Effectiveness of Science, Technology, Engineering and Mathematics Programmes Offered in Kenyan Universities

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Abstract
The purpose of the study was to assess the effectiveness of Science, Technology, Engineering and Mathematics (STEM) programs offered in Kenyan universities. The study sought to answer questions about the adequacy of STEM programmes training facilities, qualification of academic staff and competency of academic staff. The study also sought to assess the adequacy of STEM curriculum, and the level of achievement of STEM learning outcomes. The study adopted a census survey and targeted 66 lecturers, 59 laboratory technologists and 275 students from Jomo Kenyatta University of Agriculture and Technology, Dedan Kimathi University of Technology and Technical University of Kenya which are technology-based universities in Kenya. Data was collected through three sets of questionnaires each for lecturers, laboratory technologists and students. Analysis of the data was done through descriptive and inferential statistics. The findings were that there was lack of adequate facilities for training STEM programmes in the Kenyan universities and that the inadequacy varies from university to university with younger universities having the severest inadequacy. The study also found out that all the lecturers and Laboratory Technologists met the minimum requirements in terms of qualification and experience for their responsibilities and were competent. The STEM curriculum and practical sessions were either well or satisfactorily prepared and the graduates were adequately prepared. It was also found out that STEM learning outcomes were achieved by the time of graduation. From the research results, it can be concluded that although there were inadequacies in the STEM training facilities, these inadequacies did not significantly affect the overall effectiveness of the programs.
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1.0 Introduction

The acronym STEM is fairly specific in nature— referring to science, technology, engineering and mathematics— however, there is no standard definition for what constitutes a STEM job. There is less agreement about whether to include positions such as educators, managers, technicians, healthcare professionals and social scientists while science, technology, engineering and maths positions consistently make the lists of STEM occupations. The advancement in Science, Technology, Engineering and Mathematics (STEM) is fundamentally altering the way people live, connect, communicate and transact, with profound effects on economic development (Chetty, 2012). In the United States of America, STEM based careers are growing at 17%, while others are growing at 9.8% and STEM degree holders have a higher income even in non-STEM careers (Engineering for Kids, 2016).

The United States of America Department of Labor (2019) pointed out that there were more than 1.2 million jobs in STEM related fields by 2018 but there were not enough qualified graduates to fill them hence the need to open doors to immigrants to study in a STEM related field. The argument behind this move was that 25% of high-tech startups in the US were founded by the best and brightest immigrants who opted to stay. This implies that STEM disciplines play an important role in economic growth and helping to create employment opportunities for the youth in the United States of America. In India, it is predicted that 80% of the jobs created in the next decade will require some form of mathematics and science skills and that the number of STEM jobs are growing at a fast pace and currently exceeding the number of STEM graduates (Government of India, 2019).

In Kenya, the Kenyan vision 2030 and the constitution place a premium on the generation and management of a knowledge-based economy and the need to raise productivity and efficiency. To address this need, STEM (Science, Technology, Engineering and Mathematics) courses have been embraced as an essential ingredient for industrialization and sustainable development (Republic of Kenya, 2007). Many countries have realized that the capacity to compete in the global market is highly dependent on the ability to innovate and apply relevant technology to industry. As a result of this realization, STEM related programmes have since become a priority and gained popularity in the recent past. In Kenya innovation in science and technology has been considered as the key to a thriving economy, however, education and industry analysts have detected a trend that indicated an academic deficiency in STEM courses for students entering the university. Experts say that Kenya needs to invest more in STEM if she is to transform into an industrialized middle-income economy by 2030. It is believed that an emphasis in STEM programmes will promote innovations that can unlock Kenya's immense potential. Research findings have revealed that technological innovations capacity is the primary engine for wealth creation. This is a challenge for many countries, Kenya included. This challenge evokes measures to enhance innovation capacity. It further evokes questions on how well a country's education curriculum empowers her graduands for industry needs. This is because the training in STEM disciplines is believed to be the source of key skills for technological innovations. It is in this regard that this study seeks to explore the effectiveness of Science, Technology, Engineering and Mathematics (STEM) programmes offered in Kenyan universities

The discrepancy between the academic skills acquired by university graduates and the actual competencies for employability in industries is an area of concern in Kenya. Experts believe that unemployment of graduates in Kenya and especially STEM graduates is caused by lack of collaboration between industry and academia in designing curriculum. Lack of facilities and resources at universities accounts for inadequacy of skills for STEM graduates thus, leading to the problem of unemployment among university graduates.

This study seeks to identify the missing links in STEM programs, training and employability of graduates. One of the ways in which this problem can be addressed is through involvement of industry in designing STEM curriculum. Thus the study investigates how well STEM curriculums effectively help in imparting requisite skills that industry requires. Different stakeholders; university lecturers, instructors, students and industry players/employers participated in filling the existing gaps. The findings of this research will be instrumental in the achievement of the Kenyan big four agendas and specifically the manufacturing pillar. The results of the study will further impact in policy development and curriculum of STEM programmes.

Research Questions

The overall objective of the study was to assess the level of effectiveness of Science, Technology, Engineering and Mathematics programmes offered in Kenyan universities. Towards meeting this objective, the following research questions were formulated.

1) How is the adequacy of STEM programmes training facilities in Kenyan universities?
2) What is the qualification of academic staff of STEM programmes in Kenyan Universities?
3) How is the competency of academic staff of STEM programmes in Kenyan Universities?
4) How is the adequacy of STEM curriculum offered in Kenyan Universities?
5) What is the level of achievement of STEM learning outcomes in Kenyan Universities?

2.0 Methodology

The study adopted a descriptive survey research design. The target population of the study were lecturers, laboratory technologists and students in the STEM disciplines in the four technology based universities in Kenya. The universities were Jomo Kenyatta University of Agriculture and Technology (JKUAT), Dedan Kimathi University of Technology (DeKUT), Technical University of Kenya (TUK) and Technical University of Mombasa (TUM). Using simple and stratified sampling, 80 lecturers, 60 laboratory technologists and 300 students were selected from three universities. Though Technical University of Mombasa (TUM) was one of the targeted universities, it was excluded during the sampling stage. Data was collected through three sets of questionnaires for each for lecturers, laboratory technologists and students. Analysis of data was done through the use of descriptive and inferential statistics.

3.0 Results of the Study

The questionnaires response rate was 66 (53%) for lecturers, 59(98%) for laboratory technologists and 275 (92%) for students. The findings were organized along the research questions.

3.1 Adequacy of the STEM Programmes Training Facilities

In the survey, the lecturers were generally undecided as to whether the teaching facilities for STEM courses were adequate (inadequate and adequate) or inadequate. TUK lecturers were neutral (see Table 1). Conversely, the laboratory technologists clearly indicated that the facilities are inadequate (see Table 2).

Table 1: Lecturers' Perception on Adequacy of the teaching facilities for STEM courses

		Total			
		JKUAT	**TUK**	**DeKUT**	**Total**
	Inadequate	14(55.6%)	10(50.0%)	11(40.7%)	31(47.0%)
	Adequate	8(44.4%)	10(50.0%)	16(59.3%)	35(53.0%)
Total		**18(100.0%)**	**20(100.0%)**	**27(100.0%)**	**66(100.0%)**

Table 2: Lab Technologists opinion on adequacy of the Teaching Facilities for STEM Courses

		University			Total
		JKUAT	TUK	DeKUT	
Adequacy of teaching facilities	Inadequate	11(68.8%)	12 (70.6%)	10 (38.5%)	33 (55.9%)
	Adequate	5 (31.2%)	5 (29.4%)	16 (61.5%)	26 (44.1%)
Total		**16 (100.0%)**	**17 (100.0%**	**26(100.0%)**	**59(100.0%)**

The findings from the students indicated certainly that the facilities were inadequate (see Table 3). It can be argued this was the most unbiased group given that they have no interests. The sample was also good (N=275) to give a decisive vote on the adequacy of the facilities. The students' findings were significantly related to the university ($\chi2$ (6, N=275) =23.724 p=.001)(see Table 4) such that, majority of the DeKUT students (64.2%) and TUK students (62.4%) were of the opinion that the facilities were inadequate compared to 53.5% of the JKUAT students who reported that the facilities were inadequate. This implies that the inadequacy is severe at DeKUT and TUK compared to JKUAT.

Table 3: Students' Perception on Adequacy of Learning Facilities for STEM Courses

		University			Total
		JKUAT	TUK	DeKUT	
Adequacy of Learning Facilities	Not adequate	45(53.5%)	58(62.4%)	63(64.2%)	166(60.4%)
	Adequate	39(56.5%)	35(37.6%)	35(35.7%)	109(38.7%)
Total		**84(100.0%)**	**93(100.0%)**	**98(100.0%)**	**275(100.0%)**

Table 4: The relation between the adequacy of learning facilities and the university as perceived by Students

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.724[a]	6	.001
Likelihood Ratio	30.945	6	.000
Linear-by-Linear Association	2.928	1	.087
N of Valid Cases	275		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 2.75.

The relation between the adequacy of learning facilities and the university as perceived by Students was significant, χ^2 (6, *N*=275) =23.724 *p*=.001.

Overall, the study findings show lack of adequate facilities for training STEM programmes in the Kenyan universities. Indeed, nearly half of the lecturers (47%) and majority of the laboratory technologists and the students acknowledged inadequacies in STEM programme facilities. Parties in implementing STEM curriculum identified critical impediments as; inadequate learning facilities, inadequate practical/lab equipment, inadequate resources (funds), inadequate teaching staff, inadequate books in the library, and unreliable internet connections. However, as noted in the analysis (facility differences in different universities) the inadequacy varies from university to university with younger universities having the severest inadequacy (see Table 4).

3.2 Qualifications of the academic staff who teach STEM programmes in the Kenyan Universities

Lack of resources at universities to facilitate high quality learning is cited by experts as one of reasons STEM graduates lack requisite skills. This study sought to find out if universities offering STEM programmes have qualified lecturers. The findings showed that 96.6% of the STEM lecturers interviewed had Master's degree while 3.4% were Ph D holders (see Table 5).

Table 5: Level of Qualification of University Lecturers

Qualification	University			Total
	JKUAT	TUK	DeKUT	
Masters	6 (100.0%)	15 (93.8%)	7(100%.0)	28(96.6%)
PhD		1 (6.2%)		1(3.4%)
Total	**6 (100.0%)**	**16 (100.0%)**	**7(100.0%)**	**29(100.0%)**

NB: Only 29 respondents indicated their qualification level

AS a requirement, lecturers are meant to have a connection with industry through their professional bodies affiliation. A survey of professional body affiliation indicate that eighty point nine (80.9%) percent of the lecturers acknowledged being accredited to professional bodies (see Table 6). Further, majority (36.8%) of the lecturers indicated that they have less than 3 years' experience with 32.4% having 3-6 years' experience. However, the relation between experience and University was significant, $\chi2$ (12, N=68) =31.641, p=.002. That is, some Universities required higher level of experience than others, probably because of their age. Generally, DeKUT (as a younger university) lectures have fewer years of experience compared to JKUAT and TUK lecturers. More

(96.3%) of the DeKUT lecturers have less than six (6) years' experience compared to 45% from JKUAT and 55% from TUK.

Table 6: Accreditation of Lecturers by Professional bodies

		University				Total
		JKUAT	TUK	DeKUT	TUM	
Accredited	Yes	13 (65.0%)	4(20.0%)	26(96.3%)	-	55(80.9%)
	No	7(35.0%)	16(80%)	1(3.7%)	1(100.0%	13(19.1%)
	Total	**20(100.0%)**	**20(100.0%)**	**27(100.0%)**	**1(100.0%**	**68(100.0%)**
Accrediting Body	Not Sure	13(65.0%)	17(85.0%)	27(100.0%)	1(100.0%	58(85.3%
	EBK	3(15.0%)	3(15.0%)	-	-	7(10.3%)
	KTRB	1(5.0%)	-	-	-	1(1.5%)
	KMPDU	1(5.0%)	-	-	-	1(1.5%)
	CUE	2(10.0%)	-	-	-	2(3.0%)
	Total	**20(100.0%)**	**20(100.0%)**	**27(100.0%)**	**1(100.0%**	**68(100.0%)**

On the part of Lab Technologists, 35% were diploma graduates with 32% having degrees, 18% Masters and 16% indicating that they were qualified (Table 7). The findings indicated that there was a significant relation to university as well(Table 8). JKUAT had more laboratory technologists with Masters compared to the TUK and DeKUT. Still, majority (42%) of the laboratory technologists reported having experience between 3-6 years while 27% had more than 10 years' experience and 20% having 7-10 years' experience (Table 9). Relation between laboratory technologists' experience and University was significant, $\chi2$ (6, N=59) =21.573, p=.001 (Table 10), such that 88% of the JKUAT technologists had more than 6 years' experience compared to 36% from TUK and 23% from DeKUT with more than 6 years' experience.

Table 7: Overall Assessment on Qualification of the Laboratory Technologists Qualification

		University			Total
		JKUAT	TUK	DeKUT	
Assessment about the qualification	Diploma	1 (5%)	5 (29%)	10 (37%)	16 (25%)
	Degree	2 (9%)	9 (53%)	10 (37%)	21 (32%)
	Masters	7 (33%)	2 (12%)	3 (11%)	12 (18%)
	Qualified	11 (53%)	1 (6%)	4 (19%)	16 (25%)
Total		**21(100%)**	**17 (100%)**	**27 (100%)**	**65(100%)**

Table 8: The relation between qualification of laboratory Technologists and University

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	**33.980[a]**	**12**	**.001**
Likelihood Ratio	41.496	12	.000
Linear-by-Linear Association	18.623	1	.000
N of Valid Cases	59		
a. 17 cells (81.0%) have expected count less than 5. The minimum expected count is .27.			

Table 9: Laboratory Technologists Working Experience

		University			Total
		JKUAT	TUK	DeKUT	
Assessment about the experience	<3 years	3(18.8%)	16(94.1%)	21(80.8%)	40(67.8%)
	3 - 6 years	11(68.8%)	1(5.9%)	5(19.2%)	17(28.8%)
	7 - 10 years	2(12.5%)	-	-	2(3.4%)
Total		**16(100.0%)**	**17(100.0%)**	**26(100.0%)**	**59(100.0%)**

Table 10: The Relationship between laboratory Technology Experience and the University.

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	26.222[a]	4	.000
Likelihood Ratio	27.269	4	.000
Linear-by-Linear Association	15.096	1	.000
N of Valid Cases	59		
a. 5 cells (55.6%) have expected count less than 5. The minimum expected count is .54.			

The findings show that resource personnel for both lecturers and Lab Technologists met the minimum requirements in terms of qualification and experience for their responsibilities. That is, masters' degree for Lecturers and Diploma for Lab Technologists. However, the findings suggest the older the university the more the experience and better qualification of resource personnel than younger universities. This justifies the quest for students to be admitted to older universities because they have better resources and learning environment.

3.3. Competency of Teaching Staff

The study further tested competency of staff teaching in STEM programmes with reference to how they handled the subject matter and related expected learning outcomes. The findings are showed in Table 11 and 12.

Table 11: Competency opinion of Lab technologist in taking students through Laboratory practical sessions

		University				Total
		JKUAT	TUK	DeKUT	TUM	
Lab Technologists Competence	Incompetent	2(10.0%)	1(5.0%)	-	-	3(4.5%)
	Fairly competent	5(25.0%)	5(25.0%)	10(38.5%)	1(100.0%)	21(31.3%)
	Fully competent	13(65.0%)	14(70.0%)	16(61.5%)	-	43(64.2%)
Total		**20(100.0%)**	**20(100.0%)**	**26(100.0%)**	**1(100.0%)**	**67(100.0%)**

Table 12: The Relation between Laboratory Technologist competency and Universities

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.799[a]	6	.446
Likelihood Ratio	6.743	6	.345
Linear-by-Linear Association	.003	1	.956
N of Valid Cases	67		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .04.

The relation between lab technologists' competency and University was not significant, χ^2 (6, N=67) =5.799, p=.446.

Majority (64.2%) of the lecturers reported that Lab Technologists are competent in taking students through laboratory sessions while 31.1% reported that the Lab Technologists are fairly competent (See Table 11). The relation between lab technologists' competency and University was not significant, $\chi 2$ (6, N=67) =5.799, p=.446. From the Laboratory Technologists perspective, majority (72.9%) agreed that they are prepared by the subject matter Lecturers on practical sessions. These findings tend to be common across the universities as there was no significant relationship between level of preparation and university, $\chi 2$ (4, N=59) =2.170, p=.704) (see Table 12). From the students' perspective, 81.8% reported that the academic staff are competent while 10.9% indicated that the academic staff are satisfactory competent (See Table 13).

Table 13: Assessment of Qualification of Academic Staff teaching STEM Programmes

		University			Total
		JKUAT	TUK	DeKUT	
Qualification of Academic Staff	Competent	59(70.2%)	86(92.5%)	80(81.6%)	225(81.8%)
	Not competent	5(6.0%)	7(7.5%)	3(3.1%)	15(5.5%)
	I don't know	5(6.0%)	-	-	5(1.8%)
	Satisfactory	15(17.9%)	-	15(15.3%)	30(10.9%)
Total		**84(100.0%)**	**93(100.0%)**	**98(100.0%)**	**275(100.0%)**

Table 14: Relation between Competency of Academic Staff and University.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.436[a]	6	.000
Likelihood Ratio	41.404	6	.000
Linear-by-Linear Association	1.875	1	.171
N of Valid Cases	275		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.53.

The relation between the competency of the academic staff and the university was significant, $\chi 2$ (6, N=275) =31.436, p=.000) (Table 14). For DeKUT students, 96.9% were satisfied with the competency of the academic staff while 88.1% and 92.5% from JKUAT and TUK were respectively satisfied. This finding suggests competency is not dependent on qualification and years of experience. DeKUT students, (a younger university) apparently are more satisfied with their lecturers' handling of subject matter as opposed to JKUAT where there are more qualified lecturers. Similarly, majority (78.5%) of the students agreed that the Lab Technologists are competent (Table 15).

Table 15: Competencies of Laboratory Technologists

		University			Total
		JKUAT	TUK	DeKUT	
Competency of Lab Technicians	Competent	54(64.3%	77(82.8%)	85(86.7%)	216(78.5%)
	Not competent	16(19.0%)	11(11.8%)	4(4.1%)	31(11.3%)
	Average	13(15.5%)	5(5.4%)	9(9.2%)	27(9.8%)
	No opinion	1(1.2%)	-	-	1(0.4%)
Total		**84(100.0%)**	**93(100.0%)**	**98(100.0%)**	**275(100.0%)**

Table 16: Competency between the Competency of Laboratory Specialists and University

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	19.172[a]	6	.004
Likelihood Ratio	20.034	6	.003
Linear-by-Linear Association	9.524	1	.002
N of Valid Cases	275		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is .31.

The relation between competency of laboratory technologists and the university was significant, $\chi 2$ (6, N=275) =19.172, p=.004) (see Table 16) while 64.5% of the JKUAT students were satisfied with the competencies of their Laboratory Technologists, 82.8% in TUK and 86.7% from DeKUT were in agreement.

Overall, the study showed that from the three perspectives, the academic staff and Lab Technologists are competent. However, relatively fewer (64.5%) JKUAT students have confidence in the competency of their Laboratory Technologists compared to more than 80% from TUK and DeKUT. This finding confirms earlier indication of satisfactory qualifications of personnel handling STEM programmes.

3.4: STEM Curriculum Rating

In academics the curriculum plays a key role in delivering the expected learning outcomes. Based on how the curriculum was delivered either learners can acquire expected competencies or not. This study set out to assess issues to do with STEM curricula in various universities and the findings are set out in Table 17 and 18.

Table 17: Overall Rating of the STEM Curriculum

		University			
		JKUAT	TUK	DeKUT	Total
Overall STEM Curriculum rating	Not well prepared	5(25.0%)	11(55.0%)	5(18.5%)-	22(32.5%)
	Well prepared	15(75%)	9(45.0%)	22(81.5%)	46(67.5%)
Total		**20(100.0%**	**20(100.0%)**	**27(100.0%)**	**68(100.0%)**

Majority (67.5%) of the lecturers reported that generally, the STEM programmes are well prepared while 32.5% indicated that the programmes are not well prepared (Table 17). Whereas 81.5% of the DeKUT lecturers were satisfied with the STEM curriculum, only 45% of the TUK lecturers and 75% of JKUAT lecturers were satisfied. Specifically, majority (72.1%) of the lecturers observed that the STEM programmes equip the students with problem solving skills; prepare students to be creative/innovative (75%); make students to be self-reliant (76.5%); expose students to realities of industrial labour (73.6%); equip students with hands-on experience (77.9%); equip the students with interpersonal skills (72.1%); and also equip the students with leadership skills (70.6%). Thus the lecturers seem to be happy with the curriculum in meeting expected outcomes.

Table 18: Overall Rating of STEM Practical Sessions (undertaken by Lab technologists)

		University			Total
		JKUAT	TUK	DeKUT	
Rating STEM Practical	Not well prepared	7(43.7%)	5(29.4%)	0(0.0%)	12(20.3%)
	Well prepared	9(56.3%)	9(70.6%)	26(100%)	47(79.7%)
Total		**16(100.0%)**	**17(100.0%)**	**26(100.0%)**	**59(100.0%)**

From the Laboratory Technologists perspective, the findings suggest that overall majority (80%) agreed that STEM practical sessions are well prepared while a mere 20% disagreed with that the perception (see Table 18).The cross tabulation showed that all (100%) the DeKUT Lab Technologists were satisfied by preparedness of the practical sessions unlike 56.3% from JKUAT and 70.6% from TUK.

The findings from the student's perspectives are presented in Table 19.

Table 19: Overall rating of the STEM curriculum as Perceived by Students

		University			Total
		JKUAT	TUK	DeKUT	
Overall Rating of STEM Curriculum	Not satisfactory	18(22.2%)	13(14.0%)	5(5.2%)	36(13.3%)
	Satisfactory	63(77.8%)	80(86.0%)	30(94.8%)	70(86.7%)
Total		**81(100.0%)**	**93(100.0%)**	**97(100.0%)**	**271(100.0%)**

The sample of 271 students was drawn from three universities, and indicate that an overwhelming number (87%) found the curriculum satisfactory and well prepared. Students from DeKUT had the highest number (94.8%) of students satisfied followed by 86% from TUK and 77.8% from JKUAT (see Table 19). An in-depth analysis showed that majority (74%) of the students indicated that the STEM programmes equip students with problem solving skills; prepare students to be creative/innovative (76.2%); make students to be self-reliant (83.8%); expose students to realities of industrial labour (73.5%); and equip students with hands-on experience (73.9%). The study demonstrated that in general, the lecturers, Lab Technologists and the students are satisfied that the STEM curriculum and practical sessions are either well or satisfactorily prepared. The study also showed that the DeKUT STEM community has the highest confidence in their curriculum followed by the TUK and JKUAT.

3.5 Achievement of STEM Learning Outcomes

Lastly, this research examined the level of achievement for learning outcomes in STEM programmes. This was done seeking the opinion of lecturers, lab technologists, students in third to 5th year and also alumni working in STEM jobs. The findings from the lecturers indicated that forty percent (40%) were affirmative the STEM learning outcomes are achieved at the time of graduation while 30% indicated that the outcomes are somehow achieved (Figure 1).

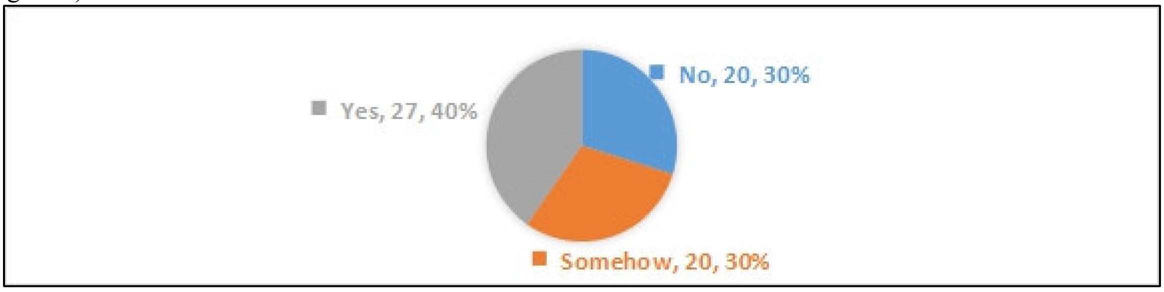

Figure 1: Achievement of learning outcome as perceived by lecturers.

For the Laboratory Technologists, cumulatively 81.4% agreed that the STEM practical outcomes are achieved (see table 20). However, more Lab Technologists (96.6%) from DeKUT were in agreement compared to JKUAT (81.2%) and TUK (58.8%) Laboratory Technologists. Seventy-four point five percent (74.5%) agreed that learning outcomes of STEM programmes achieved at graduation.

Table 20: Lab Tech opinion: Are STEM Practical Learning Outcomes Achieved

		University			Total
		JKUAT	TUK	DKUT	
Learning outcomes for STEM practical sessions	No	3(18.8%)	7(41.2%)	1(3.8%)	11(18.6%)
	Yes	13(81.2%)	10(58.8%)	25(96.2%)	48(81.4%)
Total		**16(100.0%)**	**17(100.0%)**	**26(100.0%)**	**59(100.0%)**

The student perspective yielded similar results, where 74% felt that the outcomes were achieved. The relation between students' opinion on outcomes of STEM courses and the university was significant, $\chi 2$ (2, N=274) =10.791, p=.005 (Table 22). Cross tabulation results revealed that differentially 85.7% of DeKUT, 70.7% of TUK and 65.6% of JKUAT students agreed. The study demonstrated achievement of STEM learning outcomes as more than 70% of the lecturers, Lab Technologists and students were in agreement that learning outcomes of STEM programmes achieved at graduation.

Table 21: Student perspective: Are Learning Outcomes of STEM Course Achieved at the end of the Training

		University			Total
		JKUAT	TUK	DKUT	
Are learning outcomes of STEM programmes achieved at graduation?	No	29(34.5%)	27(29.3%)	14(14.3%)	70(25.5%)
	Yes	55(65.5%)	65(70.7%)	84(85.7%)	204(74.5%)
Total		**84(100.0%)**	**92(100.0%)**	**98(100.0%)**	**274(100.0%)**

The relation between opinion on outcomes of STEM course and the university was significant, χ^2 (2, N=274) =10.791, p=.005.

Table 22: The relation between opinion on outcomes of STEM course and the university

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	10.791[a]	2	.005
Likelihood Ratio	11.398	2	.003
Linear-by-Linear Association	9.971	1	.002
N of Valid Cases	274		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.46.

The relation between opinion on outcomes of STEM course and the university was significant, χ^2 (2, N=274) =10.791, p=.005.

The findings on perception of achievement of learning outcomes were triangulated by finding out from those who had graduated with STEM degrees; if the skills they had acquired were applicable in the work place. A set of 10 questions were presented to STEM alumni, each assessing graduate experiences on application of skills, competencies acquired during their university learning. The questions had a chronbach alpha of 0.81 indicating that the questions were able to consistently gather information on the matter. About 50% of the graduates had left college in the last 5 years. Table 23 presents the results.

Table 23: Alumni response: Assessment of Curriculum Relevancy to the Job market

Please choose the most appropriate response to each question-	**Not at all (1)**	**Somewhat (2)**	**Moderately (3)**	**A great Deal (4)**	**Mean; SD**	**CV**
1. How well did your program prepare you for the career you are in?	1 (3.2%)	5 (16.1%)	16 (51.6%)	9 (29.0%)	M=3.06 SD=0.77	25.1%
2. The teaching facilities were adequate for equipping me for my work	1 (3.2%)	8 (25.8%)	15 (48.4%)	7 (22.6%)	M=2.90 SD=0.78	26.8%
3. I was well mentored for the job	1 (3.2%)	28 (90.3%)	1 (3.2%)	1 (3.2%)	M=2.06 SD=0.44	21.3%
4. As fresh graduate I was able to work and fit on the job immediately	1 (3.2%)	17 (54.8%)	7 (22.6%)	6 (19.4%)	M=2.58 SD=0.84	32.5%
5. What I learned in the University is applicable in this job?	1 (3.2%)	7 (22.6%)	10 (32.3%)	13 (41.9%)	M=3.12 SD=0.88	28.2%
6. The skills that I learned in class were useful to perform on the job?	-	6 (19.4%)	16 (51.6%)	9 (29.0%)	M=3.09 SD=0.70	22.6%
7. I was provided with adequate opportunity to develop necessary competencies	1 (3.2%)	11 (35.5%)	10 (32.3%)	9 (29.0%)	M=2.87 SD=0.88	30.6%
8. I now belief there are other training opportunities to learn skills for the industry jobs?	6 (6.5%)	3 (9.7%)	7 (22.6%)	19 (61.3%)	M=3.38 SD=0.91	26.9%
9. I used most of skills I learned in class	1 (3.2%)	10 (32.3%)	17 (54.8%)	3 (9.7%)	M=2.70 SD=0.69	25.5%
10. I attribute success in my career to the University training I received.	2 (6.5%)	4 (12.9%)	16 (51.6%)	9 (29.0%)	M=3.03 SD=0.83	27.3%
Summation	**-**	**8 (25.8%)**	**16 (51.6%)**	**7 (22.6%)**	**M=2.88 SD=0.44**	**15.3%**
Reliability (Cronbach's Alpha) (N items=10)	**0.808**					

In summary, the findings suggest most (74.2%) of the alumni found the knowledge acquired from university useful in performing their jobs; attributed success in their career to the training/skills received at college, were well prepared for the job at university and acquired necessary competencies at university. This indeed showed that they were able to do (after graduation), what the STEM curriculum had suggested they would be able to do 70% of the time.

4.0 Conclusion

The main study objective sought to assess the effectiveness of Current STEM Programmes Offered in Kenyan Universities. The study showed that there was lack of adequate facilities for training STEM programmes in the Kenyan universities, however, the inadequacy varies from university to university with younger universities having the severest inadequacy. The study also found out that all the lecturers and Laboratory Technologists meet the minimum requirements in terms of qualification and experience for their responsibilities and the academic staff and Laboratory Technologists in all the universities are competent.

The STEM curriculum and practical sessions are either well or satisfactorily prepared, while STEM graduates are adequately prepared or the STEM learning outcomes are achieved at the time of graduation. Despite the study indicating that there are inadequacies with the STEM training facilities, the study also revealed that the staff handling the students are competent, and theoretical and practical lessons are adequately prepared. Graduates are adequately prepared were able to undertake the tasks stipulated at the end of their learning. This indeed showed that STEM graduates were able to do, what the STEM curriculum had suggested they would be able to do 70% of the time. This means that although there may be inadequacies in the STEM training facilities, these inadequacies do not significantly affect the overall effectiveness programme implementation.

The findings of current study therefore reveal that STEM programmes in Kenya are effectively implemented, despite the challenges of facilities. The policy implications are that for better results on learning outcomes, the study proposes increased funding from the government and others donors, for engineering workshop/buildings and proper equipping of existing laboratories. These measures will help in improving on networks and collaborations with the industry and also as a way of addressing the challenges experienced in implementing STEM curriculum.

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