and adequate in the laboratories. The items were laboratory fittings especially sinks and water supply; furniture such as tables and stools; instructional materials in particular the apparatus and chemicals; lab safety wear such as lab coats and gloves; and lab safety equipment specifically first aid kits and fire extinguishers. These items are essential for effective chemistry teaching especially when using the highly recommended experimentation pedagogical approach. The results in Table 6 present findings on whether laboratory fittings; sinks and water were available and adequate in the laboratories.

Table 6: Availability and adequacy of laboratory fittings

Adequacy and availability of some	Sinks		Water supply	
essential laboratory fittings	(f)	(%)	(f)	(%)
Available and adequate	98	86.0	68	59.6
Available but inadequate	16	14.0	46	40.4
Total	114	100.0	114	100.0

The findings in Table 6 reveal that sinks and water supply were available and adequate by 86.0% and 59.6% respectively. The findings also show that the sinks and water supply were available but inadequate to the tune of 14.0% and 40.4% respectively. This implies that in as much as some of the laboratories had sinks, there existed a challenge of water supply. Wet laboratories such as those used in chemistry teaching need adequate supply of water. This is because, apart from being used for clean up after the practical activities, the water is also used directly in some reactions. The results presented in Table 7 show the findings on the availability and adequacy of furniture; tables and stools in the laboratories.

Table 7: Availability and adequacy of furniture in the laboratory

	Tables		Stools	
Adequacy of laboratory furniture	(f)	(%)	(f)	(%)
Available and adequate	89	78.1	76	66.7
Available but inadequate	25	21.9	38	33.3
Total	114	100.0	114	100.0

The findings in Table 7 reveal that laboratory tables and stools were available and adequate by 78.1%, and 66.7% respectively. The findings also show that the laboratory tables and stools were available but inadequate by 21.9%, and 33.3% respectively. This implies that despite some of the laboratories having furniture, there still existed a shortage. In addition, lab tables were more inadequate compared to lab stools. Tables are needed for placing the materials and equipment needed for a specific practical activity while stools are needed by students to sit on where need be thus their availability and adequacy affect the implementation of chemistry practical curriculum. According to Mudulia (2012) most low performing schools have ill equipped laboratories. Table 8 presents results of the findings on whether instructional materials; apparatus and chemicals were available and adequate in the laboratories.

Table 8: Availability and adequacy of instructional materials

Availability and adequacy of	Apparatus		Chemicals	
instructional materials	(f)	(%)	(f)	(%)
Available and adequate	84	73.7	88	77.2
Available but inadequate	30	26.3	26	22.8
Total	114	100.0	114	100.0

The findings in Table 8 show that the apparatus and chemicals were available and adequate by 73.7%, and 77.2% respectively. It also shows that the apparatus and chemicals were available yet inadequate by 26.3%, and 22.8% respectively. This suggests that most of the experiment based instructional materials were available only that, they were not enough. Apparatus and chemicals need to be adequate for the learners to have a personal experience with the intended knowledge while manipulating them in practical activities. Chepkorir et al (2014) posit that, in order for students to master chemical reactions, they need to mix chemicals and observe subsequent reactions. This is only possible if the said chemicals and apparatus are available thus their availability and adequacy affects chemistry teaching. In addition, according to Orado (2009) school laboratories need to be well equipped with the necessary apparatus and chemicals. These must then be utilised during the teaching and learning process so as to enhance students' understanding of scientific concepts. The results in Table 9 show the findings on whether the basic laboratory safety wear such as lab coats and gloves were available and enough.

Table 9: Availability and adequacy of lab safety wear

Adequacy of lab safety wear	Lab coats (f)	Lab coats (%)	Gloves (f)	Gloves (%)
Available and adequate	82	71.9	72	63.2
Available but inadequate	23	20.2	29	25.4
Not available	9	7.9	13	11.4
Total	114	100.0	114	100.0

The findings in Table 9 reveal that the lab safety wear were available and adequate as follows; lab coats 71.9% and gloves 63.2%. The findings also show that these lab safety wear was available but inadequate as follows; lab coats 20.2% and gloves 25.4%. The findings also show that the lab coats were lacking by 7.9% and gloves by 11.4%. This implies that the lab coats and gloves were available, except that they were inadequate. Conducting experiments entail handling of some dangerous chemicals and delicate apparatus. This requires the donning of appropriate attire such as gloves and lab coats. Neglecting to use suitable lab safety wear may leave users of the facility vulnerable to accidents, this possess an enormous threat on their personal safety and even life in case an experiment turns catastrophic. Table 10 presents results of the findings on whether the basic laboratory safety equipment such as first aid kits, fire extinguishers were available and enough.

Table 10: Availability and adequacy of lab safety equipment

Availability and adequacy of lab safety equipment	First aid kits (f)	First aid kits (%)	Fire extinguishers (f)	Fire extinguishers (%)
Available and adequate	79	70.2	99	86.8
Available but inadequate	21	18.4	14	12.3
Not available	14	12.3	1	0.9
Total	114	100.0	114	100.0

The findings in Table 10 reveal that the laboratory safety equipment was available and adequate as follows; first aid kits 70.2%, fire extinguisher 86.8%. The findings also show that these safety equipment were available but inadequate as follows; first aid kits 18.4%, fire extinguisher 12.3%. The findings also show that the safety equipment was lacking as follows; first aid kits 12.3%, fire extinguishers 0.9%. This means that most of the lab safety equipment for use by the chemistry teachers and lab technicians and were available, nevertheless some were inadequate. Lab safety equipment becomes handy especially in the misfortunate event that a lab accident takes place. Therefore, availability and adequacy of lab safety equipment affect the implementation of chemistry curriculum.

Generally, these findings on materials and facilities resemble those in Mutuku (2014) that most of the school laboratories in Makindu, Makueni County are not well equipped with the materials and facilities needed for effective curriculum implementation. At this juncture it is important to point out that inadequacy or unavailability of an essential laboratory item(s) chemical(s), apparatus, fitting(s) may frustrate a teacher's intentions of using experimentation approach to teach certain chemistry concepts. This is likely to inadvertently foster ineffective implementation of chemistry curriculum (Ijidike and Oyelana, 2015). The observed relatively quite high adequacy of most laboratory materials and facilities for teaching chemistry also indicates the success of the laboratory equipment grant initiative by the Ministry of Education Science and Technology (MOEST). Within the initiative, the government endeavours to enhance effective implementation of science subjects' curriculum by allocating a certain amount of funds annually to public secondary schools to be used specifically for acquisition of laboratory chemicals and apparatus.

Teachers' workload and chemistry curriculum implementation

To establish the influence of chemistry teachers' workload on the implementation of curriculum, the teachers were asked to indicate on the questionnaire details regarding their number of lessons per week, second teaching subject, whether they held positions of responsibility and the specific position of responsibilities which they held. The results presented in table 11 show the findings concerning the number of lessons which the chemistry teachers were allocated in a week.

Table 11: Chemistry teachers' number of lessons per week

Chemistry teachers' number of lessons per week	(f)	(%)
11- 20	3	13.6
21- 30	19	86.4
Total	22	100.0

The findings in Table 11 show that 86.40% of the chemistry teachers had between (21-30) lessons while 13.6% had between 11-20 lessons. This means that the teaching load of most chemistry teachers was fairly high since the recommended number of lessons for a teacher is about 28. A moderate or low teaching load is expected to give a committed chemistry teacher ample time come up with the most suitable approaches for effective presentation of subject matter to learners during lesson time. The results presented in table 12 show the findings on the second teaching subject of the chemistry teachers.

Table 12: Second teaching subjects of the chemistry teachers

Second teaching subject of chemistry teachers	(f)	(%)
Biology	13	59.1
Maths	6	27.3
Physics	3	13.6
Total	22	100.0

The findings in Table 12 show that 59.1% of the chemistry teachers were of biology and chemistry combination, 27.3% were of maths and chemistry combination and 13.6% had specialized in physics/chemistry. This implies that 72.7% of the teachers specialized in two practical based science subjects, as such they are capable of implementing chemistry curriculum easily and effectively. According to Gatana (2011) science subjects are ideologically interconnected and have similar instructional methodologies, a feature that makes their teaching easy for teachers specialised in two of them. Nevertheless, having two practical based science subjects translates into a heavy workload considering the experimentation demand of the content of both subjects. Essentially, According to Okono et al (2015) teaching by experiments requires lesson preparation and pre-trial of experiments before actual execution. This enhances physics teachers' workload and reduces their frequency of teaching by use of the highly recommended experimentation approach. In the same way, heavy workload also threatens teaching of chemistry by experiments. The results in table 13 show the findings obtained on whether the teachers held other positions of responsibility apart from teaching chemistry.

Table 13: Chemistry teachers with positions of responsibility

Chemistry teachers with positions of responsibility	(f)	(%)
Held position of responsibility	15	68.2
Did not hold position of responsibility	7	31.8
Total	22	100.0

The findings in Table 13 show that 68.2% of the chemistry teachers had been assigned positions of responsibility in addition to teaching while 31.8% were not. Holding of administrative and managerial posts in a school enhance the number of tasks which a chemistry teacher is required to accomplish. According to SABER (2012) number of job tasks and the anticipated time of completion influence teachers' job performance and even motivation. Considering that most chemistry teachers had a practical oriented second teaching subject and a weekly lesson burden of between (21-30) lessons per week, it means that they had a heavy workload. This situation negates effective implementation of chemistry curriculum. The findings in table 14 show the results on the actual positions of responsibility held by the chemistry teachers.

Table 14: Positions of responsibility held by some chemistry teachers

Positions of responsibility held by the chemistry teachers	(f)	(%)
Senior teacher	1	6.7
Head of department	5	33.3
Class teacher	7	46.7
Head of subject	2	13.3
Total	15	100.0

The findings in Table 14 reveal that out of the 68.2% of the chemistry teachers that held positions of responsibility in school, 46.7% were class teachers, 33.3% departmental heads, 13.3% Subject heads while 6.7% were senior teachers. As already pointed out, holding of administrative and managerial positions in a school enhance the number of tasks which a chemistry teacher is required to accomplish. Ndirangu et al (2017) express concerns that engagement of science teachers in other demanding duties negatively affects their preparation for practical lessons. Furthermore, according to Mwagiru (2014) enhanced workload for teachers hinder their innovativeness in curriculum delivery.

Conclusion

Based on the analysis of the findings, teaching and learning materials for implementation of chemistry curriculum such as laboratory fittings especially sinks and water supply, furniture specifically tables and stools, instructional materials in particular the apparatus and chemicals, lab safety wear namely lab coats and gloves, and lab safety equipment especially first aid kits and fire extinguishers were available, only that they were undersupplied. Considering that, teaching chemistry by experimentation pedagogical approach demands for specific teaching, learning materials and facilities, it was concluded that, their availability and adequacy influence perfect implementation of the subject's curriculum. It was recommended that, chemistry teachers should as much as possible emphasize on the use of experimental verification of concepts during instruction by using the available TLMFs. In particular, individual students should be given a chance to conduct the experiments while under guidance.

Concerning chemistry teachers' workload, it was found that, the teachers had a relatively high lesson allocation. Furthermore, most of them taught another practical based science subject in addition to chemistry and some of them had been assigned some administrative responsibilities in the institutions where they were working. This enhanced their workload thus influencing their effectiveness while implementing the subject's curriculum. It was therefore recommended that, for effective implementation of chemistry curriculum, additional staff should be hired to science departments in which the practical based science subject teachers are holding other positions of responsibility in the school.

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