GOVERNMENT POLICIES ON ADMISSION INTO SCIENCE AND TECHNOLOGY BACHELOR DEGREE PROGRAMMES AND IMPACT ON STUDENTS' PARTICIPATION IN PUBLIC UNIVERSITIES, KENYA

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DECLARATION

I confirm that this research thesis is my original work and has not been presented in any other University for certification. It has been complimented by referenced works duly acknowledged. Where text, data, graphics, pictures or Tables have been borrowed from other works, including the internet, the sources have been specifically accredited through referencing in accordance with anti-plagiarism regulations.

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In loving memory of my revered parents, Epainito Wanyama Wamocho and Priscillah Nasenya Wanyama (the foundation of inspiration)

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LIST OF ABBREVIATIONS AND ACRONYMS

ACBF	African Capacity Building Foundation
ACE-PTRE	African Centre of Excellence in Phytochemicals, Textiles and Renewable Energy
ACOLA	Australian Council of Learned Academies
ACP-EU	Africa, Caribbean and Pacific- European Union
ASAL	Arid and Semi- Arid Lands
AUC	Africa Union Commission
BRIICS	Brazil, Russia, India, Indonesia, China and South Africa
CEIP	Centre for Engineering Innovation and Production
CESAAM	Centre of Excellence in Sustainable Agriculture and Agribusiness Management
CODESRIA	Council for the Development of Social Science Research in Africa
CoELIB	Centre of Excellence in Livestock Innovation and Business
CUE	Commission for University Education
DDR	Discipline Differentiated Remuneration
DELPHE	Development Partnerships in Higher Education
DRC	Democratic Republic of Congo

DU	University of Delhi
DUC	Differential Unit Cost
EBK	Engineering Board of Kenya
EU	Egerton University
GATE	Government Assistance for Tuition Expenses
GSP	Government Sponsored Programme
HEIs	Higher Education Institutions
HELB	Higher Education Loans Board
HoDs	Heads of Departments
IBL	Industry Based learning
IGAs	Income Generating Activities
IPO	Intellectual Property Organization
ISCED	International Standard Classification of Education
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KACE	Kenya Advanced Certificate Education
KCE	Kenya Certificate of Education
KCSE	Kenya Certificate of Secondary Education
KESSP	Kenya Education Sector Support Programme

KNUST	Kwame Nkrumah University of Science and Technology
KU	Kenyatta University
KUCCPS	Kenya Universities and Colleges Central Placement Services
KVB	Kenya Veterinary Board
LESS	Less-Endowed Secondary Schools
LUANAR	Lilongwe University of Agriculture and Natural Resources
MU	Moi University
NACOSTI	National Commission for Science, Technology and Innovation
OECD	Organization for Economic Co-operation and Development
OSSREA	Organization for Social Science Research in Eastern and South Africa
PAU	Pan African University
PPP	Public-Private Partnerships
PUIB	Public Universities Inspection Board
REAL	Rivatex East Africa Limited
SDR	Staff Differential Remuneration
SSP	Self -Sponsored Programme
STEM	Science Technology Engineering and Mathematics
SYSTEM	Students and Youth into Science Technology Engineering and Mathematics

TAP	Tatton Agriculture Park
TTIs	Technical Training Institutions
TUK	Technical University of Kenya
TUM	Technical University of Mombasa
TVET	Technical and Vocational Education Training
UCC	University of Cape Coast
UCT	University of Cape Town
UDSM	University of Dar es Salaam
UFB	Universities Funding Board
UIP	University Industry Partnership
UMAT	University of Mines and Technology
UNESCO	United Nations Education Scientific and Cultural Organization
UNIMA	University of Malawi
UOE	University of Eldoret
UON	University of Nairobi
USA	United States of America
UWI	University of Western Indonesia

ABSTRACT

Despite the government commitment to the implementation of admission policies like targeting enrolment of 50% of all students in science and technology related courses, introduction of maximum Differentiated Unit Cost (DUC), disbursement of loans, bursaries and scholarships through HELB, the use of dual track admission policy in developing and placement of students into these programmes and significantly expanding them, only 29% of students were studying a course in Science and Technology by the year 2016. Such scenario implies that the country is seriously lagging behind in the realization of Kenya Education Sector Support Programme (KESSP I) participation target of 50%. The purpose of this study was to establish the gaps that existed in the stated government policies on admission and the actual practice during implementation, the impact of the actual practice during implementation and the interventions that could be employed to increase student participation. The study explored the trend of students' participation in Science and Technology Programmes in line with government admission policies, analyzed the relationship between funding of University students and participation in these programmes, analyzed the effects of infrastructure, teaching and learning resources and established institutional based interventions that could increase students' participation in Science and Technology Programmes. Eccle's Subject-Task Value Theory and Rendon Validation Theory were used to guide the research. The study employed descriptive survey design to target 31 public Universities, 3179 students in Veterinary and Manufacturing Engineering Programmes, 237 lecturers, 107 Heads of Departments (HoDs) and 31 Academic Registrars. Purposive sampling technique was employed to select three Public Universities, 12 HoDs, 24 lecturers, and three Academic Registrars while simple random sampling technique was employed to select 355 students who participated in the study. Documentary analysis was done on University admission records and fees structures. Questionnaires were administered to students, interview schedules were administered to lecturers, HoDs and the Academic Registrars while structured observations schedules were utilized by the researcher to collect data. Validity of research instruments was ascertained by a panel of 10 discussants and a pilot study while reliability was established through the test-retest method. Qualitative data was analyzed thematically and reported in form of tables, quotations and narrations while quantitative data was analyzed by use of frequencies, percentages, means, pie charts and bar graphs. It was established that enrolment stood at 41%, graduation at 23% and Universities had prioritized 55.2% of their programmes in the same area. Differential Unit Cost (DUC) formula has a net effect of decreasing capitation while the HELB loan awarded is equivalent to 53% and 15% of science and technology cost through Government Sponsored Programme (GSP) and Self Sponsored Programme (SSP) per year respectively. Moreover, participants came from middle or upper socio economic backgrounds. Inadequacy of physical facilities stood at 74% as 69% of the academic staff had their highest qualifications of Masters. Only 25.2% were in the rank of Senior Lecturer and above. The lecturer-student ratio was 1:18. Inter-governmental co-operations, linkages and agreements, University-secondary schools linkages, IGAs and relying on philanthropic gestures were interventions employed. The study concludes that Universities should balance enrolment in science and technology and non-sciences and programmes have to be clearly aligned to the developmental needs of the country. Additionally, University funding ought to be backed by coherent policies which prioritize quality and quantity.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This Chapter covers students' participation in Science and Technology Programmes at global, African and Kenyan contexts. It further gives the statement of the problem, objectives, research questions, significance, limitations, delimitations, and assumptions of the study, theoretical frame work, conceptual framework and operational definitions of terms.

1.2 Background to the Study

The International Standard Classification of Education (ISCED) developed by UNESCO, classified programmes offered at the Universities into: Education; Arts and Humanities; Business, Administration and Law; Natural Sciences, Mathematics and Statistics and Information and Communication Technologies. Others are Engineering, Manufacturing and Construction; Agriculture, Forestry, Fisheries and Veterinary; Health and Welfare and Services (UNESCO, 2015). With respect to participation in Science and Technology Programmes at Bachelor Level in Public Universities, Kenya, the ISCED classification was adopted and covers: Natural Sciences, Mathematics and Statistics; Engineering, Manufacturing and Construction; Agriculture, Forestry, Fisheries and Veterinary and Health and Welfare.

1.2.1 Student Participation in Science and Technology Programmes Globally

Higher Education Gross Enrolment Ratio (GER) globally, increased from 19% to 34% during 2000-2014 periods (UNESCO, 2017). This increase was as a result of

acknowledgements by national governments and international agencies that Universities play a critical role in the provision of development and wellbeing of societies (World Bank, 2008; Republic of Kenya, 2007; UNESCO, 2014). Global development agenda greatly focuses on science and technology education as one of the prioritized sector components and, as such, students' participation in such programmes in Universities needs to match the expectations of the goals of the development agenda (Kirimi, 2015; Filippetti & Savona, 2017). However, by 2015, the Organization for Economic Co-operation and Development (OECD) member countries had three times more Humanities and Social Science graduates than Science, Technology, Engineering and Mathematics (STEM) graduates. The trend further pointed to a skewed global STEM graduates pool where China and India had 40% and 35% STEM graduates respectively in 2012 and it was projected that by 2030, Brazil, Russia, Indonesia, India, China and South Africa (BRIICS) countries would produce three- quarters of global STEM graduates (OECD, 2015).

The demand for science and technology graduates in the United States of America (USA) was expected to increase at a Compounded Annual Growth Rate (CAGR) of 1.8% between the years 2008-2018. However, by 2014, the supply of domestic science and technology graduates was not sufficient to meet the demand (Federation of India Chambers of Commerce and Industry, 2014). In Latin America and Caribbean countries, the average percentage of students graduating with science-related disciplines out of total graduates in 2013 was 11.7%. Many countries posted lower graduation numbers in engineering, manufacturing and construction clusters.

For example, Cuba posted the lowest percentage standing at 1.4%, followed by Argentina, 6%, Costa Rica 6.5%, Brazil 6.77%, Uruguay 7.8%, Ecuador 8.8% and Dominican Republic 9.8% while Mexico and Venezuela were above average with 21.3% and 19.5% respectively (World Bank, 2017). The deficit of scientists and engineers in Latin America and the Caribbean were attributed to the regions low innovation, relative to that of upper middle income economies (World Bank, 2017). In Brazil, more than 50 candidates from low income backgrounds and those from advantaged backgrounds compete for a single place in popular science and technology programmes where chances of passing competitive examinations are linked to prior attendance at high quality primary and secondary schooling and fee-paying preparatory courses, all of which are out of reach for most lower-income students (McCowan, 2016).

The need to recruit more teachers in science and technology areas is an issue which faces many countries in Europe, particularly secondary schools. Lack of science and technology teachers is reported in Hungary, Switzerland, France and Latvia (Kearney, 2016). In England, the introduction of repayable tuition loans policy in higher education discouraged students from entering science and technology subjects because they were generally more expensive, and within a system of variable fees, students ended up incurring higher level of debt (House of Lords, 2012). In Turkey, the number of Science and Technology University applicants in each year is much higher than the number of places each University is able to offer. Consequently, students from low income families find it difficult to compete on competitive

entrance examinations to Science and Technology Programmes with applicants from advantaged backgrounds that have more resources to spend on high quality primary and secondary schooling, private tuition and examination preparations (Caner & Okten, 2013).

As intervention measures to increase participation in Science and Technology Programmes, Lithuania and Netherlands have updated and modernized their initial teacher training courses to reflect Science and Technology Curriculum by introducing innovative content and methods (Kearney,2016). Malta and United Kingdom (UK) have developed new programmes to facilitate and enhance the studying of sciences for prospective science teachers while Finland has set up a science and technology teacher education forum to promote cooperation between science teachers in different Universities and jointly established national quality standards for science initial teacher education (Kearney, 2016). Newly industrialized countries like Chile, Malaysia, Taiwan and South Korea, reformed and modernized University admission policies particularly those that were supportive of science and technology education participation through funding the development of public research laboratories or funding research activities collaboratively with the private sector and creating incentives to encourage foreign-based scientists to return home (Nyang'au, 2015).

Malaysia government instituted the 60:40 science/technical: arts (60:40) policy in education in 1967 and started implementing it in 1970 with specific interventions being to raise student interest through new learning approaches like developing a

series of interactive videos to compliment teaching and learning activities known as Blended Learning Open Source Science and Mathematics Studies (BLOSSOMS) which started in 2015 in collaboration with Massachusetts Institute of Technology (MIT) and University of Technology Malaysia. Another intervention was sharpening skills and abilities of teachers by identifying gaps in content knowledge and pedagogy through School Improvement Specialist Coaches (SISC+) for mathematics and science and building public and students awareness (Government of Malaysia, 2014).

Further, women in Malaysia attain 57% of science degrees. Hence, the government has partnered with UNESCO to promote gender-responsive science and technology education by sending expertise and successful experiences in promoting the participation of girls and women in science and technology education in Cambodia and Viet Nam (UNESCO, 2017). In Israel, science and technology disciplines receive the lion share of the funding at Universities where the six highest allotments are for dentistry 6.67%, physical sciences 6.23%, biology and environmental studies 5.74%, engineering 4.99%, chemical, material and medical engineering 4.99% and clinical medicine 4.35% of the teaching allotment. Further, the size of the academic faculty in mathematics, physics, biology, engineering and architecture is more senior and far larger than the faculty size in other disciplines (Drori & Netivi, 2013). Afghanistan has developed an intensive programme approved by the Ministry of Education and integrated in public school curriculum with the aim to encourage girls

to follow careers in computer science by connecting them with mentors and opportunities in higher education programmes (UNESCO, 2017).

1.2.2 The Status of Student Participation in Science and Technology Programmes in Africa

Africa has a lower Gross Enrolment Ratio (GER) of 8.17% in Universities compared to the global GER of 32.88% (Oanda & Sifuna, 2016). Further, Universities in Africa offer a curriculum that is too general with less than 5% enrolling in Science and Technology Programmes at Bachelor Level (Oanda & Sall, 2016). The Africa Union (AU) recently crafted the continents' most ambitious and long-term development blueprint dubbed as Agenda 2063 which recognizes the role of higher education in achieving the objective of balanced teaching hard sciences in areas of agriculture, livestock, health sciences and engineering in order to develop new technology. The blueprint envisages that by 2063, at least 70% of all high school graduates will go on to tertiary education, with 70% of them graduating in the sciences and technology programmes (Africa Union Commission, 2014). However, the continent faces enormous challenges in implementing this agenda. For instance, in 2016, there were a paltry 1.28% engineers in Africa (African Capacity Building Foundation, 2016).

The dismal data is a manifestation of dire state of science and technology education, teaching and learning conditions in African Universities, like low and falling science and technology funding and declining quality of science and technology education at all levels of education, thus primary, secondary, tertiary and vocational (Africa Capacity Building Foundation, 2016). Like Lesotho, the levels of laboratory facilities are far too poor to adequately cater for students registering for chemistry at advanced

level in Lesotho secondary schools. Equally, private schools seem to be the worst performing due to the fact that the science-based programmes are expensive. Hence, private schools, being profit-driven, certainly shy away from undertaking activities that are deemed to negatively affect profits (Mosotho, 2017). Ethiopia government has admission policy that calls for 70:30 intakes into science and technology programmes and social sciences and humanities at Bachelor level. The allocation of the students to Universities and programmes is managed centrally by the government by considering the space available for each programme in the University and students' preferences. However, there is little attention on availability of staff and facilities, particularly the adequacy and quality of laboratory facilities (Shibru *et al*, 2016).

In Nigeria, most Technical Vocational Education and Training (TVET) institutions lack the tools and equipment necessary for practical education where inadequate and decaying infrastructure like workshops and laboratories are often obsolete and bearing little or no resemblance to the technologies currently used in 21st century workplace. Consequently, trainees overcrowd during classes, with most of them only observing the teacher demonstrate and have no opportunity to get hand on practice (Oviawe *et al*, 2017). The situation is not different in Ghana where government policy targets 60:40 enrolment ratios for programmes in science and technology and the arts and humanities respectively. However, the ratio was 40:60 in 2010/2011 academic year and the low number of students in science programmes was largely attributed to inadequate physical infrastructure, for example, laboratories, laboratory

supplies and workshops. The situation is further compounded with inadequate number of lecturers and technicians, making learning largely passive with few practicals and limited field trips due to funding constraints. These largely compromise quality (Sam-Amoah *et al*, 2016; Atuahene & Owusu-Ansah, 2013).

There is also poor enforcement of policy targets for science and technology programmes by higher education institutions in Ghana. For instance, Kwame Nkrumah University of Science and Technology (KNUST) and University of Mines and Technology (UMAT) are science-based institutions. But over the years, they have expanded the number of arts and humanities programmes offered. At the University of Cape Coast (UCC), the ratio of science and technology and arts and humanities in 2010 was 28:72 which was below the government projected 60:40. Ghana also experiences low number of qualified applicants (Sam-Amoah *et al*, 2016; Atuahene & Owusu-Ansah, 2013).

In Malawi, the National Council for Higher Education (NCHE) coordinates University selection but the actual selection into various programmes of study is done by individual Universities. Students' enrolment in agriculture programmes at Lilongwe University of Agriculture and Natural Resources (LUANAR) had increased by 200% in 2015, although the curriculum was largely theoretical and lacking industrial orientation. Practical and laboratory sessions only contribute 10% to 30 % to the overall assessment as industrial attachments are only done once in third year of study and only for 4 weeks as opposed to 8 weeks stipulated in curriculum due to monetary limitations associated with attachments which

compromise quality (Valeta *et al,* 2016). Furthermore, several new programmes have been developed with a lot of specialization. For example, Bachelor of Science (B.Sc.) in Agronomy and Bachelor of Science in Seed Science were split from Bachelor of Science in Crop Science, a practice which made the over specialized graduates lack versatility (Valeta *et al*, 2016).

In Namibia, the capacity of enrolment in Vocational Education and Training (VET) remained insufficient at 26.3% by 2014/2015 academic year. The low numbers were majorly attributed to the system lacking the capacity to accommodate sufficient numbers due to low workshops capacity, poor safety issues, infrastructure constraints, and costly acquisition of equipment for trainees' practical work. This made access to be a challenge for graduates from secondary school education. Furthermore, those who had entered the system struggled to complete their training, owing to difficulties in quality (UNESCO, 2016).

In Uganda, 2010/2011 academic year recorded enrolment of 35,847, representing 26 per cent in Science and Technology Programmes, compared to 103,836 representing 74 per cent in Arts and Humanities. The low numbers of students participating in Science and Technology Programmes was majorly attributed to admission process which commenced immediately after ordinary levels where students were streamed into science and arts. Consequently, this early specialization makes Uganda lose potential scientists and permanently place students in Arts streams since change from the Arts to Science after this level was impossible. Yet students were streamed into those components when they were young to know what the future would bring

(Kasozi, 2016). Furthermore, the ratio of practicing doctors to Ugandan population was 1: 6727. These high ratios were a manifestation of challenges in accessing training opportunities. Access to health professional training was skewed to the elite and well-to-do who attended the top ten secondary schools with infrastructure, teaching and learning resources from central region of the country: the capital city (Kampala), Wakiso and Mukono districts (Galukande *et al*, 2018).

Countries and Universities in Africa have come up with interventions and remedial measures in an attempt to increase the number of students enrolling in science programmes at Bachelor level. Like Egypt's national Parliament approved the exemption of higher education from taxation and tariffs, including value-added tax on equipment and materials imported, as a way of improving Universities' infrastructure needed to support science and technology education (Sawahel, 2018). In South Africa, the University of Cape Town (UCT) has developed Academic Development Programme (ADP) in the School of Engineering and Built Environment where students whose school leaving certificate results were not good enough for direct University entry were granted admission. The beneficiaries receive academic and tutorial support from ADP staff in the first year and take five years instead of four to obtain a first degree in Engineering (Muluh, 2012).

Ghana had established remedial Science Programme where students from deprived schools were identified by the Joint Admissions Board. The programme accepted applications from students who did not meet the highly selective admission requirements but demonstrated the potential to succeed in science and technology

higher education. Those who participated in this programme were admitted to the University to take remedial classes and final examinations. Successful students were then accepted to pursue various science programmes (Atuahene & Owusu-Ansah, 2013). Furthermore, in 2016/2017 academic year, Kwame Nkrumah University of Science and Technology (KNUST) lowered cut-off points in science-related programmes, introduced remedial pre-University programmes and financial assistance for females (Atuahene & Owusu-Ansah, 2013). In Tanzania, several affirmative action strategies had been introduced to increase enrolment of women to Engineering and Science Programmes. For instance, University of Dar es Salaam (UDSM) lowered the entry cut-off point by 1.5 points. Students were then given remedial pre-University programmes and provision for Female Undergraduate Scholarship Programme (FUSP) financed with assistance from the Carnegie Corporation of New York (CCNY) (Kilango *et al,* 2017). Similar affirmative action programme to encourage women into Science and Technology Programmes was equally practised in Makerere University, Uganda (Chege & Sifuna, 2006; Sifuna, 2006).

1.2.3 Student Participation in Science and Technology Programmes in Kenya: Trends, Impact, and Interventions

The Kenya Vision 2030 and Sessional Paper No.2 of 2015 placed much emphasis on Science, Technology and Innovation by prioritizing Science, Technology, Engineering and Mathematics (STEM) education. It was envisaged that more resources will be devoted to scientific research, technical capabilities of workforce and raising the quality of teaching STEM in schools, Polytechnics and Universities

(Republic of Kenya, 2007; Republic of Kenya, 2015). The need to enroll many students in science and technology Bachelor degree programmes has been articulated by the government from time to time, but the number of those participating has persistently remained low. In 1974-1978 development periods, students were encouraged to enter sciences and mathematics based faculties at the University of Nairobi (UoN) since the University at the time was expected to produce high level manpower, particularly in professions such as medicine, engineering and agriculture which were seen as essential to support the nation's rapid social and economic development (Republic of Kenya, 1974). A Report of the National Committee on Educational Objectives and Policies (Gachathi report) (1976) pointed out that UoN had not kept pace with the increasing demands made on it in terms of diversified curricula and recommended creating additional programmes in scientific and technical fields that were not being taught such as mining engineering, chemical engineering, water engineering, marine and arid zone science and technology (Republic of Kenya, 1976).

The need to emphasize on scientific and technological fields was again seen in the government's move to establish a second University in the country during the 1979-1983 development periods (Republic of Kenya, 1979). A Presidential Working Party on the Second University in Kenya was appointed (Mackay Commission) with some of the terms of reference being to review generally the higher education system in relations to development objectives of the country and recommend on size including student enrolment, structure and disciplinary coverage of the proposed University.

The Working Party recommended that disciplines in the second University were to be oriented towards developing the infrastructure necessary for rural development. It emphasized the need to train more scientific and technological manpower in areas such as arid and coastal zones, marine science and engineering, chemical engineering, water engineering and mining engineering (Republic of Kenya, 1981).

Since the establishment of the second public University in 1984, there are currently 31 public Universities in Kenya, all offering Programmes in science and technology. But the challenge of imbalance between the number of students studying science and arts based courses still persists. There was low enrolment capacity in strategic courses like medicine, engineering, computer science, dentistry, pharmacy and actuarial science (Republic of Kenya, 2005; Republic of Kenya, 2006). Between 2005 and 2010, majority of undergraduate students in Universities in Kenya were enrolled in non-science related courses. In 2005, enrolment in science programmes accounted for 20% with a slight increase to 22% by 2010 (World Bank, 2016).

The government committed to the implementation of investment programmes outlined in the Kenya Education Sector Support Programme (KESSP) 2005-2010 where one of the targets was increasing the proportion of all students studying science-related courses to 50% with at least one third of those being women by the year 2010 (Republic of Kenya, 2006; UNESCO, 2010). The actual placement of government sponsored students to Universities was initially coordinated by Joint Admissions Board (JAB). Currently, the role is being played by Kenya Universities and Colleges Central Placement Services (KUCCPS) which was established

following the operationalization of the Universities Act No. 42 of 2012 (Republic of Kenya, 2014). The placement policy requires that programmes must be identified as a priority area by the government (Kenya Universities and Colleges Central Placement Services, 2014). In 2016, public Universities in Kenya recorded a total enrolment of 29% in Science and Technology Bachelor Degree Programme (Commission for University Education, 2016). Table 1.1 below summarizes enrolment per cluster and the per cent of each cluster at Bachelor level in 2016.

Table 1.1: Summary of Enrolment in Public Universities at Bachelor Level in 2016

Cluster of programmes	**Total number enrolled**	**Percentage**
Agriculture, forestry & fisheries	23361	6.1
Architecture	4877	1.2
Engineering	19851	5.2
Health and welfare	19489	5.2
Life and physical sciences	31305	8.3
Mathematics and Statistics	12360	3.3
Veterinary	1022	0.2
Manufacturing	2157	0.5
Business & Administration	65832	17.5
Education	91860	24.4
Humanities, Arts, Social & Behaviour	62226	16.5
Environment & Services	16139	4.3
Law, Journalism, Security & Conflict	17480	4.7
Others	9952	2.7
Total	**377,911**	**100**

Source: Commission for University Education data, 2016

From table 1.1, the clusters that were poorly represented were Veterinary at 0.2%, Manufacturing at 0.5%, Architecture 1.2% and Mathematics 3.3%. Yet these were some of the areas that had been identified as priority by the government (Republic of

Kenya, 2007). Consequently, Kenya failed to meet KESSP I science and technology participation target of 50 per cent (UNESCO, 2010).

The low number of students participating in science and technology Bachelor degree programmes in Kenya was mainly attributed to funding which was critical factor that hindered the development of science and technology programmes (Karimi, 2015). In Kenyan public Universities, 48% of income from government capitation, 42% from students' fees and research grants and other incomes contribute 5 % (Mukhwana *et al*, 2016). With regard to government capitation, Universities Fund and the Funding Board were established under the Universities Act No. 42 of 2012 to advise the government on matters relating to financing of Universities (Government of Kenya, 2014). The Board has established maximum Differential Unit Cost (DUC) for academic programmes offered. The Board utilizes student enrolment numbers and the courses offered instead of flat rate per year to allocate funds to Universities (Universities Funding Board, 2019).

Apart from government capitation, Higher Education Loans Board (HELB), which is a State Corporation, was established by an Act of Parliament (Cap 213A) in 1995 with the mandate to disperse loans, bursaries and scholarships to students pursuing higher education in recognized institutions (Government of Kenya, 1995). The loans awarded are supposed to be used for tuition, books and stationery, accommodation and subsistence. Based on the need basis, the Board also awards bursaries ranging between Ksh. 4,000/= and Ksh. 8,000/= (Higher Education Loans Board, 2017).

However, despite implementation of these funding policies, Universities normally operate on a deficit. For instance, public Universities operated on a deficit of Ksh. 1,860.56 million in 2016 (Mukhwana *et al,* 2016). This led to the use of dual track policy when developing and placement of students into various programmes. Dual track policy is a trend of shifting the cost burden to students and away from government. Through greater contributions by students and their families, they enroll in Self-Sponsored Programmes (SSP)/ Module II Programmes/ Parallel Programmes as they got to be named by different Universities (Oanda, 2013; Sifuna & Oanda, 2014).

This policy posed a number of implications on Science and Technology Programmes participation. First, the Universities developed programmes which attracted many students leading to unethical competition for students in an attempt to finance the deficit. Eventually, skewed development and mounting of programmes which ignored the more expensive Science and Technology Programmes ensued (Mukhwana *et al*, 2016). Moreover, to mount programmes in science and technology cluster, Universities need to invest in very expensive equipment since laboratory-based education costs higher (World Bank, 2016). This implied that science and technology participation was now restricted to privileged few with under-representation of many groups like lower- income earners (Sifuna & Oanda, 2014). In 2018/2019 academic year, only 2.5% of students who applied for admission through government sponsorship to Bachelor of Science Electrical and Electronic Engineering at Jomo Kenyatta University of Agriculture and Technology (JKUAT)

were placed. 4% and 2% of students who applied for the same programme at University of Nairobi (UoN) and Kenyatta University (KU) were placed respectively (Wanzala & Nyamai, 2018). The overall deduction from such trend was that a very small percentage for government sponsored into Science and Technology Programmes were successful (Yokoski & Birubaum, 2013; Oanda, 2013).

Another critical factor contributing to student participation in science and technology Bachelor degree programmes was infrastructure, teaching and learning resources. The government targeted expansion of public Universities through upgrading of a large number of middle-level technical colleges to University status. For instance, there were 14 new public Universities created in 2013 alone (Republic of Kenya, 2006; UNESCO, 2010; McCowan, 2018). This led to significant expansion of Science and Technology Programmes offered in public Universities at Bachelor level with Life Science and Physical Science cluster having 164 programmes; Agriculture, Forestry and Fisheries 140; Health and Welfare 92; Engineering 85; Mathematics and Statistics 44; Architecture 17; Veterinary 10; and Manufacturing seven (Mukhwana *et al,* 2016). Despite this expansion, inputs like laboratory space and workshops, as well as spare parts for equipment maintenance and repair, routine replacement and upgrading of equipment, reagents and other consumable supplies were not carried out (Sifuna, 2010; Gudo *et al,* 2011; Mukhwana *et al*, 2017; McCowan, 2018).

Due to the need to invest in expensive equipment and the nature of laboratory-based education, policy makers and institutions tended to push more students towards

Humanities. In the same breath, small numbers of private tertiary institutions have invested in science and technology disciplines as a consequence of the high costs associated with investments in laboratories (UNESCO, 2010). In Polytechnics and Institutes of Technology, there are inadequate physical facilities and capacities to meet demand of school leavers seeking training at Technical and Vocational Education and Training (TVET) institutions, lack of adequately trained tutors to teach at TVET institutions and obsolete equipment compromises effective training for a modern economy (UNESCO, 2010; Mango, 2015).

Chronic shortage of sufficiently qualified faculty with capacity to teach science and technology related programmes of sufficient quality to meet recognized standards and lack of infrastructure, teaching and learning resources have contributed to inefficient implementation of science based curricula. There is too much theory, few practicals and less practice, a scenario that led to Engineering Board of Kenya (EBK) threatening to cancel engineering accreditation of some Universities in Kenya (Ochuodho, 2016; Ligami, 2018, Kiplang'at, 2018). Such trend equally leads to poor learning outcomes where learners don't get desired level of skills. This leads to wastage of precious years and dashes the high hopes of families who had incurred huge debts (Schendel & McCowan, 2015).

Further, some Universities offering science and technology programmes tend towards splintering, a concept where Universities are offering increasingly specific programmes like specialized areas of Electrical Engineering such as BSc. (Electrical and Computer Engineering) and BSc. (Electrical and Communication Engineering)

as a means of maximizing income through new markets. In the rush for these courses tailor-made for specific markets, there is dilemma of not developing individuals with strategy and critical thinking since the new programmes are too narrow (Oanda &Sifuna, 2016; Ochuodho, 2016). The situation is further compounded by KUCCPS admitting students to degree programmes in Universities they did not choose. In 2015/2016 academic year, 40% of students admitted into Agriculture Programmes at the University of Eldoret (UoE) did not choose the courses and 30% did not choose the University. When such students report to University, they try to shift to other programmes and such situation breeds discontent among them which affects participation in Agriculture Programmes (Ochuodho, 2016).

As an intervention measure, the Government of Kenya through National Commission for Science Technology and Innovation (NACOSTI) and University of Nairobi (UoN), together with United Nations Education Scientific and Cultural Organization (UNESCO), organize annual scientific camps of excellence for mentoring girls in science and technology with the aim of demystifying science, and inspire girls to embrace the sciences and nurture them as future science and technology professionals and leaders (UNESCO, 2017). Moreover, the Universities have attempted in a number of ways to increase funding in order to enhance students' participation in science and technology programmes like diversification of sources of revenue (Oanda and Sifuna, 2016). They have attempted to capitalize on their niche areas of expertise like Egerton University (EU) using its dairy facilities to produce products like yoghurt (Akuno, *et al,* 2017). Other measures put in place by

public Universities to generate extra revenue to augment meagre government allocation include: introduction of Self-Sponsored Programmes (SSP), introduction of commercial ventures such as shopping malls, funeral homes, industrial parks, rented out property and provision of catering services (Michieka, 2016). Further, they attract funds through research grants from local, regional and international bodies like Council for the Development of Social Science Research in Africa (CODESRIA), Organization for Social Science Research in Eastern Africa (OSSREA), the Ford Foundation and Rockefeller. Equally, Universities have also entered into inter-governmental linkages, exchanges and agreements which have resulted in government procurement of resources that boost the capital in institutions of higher learning. For example, Technical University of Kenya (TUK) benefitted by receiving equipment through Kenya-China technical cooperation initiative which brought state-of- the- art equipment for mechanical engineering workshops (Akuno, *et al,* 2017).

Despite efforts by the government and other interested groups, the level of enrolment and participation in science and technology-based Bachelor degree programmes remains as low as 29%. Yet these are the programmes identified as priority area for training with the potential to catapult the country to greater heights of development (World Bank, 2014; Too *et al,* 2018).

1.3 Statement of the Problem

The attainment of global development agenda greatly focuses on science and technology education (Republic of Kenya, 2007; Nyang'au, 2016; Kivati, 2017). The

Government of Kenya introduced several measures in order to increase students' participation in Science and Technology Programmes at Bachelors' level. Some of the measures included a policy on admission which targeted enrolment of 50% of all students in science and technology related courses, introduction of maximum Differentiated Unit Cost (DUC), disbursement of loans, bursaries and scholarships through HELB, the use of dual track admission policy in developing and placement of students into these programmes and significantly expanding them (Republic of Kenya, 1995; UNESCO, 2010; Republic of Kenya, 2014; Kenya Universities and Colleges Central Placement Services, 2014; Mukhwana *et al*, 2016). Despite implementation of all these policies, participation rate from public Universities in Kenya stood below 29% (Commission for University Education, 2016), which was twenty-one percentage points behind 2010 KESSP I target of fifty percent (UNESCO, 2010).

This low numbers of students participating in Science and Technology programmes at Bachelor level constituted a major concern in this study because these were the programmes prioritized for training with the potential to spur the country's national development. Leaving out majority of the population from science and technology disciplines was going to have negative implication for attainment of an industrialized nation as envisaged in Kenya Vision 2030. Additionally, the continued low participation of students in Science and Technology Programmes meant that any benefits which could accrue from increased students' participation like viable productivity and social-economic development might be difficult to be realized.

Therefore, the task of this study was to explore the gaps which existed in the stated government policies designed to guide admission to science and technology Bachelor degree programmes and their actual practice and impact during the implementation and also interventions which could be employed to popularize the Science and Technology Bachelor Degree Programmes.

1.4 Purpose of Study

The purpose of this study was therefore to establish the gaps which existed in the stated government policies designed to guide admission to science and technology Bachelor degree programmes and the actual practice during their implementation, the impact of the actual practice on students' participation in order to determine the interventions that could enhance the science and technology Bachelor degree programmes.

1.5. Objectives of the Study

The objectives of the study were to:

a. Explore the trend of students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in line with Government of Kenya admission policies.
b. Analyze the relationship between funding of University students and participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya.

c. Examine the effects of infrastructure, teaching and learning resources on students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya.

d. Evaluate the institutional based interventions which could increase students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya.

1.6. Research Questions

The study sought to answer the following questions:

a. To what extent is the trend of students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in line with Government of Kenya admission policies?

b. To what extent does the funding of University students relate to their participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya?

c. In what ways do infrastructure, teaching and learning resources affect students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya?

d. Which institutional based interventions contribute to enhancing students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya?

1.7. Significance of the Study

The study sought to establish the gaps which existed in stated government policies designed to guide admission into Science and Technology Bachelor Degree

Programmes and the actual practice during implementation. The identified gaps might provide Commission for University Education (CUE) policy makers, University level policy makers, the Senate and managers (including Vice-Chancellors, Deputy Vice- Chancellors, Registrars, Deans of Schools) with information that could be utilized to develop specific interventions aimed at boosting participation in Science and Technology Bachelor Degree Programmes.

While data exists on students' enrolment in Universities, the information preceding the current study tended to focus on consolidated data for enrolment in all programmes, that is: Science and Technology, Humanities and Social Sciences. This mode of presenting data only shows the students' numbers in institutions but not the respective academic disciplines in which they are registered. This study breaks down the data to illuminate participation trends down to the level of Science and Technology Programmes which is significant in policy-making and could stimulate further inquiry on participation, with specific focus on Science and Technology Programmes due to the central role they play in national development.

Consequently, parents and benefactors could develop measures to enhance students' participation in these programmes. Additionally, information on various interventions at policy and University levels could yield improvements in the gaps so far identified. For parents, understanding the background of possible obstacles could help the households to develop their own prudent approaches for students' successful participation.

1.8. Limitations of the Study

This study had some limitations including, focusing on Public Universities only. Hence, the findings may not be generalized to Private Universities. Secondly, three Public Universities: Technical University of Kenya, Moi University and Egerton University were surveyed and they were by no means, representative of the 31 Public Universities which were in existence in Kenya at the time of the study. However, an in-depth study of the three Public Universities revealed more detailed information about the implementation of government policies on admission into Bachelor Degree Programmes and the impact on students' participation. This would have not been possible with a wide coverage of many Universities targeted through a general questionnaire.

1.9. Delimitation of the Study

This study was limited to three programmes which were: Bachelor of Engineering (Manufacturing, Industrial and Textile Engineering), Bachelor of Science (Manufacturing and Technology) and Bachelor of Veterinary Medicine. These were some of the science and technology priority areas experiencing low enrolment in Public Universities in Kenya. Secondly**,** the government admission policies which dated back to colonial period had changed considerably with time. This study therefore, focused on the period 2013-2017 because this was the period that Kenya articulated more on science and technology education and training in KESSP II as the core priorities essential for the national development. Thirdly, University education in Kenya includes Certificate, Diploma, Bachelors and Graduate

Programmes. The researcher selected bachelors' level for investigation so as to avoid multiple themes that could emerge in investigating different levels.

1.10. Assumptions of the Study

The assumptions of this study were that science and technology University education would continue to be core priority areas, essential for national development. Secondly, it was assumed that the respondents would answer truthfully and data trends for 2013-2017 would be available. Finally, the sample would be representative of the target population.

1.11. Theoretical Framework

The focus of this study was to analyze government policies on admission into Science and Technology Bachelor Degree Programmes and their impact on students' participation in Public Universities, Kenya. Eccle's (2002) Subject-Task Value Theory and Validation Theory, proposed by Rendon (1994), complemented each other in guiding the study. The Subject-Task Value Theory postulates that individuals' choice and motivation to study any given subject is determined by the value attached to it. The theory identifies four tenets, namely; Attainment Value which is the importance derived from having the ability to do well on a task as the basis for choice; Intrinsic Value is the importance derived from the enjoyment one gets in carrying out a task of choice. The Utility Value is in reference to how important the task is for attaining some other short or long term goal, and Cost Value is associated with the sacrifices one has to make to perform the task and the efforts required to complete it.

Eccle's Subject-Task Value Theory (2002) guided this study to highlight reasons why students enroll and participate in Science and Technology Programmes and the challenges they face. The Utility Value guided the study to explain how participation in Science and Technology Programmes enables students acquire knowledge, skills and competencies needed both for individual and government development. The Cost Value guided the study to identify financial burdens pushed to parents and guardians in dual track admission policy. The study was also guided by the Validation Theory proposed by Rendon (1994): "Validation is the intellectual, proactive affirmation of students by in-and out of class agents" (Rendon & Munoz, 2001). The five tenets of Validation Theory are: learning institutions should be proactive and initiate contact with the disadvantaged students for assistance; support offered by institutional agents should be consistent; needy students should be assisted to easily access both financial and non-financial support; support should be provided throughout the cycle of education; and assistance is more effective when done in the initial years of enrolment. In the context of this study, the Validation Theory was used to highlight the approaches that could be used by Universities to assist poor students to participate in Science and Technology Programmes. Validation is critical to this group of students due to the unique challenges they face both economically and socially. Such challenges call for improved interventions in form of financial aid, academic and institutional support.

1.12. The Conceptual Framework for the Study

The purpose of this study was to analyze the implementation of government policies on admission into Science and Technology Bachelor Degree Programmes and the impact on student participation in Public Universities, Kenya. The Framework presented three variables; independent variables, which were in form of government enrolment targets, funding of University students and infrastructure, learning and teaching resources. The dependent variables (participation in Science and Technology Programmes) were measured in form of enrolment into the programmes, variety of the programmes and graduation numbers while the intervening variables included government measures and University-based interventions which aimed at enhancing participation in Science and Technology Programmes at Bachelor level.

In this study, participation depended on admission of students into priority Science and Technology Programmes, funding of University students by households and government capitation, provision of physical facilities and human resources lead to participation. Together with interventions like tax waivers, tax rebates, endowment funds, University-industry linkages, commercializing intellectual property and entrepreneurships, then, higher enrolment, many graduation numbers, and variety of programmes occurs. The Conceptual Framework presented the three variables in Figure 1.1:

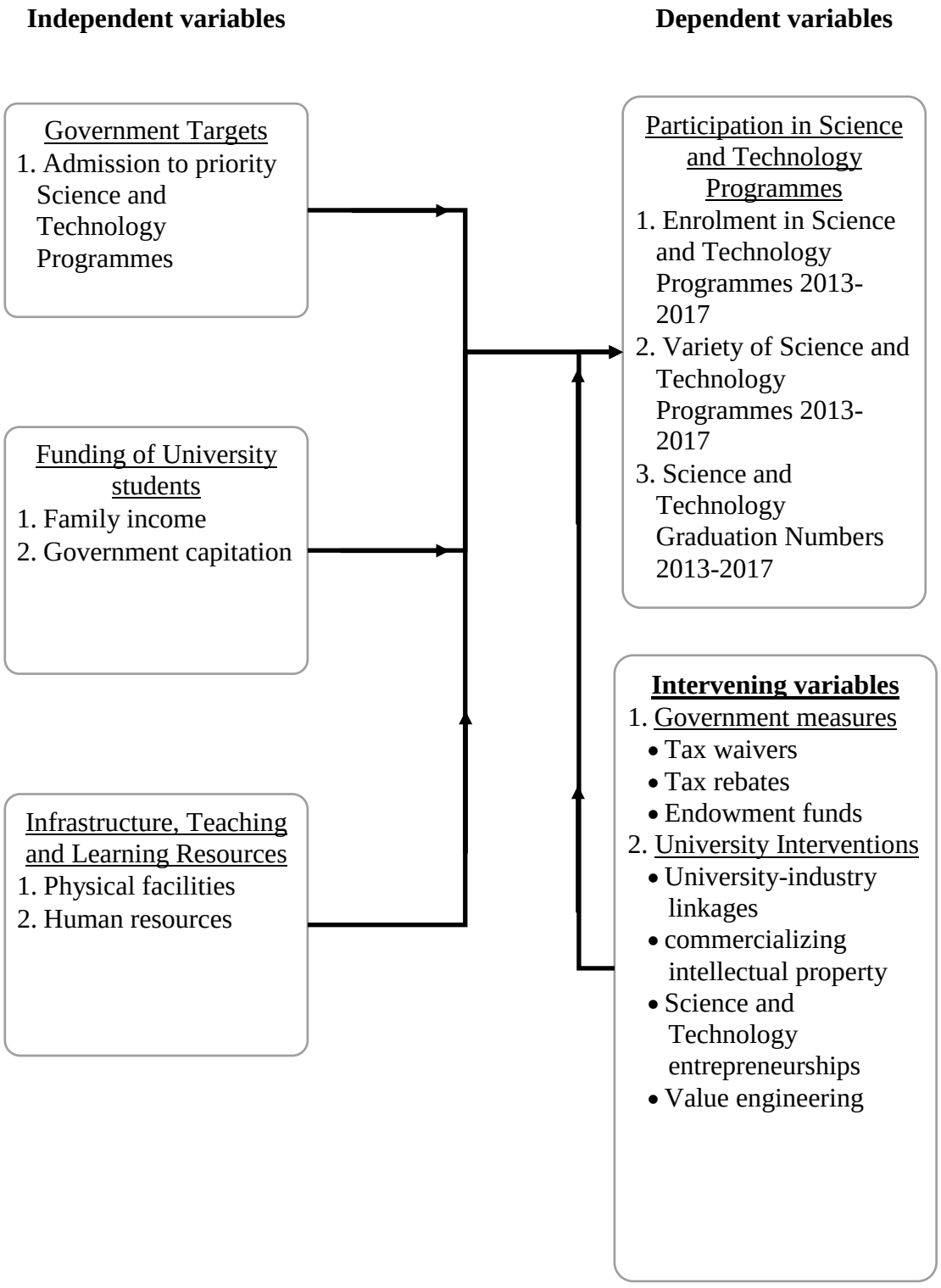


Figure 1.1: Conceptual Framework

1.13. Operational Definitions of Terms

Academic programme: the designed learning content which includes the intention, the structure of the content, the delivery mode, academic resources and assessment modes at the University

Accreditation: the procedure by which the CUE formally recognizes an institution as a University and as having fulfilled the prescribed criteria for mounting its academic programmes

Admission: the act of allowing qualified applicants to pursue studies in University education at a given University or in a given programme.

Bachelor degree: refers to undergraduate academic degree awarded by a University upon completion of a course of study lasting between four to six years depending on academic discipline.

Dual track admission policy: trend of self- financing through shifting the cost burden to students and away from public subsidies through greater contribution by students and their families .

Higher Education Institutions: refers to post-secondary institutions including Universities, Colleges and professional schools

Participation: the process that entails the enrolment, retention and graduation rates of students in Science and Technology Bachelor Degree Programmes in Public Universities.

Programmatic isomorphism: concept where Universities shade off their technical orientation in favour of Arts and Humanities degree programmes.

Programme accreditation: a process by which the CUE formally recognizes an academic programme of a University.

Public University: a University established and maintained or assisted out of public funds.

Science and Technology Programmes: refers to Kenya's priority areas of Natural Sciences, Mathematics and Statistics, Engineering, Manufacturing and Construction, Agriculture, Forestry, Fisheries and Veterinary and Health and Welfare

Splintering concept: a concept where Universities are offering increasingly specific programmes like specialized areas of Electrical Engineering as a means of maximizing income through new markets.

University admission policies: refers to the criteria that govern the act of allowing qualified applicants to pursue studies in University education at a given

University or in a given programme

1.14. Organization of the Study

This study comprises five Chapters. Chapter One includes background to the study which covers students' participation in Science and Technology Programmes at global, African and Kenyan contexts. It further gives the statement of the problem, objectives, research questions, significance, limitations, delimitations, and assumptions of the study, theoretical frame work, conceptual framework and operational definitions of terms. Chapter Two encompasses review of related literature on status of participation in Science and Technology Programmes, funding, infrastructure, teaching and learning resources, institutional based interventions and summary of knowledge gaps. Chapter Three entails research methodology which covers research design, location of the study, target population, sampling techniques and sample size, data collection instruments, pilot study, validity and reliability, data collection procedure, data analysis and logistical and ethical considerations. Chapter Four contains presentation of findings, interpretation and discussion. Finally, Chapter Five focuses on summary, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Introduction

This chapter covers review of related literature on status of participation, funding, infrastructure, teaching and learning resources, institutional based interventions in Science and Technology Programmes, and summary of knowledge gaps. The review is cascaded from a global viewpoint to regional level and then national level.

2.2. Status of Participation in Science and Technology Programmes at Bachelor Level: Global, Regional and National Level

Yingyi & Liu (2017) conducted an intersectional study on entry and degree attainment in STEM subjects in United States of America (USA) by sampling 9272 students of non- Hispanic whites, non-Hispanic blacks, Hispanics and Asians. The study revealed that women and racial minorities are more under-represented in physical STEM fields. It further revealed that racial disparities in completing STEM degrees are much larger than at the entry point, where blacks and Hispanics trail behind Asians and whites in persistence (Yingyi & Liu, 2017). Bagde *et al* (2016) conducted an empirical review of the admission policy in 225 Indian Engineering Colleges and found out that the most disadvantaged castes participated in Engineering Programmes in smaller proportion than their population shares (Bagde *et al*, 2016).

Koketso (2015) conducted a qualitative research on understanding the gender disparity in enrolment and graduation in post-secondary education in Botswana. The study revealed that female enrolment in engineering and technology stood at 20%

and that male students were 60% more likely than female students to receive associates degree in STEM-related fields. This study identified gaps of interest in studies conducted by Yingyi & Liu, 2017; Bagde *et al*, 2016 and Koketso, 2015. The gap in the Yingyi & Liu study was that although intersectional studies address marginalization both in feminist and antiracist policies, it narrowed too much on entry and degree attainment in Science Technology Engineering Mathematics (STEM) at the intersection of gender and race/ethnicity. The gap in Bagde *et al*, study was that it majorly focused on participation in Engineering programmes based on different castes. Another limitation was being too general by reviewing admission policy in 225 colleges which offered Engineering programmes in India while the study by Koketso (2015) equally focused on gender disparities in enrolment and graduation. In that regard, our study broadened the scope to explain participation in Science and Technology Programmes irrespective of gender, caste, ethnicity or race. Moreover, it carried out an in-depth study in only three Public Universities in Kenya and discovered more detailed information about government policies on admission into the stated programmes.

Garwe (2015) did a study on trends in students' enrolments in Agricultural Degree Programmes in Zimbabwe. The study utilized documentary evidence and structured questionnaire to collect data from 250 students in 15 different Universities for a span of 6 years (2009-2014). The study found out that despite the increase in number and variety of agriculture-related programmes, the share of enrolments in those programmes, compared to overall enrolments, showed a downward trend. Although

agriculture was one of the subjects in STEM programmes, the study by Garwe narrowed too much on a single programme and the findings could not give a clear picture on the number and variety of STEM related programmes. Apart from agriculture programme, our study broadened the scope by also analyzing trends in students' enrolments in Manufacturing Engineering Programmes.

Mpehongwa (2014) conducted a documentary review on career choices of University students and their implications for Vision 2025 in Tanzania and found out that enrolment in sciences (Agriculture, Engineering, Medicines and Natural Sciences) had decreased to 23,922, representing 17.6% while that of Arts and Humanities (Business and Management, Education, Law and Social Sciences) had increased to 111,445, representing 82% between 2006-2011 (Mpehongwa, 2014). Another study in East Africa by Karimi (2015) on participation in academic programmes which sampled the websites of the national quality assurance agencies had similar findings, that there was over-subscription of students in the categories of Humanities and Commerce while Engineering, Architecture and Natural and Life Sciences, which were critical to the realization of the global development agenda, were not adequately being offered in East African Universities (Karimi, 2015).

One of the limitations in both studies by Mpehongwa (2014) and Karimi (2015) was collecting data from one source: documentary review for the case of Mpehongwa and websites in the case of Karimi. The gap was that data collected from one source could not be corroborated. But our study employed documentary analysis, self-administered questionnaires, open-ended interviews and structured observations to

collect data from lecturers, students, Heads of Departments, and University administrators for possible corroboration. The second gap in the study by Karimi was the inclusion of Universities from Kenya, Uganda, Tanzania, Rwanda, Burundi and South Sudan which produced general information about students' participation in Science and Technology Programmes since these countries were experiencing varying levels of development. Nevertheless, our study focused on participation in Science and Technology Programmes in Public Universities in Kenya.

Sader & Gabela (2017) carried out an inquiry on spatiality of widening participation in South Africa Higher Education Institutions (HEIs). The study revealed that out of 969,155 students enrolled in public HEIs, only 18% of the starting number graduated and 48% had either dropped out or not completed their studies (Sader & Gabela, 2017). Misaro *et al* (2013) reviewed various literatures pertaining on the impact of massification on quality of higher education in Kenya. Their study was underpinned by Martin Trow's theory of massification of higher education and revealed an emerging trend of ever-increasing student enrolments (Misaro *et al*, 2013). Muema & Lavery (2018) systematically reviewed literature with a quantitative synthesis of data on redefining quality in higher education in Kenya and found out a sharp rise in enrolment where the number increased by 48% in 2009/2010. The second finding was that the number of graduating students increased by 93% in 2012. The study further found out that 3408 programmes were offered at Bachelors, Masters, Doctoral and Postgraduate Diploma Levels, where most of the programmes were completely new (Muema & Lavery, 2018).

Our study identified three gaps of interest in researches conducted by Sader & Gabela (2017) in South Africa, Misaro *et al* (2013) in Kenya and Muema and Lavery (2018) in Kenya. First, the studies primarily looked at the numbers (massification of higher education) but failed to look at the question of enrolments, retention, and completions in specific programmes. The second gap was presenting consolidated data for enrolments and graduating numbers of Bachelors, Masters and PhD students. The third gap was presenting consolidated number of programmes offered at Bachelors, Masters, Doctoral and Postgraduate Diploma Levels. In light of the global development agenda, Africa Union's long-term development, Agenda 2063 which recognizes the role of balanced teaching of the hard sciences to develop new technology and Kenya's Vision 2030 which prioritizes training of science and technology, our study focused on enrolment, retention and completion in Science and Technology Programmes at Bachelors' Level. The study was guided by Eccle's (2002) Subject-Task-Value Theory to explain the importance attached to participating in these programmes.

2.3. Funding and Participation in Science and Technology Programmes at the Global, Regional and National Levels

Usher & Medow (2010) carried out household surveys to compare affordability and accessibility of higher education and the average national household income in Mexico, Canada and New Zealand. The surveys established that the total cost of higher education in Mexico was 1.75 times the level of the average national household income while it was half that in Canada and New Zealand. This study identified one gap of interest in studies conducted by Usher & Medow (2010). Given

that calculating the costs of higher education was not a straightforward task since tuition, registration and examination fees often differed by subject area and by institution, it was not feasible how household surveys only could be used to generalize the cost of higher education without the specific information from higher education institutions themselves, particularly in specific programmes. To address this gap, our study focused on the cumulative costs of participating specifically in Science and Technology Programmes by analyzing fees structures of Public Universities in Kenya and administering questionnaires to students. This contextualized financial issues which affected participation in these programmes within the financial environment in Kenya.

Bekir (2016) conducted a study on the challenges of massification of higher education in Turkey. The study found out that Turkey had an expanding public higher education system with no tuition fees since 2013. Consequently, many students, especially in the public Universities faced low quality education experience. The gap in Bekir study was that it never desegregated how free tuition impacted on quality in specific programmes. Our study desegregated finance data down to Science and Technology Programmes, given that laboratory education costs more.

A study on cost sharing policy in Zambia's public Universities by Masaiti & Shen (2013) found out that a big proportion of Zambian parents had no capacity of paying economic fees (self-sponsored stream) in an environment where tax funding was becoming limited due to massification in higher education (Masaiti & Shen, 2013).

A study by Sumaworo & Ibrahim (2015) on challenges of tertiary education pointed out that Liberia Universities and Colleges struggled with financial constraints which had forced professors to have multiple assignments and jobs in an attempt to meet their financial needs (Sumaworo & Ibrahim, 2015). Another study by Kobla *et al* (2018) on the impact of massification on higher education, the case of Bunda College in Malawi found out that the government had reduced the amount of money being allocated to the College because available resources were not enough. Consequently, the College had resorted to increasing the fees. This led to massive dropouts since a large number of students could not afford to pay the fees (Kobla *et al*, 2018).

Our study identified gaps of interest in studies conducted by Masaiti & Shen, 2013; Sumaworo & Ibrahim, 2015 and Kobla *et al*, 2018. The gap in the Masaiti & Shen study was that it generalized the effects of payment of economic fees in higher education without focusing on Science and Technology Programmes given that science education was more expensive. Sumaworo & Ibrahim looked at financial constraints affecting professors generally in Colleges and Universities without considering financial constraints in specific programmes while Kobla *et al* equally looked at the impact of government reduced funding to Bunda College which led to massive dropouts without considering specific programmes like science and technology which were more expensive. The studies never desegregated finance data down to specific programmes. Secondly, they all focused on finance payable to Universities by students or received by Universities from the government and never

considered other costs that students incur. Our study desegregated finance data down to Science and Technology Programmes, given that laboratory education costs more. This precisely established the effect of funding on participation in Science and Technology Programmes. Also, this study considered other costs incurred by students. Hence, it came up with cumulative costs of participating in these programmes.

Debrah (2008) conducted a study on financial challenges for students at the University of Ghana. The study adopted a multi-strategy approach and interviewed 117 first year students. It found out that 86% of the students at the University of Ghana had at least a parent with high or middle income. The second finding was that the main source of funds which majority of the students at the University depended on came from parents. The third finding was that few students whose parents fell within low income group faced challenges in financing their education (Debrah, 2008). In the upper west region of Ghana, Pantah & Asante (2018) conducted an evaluation of students' sources of financing at University of Development Studies and Wa Polytechnic. The study surveyed 153 students and revealed that the main source of financing included: self- financing 22%; parents 34%; friends and relatives 12%; and scholarship, one per cent. It further found out that late payment of school fees and inability to meet basic needs were major challenges faced by the students (Pantah & Asante, 2018).

Failure to provide cumulative costs per year in Science and Technology Programmes, in both Debrah (2008) and Pantah & Asante (2018) studies, indicated

another gap for this study since it was not possible to conclude on challenges of funding on the basis of family income without getting the cumulative cost per year. The second gap in the study by Debrah was sampling only first year students, yet these had not been in the university long enough to clearly understand financial challenges. Consequently, both family income and cumulative costs in Science and Technology Programmes per year, as listed in the University fees structure, were calculated for comparison. This led to a clear understanding of the relationship between funding of University students and their participation in Science and Technology Programmes in Public Universities in Kenya. In Kenya, there are two systems of funding University education. One is where students receive government subsidy and the other system is where they pay fees themselves as determined by an individual University as self-sponsored. Our study sought to get the relationship between family income and participation in the stated programmes in both systems of funding. Hence, it established how funding of University students related with participation in the programmes. With regard to sampling, this study targeted students in the second, third, fourth and fifth years of study. This was decided on the basis that students at different levels have different experiences of funding and participation in Science and Technology Programmes.

In Nyeri North and Kieni West Sub- Counties, Central Kenya, Gichuhi (2015) conducted a study on alternative methods of financing higher education and found out that household financing of education was faced by several challenges, especially if the mechanisms included fees from savings, borrowing from commercial banks

and relying on friends and relatives for contributions. The study concluded that education expenditures were major components in consumption of households with children in school. Therefore, as the government funding reduces in higher education, this affected access, especially for the poor. Another study on inequalities in accessing higher education in Kenya by Mulongo (2013) established that education was mostly dependent on a student's social-economic background. It found that 84% of students at University of Nairobi (UoN) came from high income potential areas and access to higher education was determined by quality secondary schools (Mulongo, 2013).

One of the limitations in the studies by Gichuhi (2015) and Mulongo (2013) was that they focused on higher education in general without desegregating access data down to specific programmes. But our study established how reduction in government funding and students socio-economic background, particularly in Science and Technology Programmes affected participation given that these programmes were more expensive.

Akumu *et al* (2017) conducted a study on whether loan amount affected choice of programme of study from privately sponsored undergraduate Higher Education Loans Board (HELB) loan recipients in Kenyan Public Universities. It found out that there was no significant relationship between HELB loan amount and the choice of programme of study by self-sponsored students in Public Universities. However, there was one major limitation in the study conducted by Akumu *et al*. The data was collected from privately sponsored HELB loans recipients' in Public Universities.

This finding narrowed so much on privately sponsored HELB loans recipients and left out the wider picture on the relationship between HELB loans recipients and choice of Science and Technology Programmes. Yet in Kenya, we also have a category of students who receive HELB loans but are government sponsored. Our study considered both categories of students who received HELB loans as regular and self-sponsored in Public Universities in order to get a wide and balanced relationship between HELB loans and participation in Science and Technology Programmes.

Another ex-post-facto study on the relationship between the socio-economic status of diploma students bursary recipients and the amount awarded by HELB by Aliva & Amunga (2017) established a positive significant relationship between the socioeconomic status and the amount of bursary awarded to college students in Kenya (Aliva & Amunga, 2017). The idea of narrowing down to socioeconomic status and the amount of bursary awarded indicated yet another gap for this study. In Kenya, the government finances students in higher education at various levels. One level is government sponsorship through capitation and subsidies (Government of Kenya, 2014). The second level is through awarding of loans through HELB and the third level is award of bursaries through HELB (Government of Kenya, 1995). This study considered further the relationship between socioeconomic status and these other two levels of financing, that is, capitation and subsidies and HELB loans.

Mbirithi (2013) conducted a descriptive research on management challenges facing Kenya's Public Universities. The study found out that insufficient funds were the

biggest management challenge since they affected all the areas of research, teaching and learning (Mbirithi, 2013). By focusing on financial challenges in Public Universities, the endeavour by Mbirithi (2013) pointed to another gap for this study. The latter further focused on students' financial challenges with regard to participation, particularly in Science and Technology Programmes since the students were the ones who enrolled and participated in the programmes.

2.4. Infrastructure, Teaching and Learning Resources and Participation in Science and Technology Programmes at the Global, Regional and National Level.

Vibhash (2013) conducted a survey at the University of Delhi (DU) regarding challenges and opportunities in higher education system in India. It established that India needed to strengthen its existing infrastructure. But it had two gaps of interest to our study. First, considering the faculty members of University of Delhi (DU) only, did not give a complete picture of the effect of infrastructure on participation in Science and Technology Programmes in India. The second gap of the survey was failure to come up with the components of infrastructure which were needed to be strengthened. But our study went further to solicit information from science and technology lecturers in three different Kenyan Public Universities in order to ascertain the effects of infrastructure and participation. Furthermore, focus was on specific components of infrastructure which affected participation like availability of workshops, laboratory space, and spare parts of equipment, maintenance, repair, upgrading, reagents and consumables.

A study by Barthope (2012) on trends and issues affecting workforce planning in New Zealand University Libraries found out that technological development had impacted on workforce planning. Hence, recruitment of new staff to the library profession and relevance of the current professional qualifications were issues of great concern (Barthope, 2012). Just like the study by Vibhash in India which did not identify various components of infrastructure, Barthope narrowed to workforce in University Libraries and did not go further to look at other components of workforce resources like lecturers, technicians, and laboratory assistants, their numbers and qualifications in order to ascertain how these affected participation in Science and Technology Programmes. Our study focused on all these components of workforce and came up with the effects of human resources on participation.

Fabiyi & Uzoka (2012) conducted a survey on infrastructure and teaching and learning resources in tertiary education. It found out that there was inadequacy of infrastructure which affected quality in tertiary institutions (Fabiyi & Uzoka 2012). A diagnostic study by Gadzirayi *et al* (2016) on status of STEM education in Zimbabwe had similar findings, like dearth of infrastructure which supports Sciences and Mathematics, few laboratories, equipment and chemicals in schools (Gadzirayi *et al,* 2016). Another qualitative case study by Osei-Asibeyi (2015) on challenges in the implementation of Technical and Vocational Education and Training (TVET) curriculum in Ghana equally established that Ghana's TVET had inadequate tools and equipment and obsolete and broken down facilities (Osei-Asibeyi, 2015).

Our study identified gaps of interest in researches conducted by Fabiyi & Uzoka, 2012; Gadzirayi *et al,* 2016; and Osei-Asibeyi, 2015. The gap in the study by Fabiyi &Uzoka was that it could not produce accurate inference on participation in Science and Technology Programmes at Bachelor Level since tertiary education could involve institutions which did not offer Bachelor Degree Programmes. The gap in Gadzirayi *et al* study was that it focused on status of STEM education generally in primary and secondary schools, while that by Osei-Asibeyi had two gaps which were of interest to this study. First, the researcher focused mainly on TVET institutions and not Universities. Secondly, Osei-Asibeyi (2015) pointed out that some participants pulled out from focus groups prior to the start of interviews upon realizing that these were going to be recorded, yet this was the sole data collection instrument.

In that regard, our study was more specific and utilized statistics of students participating in Science and Technology Programmes at Bachelor Level in three Public Universities. Moreover, it used different data collection instruments, namely: document analysis, self-administered questionnaire, open-ended interviews and structured observations. Equally, participants and informants were assured of the purpose of data collection, confidentiality, professional handling of data to ensure privacy and security.

A study by Ntim (2016) on implications for pedagogical quality, equity and assessment in Ghanaian higher education noted that in Public Universities, the ratio of academic population to student population is six times more than the required

internationally accepted student–to-teacher ratio (Ntim, 2016). Matovu (2018) carried out a study on massification and quality of graduates in Uganda which also noted that Higher Education Institutions (HEIs) had less academic staff and that highly qualified academic staff (Professors and Associate Professors) moved to other parts of the world looking for greener pastures. It further found out that the curriculum was obsolete and it did not emphasize technical skills (Matovu, 2018). Etshim (2017) used multiple approaches to study collaboration between higher education and labour market in Kinshasa, Democratic Republic of Congo (DRC). The study established that the Congolese higher education system was struggling with the lack of qualified personnel and outdated curriculum which had inefficiencies that did not provide new graduates with sufficient skills (Etshim, 2017). Thomas (2014) carried out a study on academic staff views of higher education quality in Somaliland. It found out that Somaliland Universities lagged behind in terms of the qualifications of academic staff. Furthermore, most institutions employed significant number of professors with only a bachelor's qualification since those with a master's degree or higher were few (Thomas, 2014).

The four studies by Ntim, 2016; Matovu, 2018; Etshim, 2017; and Thomas, 2014 had one common gap that is, generally considering student-to-lecturer ratio, staff qualifications, and curriculum on offer without considering specific programmes. This approach could not bring out a clear picture in Science and Technology Programmes. Our study focused on student-to-lecturer ratio, staff qualifications and curriculum on offer specifically in Science and Technology Programmes. The study

by Etshim (2017) had one more limitation, that is, adopting online survey, yet there was limited access to internet in DRC which made most targeted respondents fail to respond to questionnaires. The study by Thomas (2014) had two other limitations. He stated that the sample was not representative and this limited the statistical analysis of quantitative data. For instance, the largest Gollis University with 200 lecturers and which focused on engineering and science based education was not surveyed. The second limitation was inadequate feedback since English language competence was a challenge for some respondents. Our study filled the gap in Etshim study by the researcher personally travelling to the target Universities to conduct interviews and administer questionnaires. The gaps in the study by Thomas were filled by sampling Technical University of Kenya (TUK), Moi University (MU) and Egerton University (EU) which had a history of offering Science and Technology Programmes since their establishment and the researcher conducted interviews and administered questionnaires which were in English language, understood by all respondents.

Gudo *et al* (2011) conducted a survey on infrastructure, teaching and learning resources in Kenya between May 2010 and November 2010 and the survey established that there was shortage of physical facilities for teaching and learning and shortage of lecturers in Public Universities (Gudo *et al*, 2011). An evaluation study by Kaburu & Embeywa (2014) on infrastructure, teaching and learning resources in Kenya in 2014 corroborated the findings of the 2010 survey. The study further found out that Public Universities were lagging behind in e-learning facilities.

The survey by Gudo *et al* and Kaburu & Embeywa on the state of infrastructure and teaching and learning resources in Universities in Kenya converge with our study on effects of infrastructure, teaching and learning resources on participation in Science and Technology Programmes. The first gap in the survey conducted by Gudo *et al* is the applicability of the findings due to the time factor. The research was conducted between May 2010 and November 2010. Ten years later it may, therefore, not accurately reflect the current situations, given the new higher education legal framework which led to the operationalization of the Universities Act No. 42 of 2012 which called for developing acceptable levels of infrastructure before accreditation (Republic of Kenya, 2014). Consequently, a study in 2019 with regard to effects of infrastructure, teaching and learning resources on participation in Science and Technology Programmes was necessary to ascertain the levels of these crucial aspects in Public Universities after operationalization of the Universities Act No. 42 of 2012.

The study by Kaburu & Embeywa had a limitation on the type of infrastructure. It only considered e-learning facilities as a parameter for participation in Science and Technology Programmes. It was not feasible how such a conclusion was arrived at, given that the use of e-learning platform *parse* did not lead to increased participation in these programmes. Consequently, a study on effects of infrastructure, teaching and learning resources like laboratory space, workshops, student-lecturer ratio, and number of laboratory assistants rather than just e-learning facilities was carried out in

order to arrive at a balanced conclusion on how these components affected participation at Bachelor Level.

Mwirichia *et al* (2017) carried out a causal-comparative survey on the impact of massification on resource adequacy in Public and Private Universities in Kenya. It found out that there were inadequate resources in these institutions and that there was no statistical significant difference on the impact of massification on resource adequacy between them (Mwirichia *et al,* 2017). A descriptive survey by Sang *et al* (2012) on challenges facing Technical Training in Kenya found out that training facilities used by TTIs were inferior to facilities used in industries and business organizations (Sang *et al,* 2012). Siocha *et al* (2017) conducted a small scale study of a County in Kenya on quality implications of learning infrastructure on performance in secondary education. The study found out that learning resources were not adequate and that this was replicated in the other teaching and learning infrastructural facilities (Siocha *et al,* 2017). Another analytical study by Mwebi & Simatwa (2013) on expansion of Private Universities in Kenya and its implications on quality and completion rate found out that the physical facilities were low for provision of quality Science and Technology education (Mwebi & Simatwa, 2013).

The studies by Mwirichia *et al,* 2017; Sang *et al*, 2012; Siocha *et al*, 2017; and Mwebi & Simatwa, 2013 in Kenya had gaps that were similar to the study by Vibhash (2013) in India, thus failure to come up with the components of infrastructure which were needed to be strengthened. This study focused on specific components of infrastructure which affected participation in Science and Technology

Programmes like availability of workshops, laboratory space, spare parts of equipment, maintenance, repair, upgrading, reagents and consumables, hence an accurate report on effects on infrastructure and participation in these programmes at Bachelor Level in Public Universities.

2.5. Institutional based Interventions and Participation in Science and Technology at Bachelor Level: Global, Africa and Nation level

Streete (2016) conducted an online survey of graduates of Government Assistance for Tuition Expenses (GATE) in Trinidad and Tobago. The survey revealed that for a lifespan of the programme from 2004/2005 financial year through the 2014/2015 financial year, 369,101 students had been funded by GATE. This is a tuition-free higher education system with the aim of massification of higher education and the driving force behind a developed country. The study further revealed that GATE programme led to oversupply of graduates in certain areas such as accounting and management and shortage of graduates in critical areas such as nursing, medicine and technical/scientific skills necessary for a robust manufacturing and industrial sector (Streete, 2016).

Three limitations were identified by this study. First, GATE intervention resulted in the mismatch between the output of the postsecondary education sector and the needs of the labour market. Secondly, Streete (2016) stated that many politicians who were responsible for implementing the GATE policy were unavailable to be interviewed. Thirdly, the researcher stated that it was difficult to access quality data in Trinidad and Tobago which severely hampered the study. Our study explored such

interventions as GATE but with focus on critical areas of Science and Technology Programmes which are important in the realization of Kenya's development agenda. Consequently, interviews were conducted with policymakers at the three sampled Public Universities where quality data was accessed. Yano (2012) conducted a study on the impact of higher education expansion in post- transition Mongolia. It established that the government was offering stipends to students who enrolled in TVET courses, in order to meet demand for technicians for Mongolian booming mining industry (Yano, 2012). Our study explored such interventions like the one in Mongolia but with main focus on students pursuing Science and Technology Bachelor Degree Programmes in Public Universities.

Rajibussalim (2017) did a case study of the impact of industry-based learning programmes on science, technology, engineering and mathematics students in Indonesian higher education. It found out that Industry Based Learning (IBL), through University Industry Partnership (UIP) placement policy recognized the universities science and engineering programmes as part of the Science Technology Engineering Mathematics (STEM) education chains at the tertiary education level. The IBL programme promoted the STEM education to the industry world and provided an opportunity to other prospective STEM students, who could see the benefit of its programmes (Rajibussalim, 2017). But it had a gap similar to that by Vibhash (2013) in India which conducted a survey at the University of Delhi (DU) only. Rajibussalim carried out a case study of the University of Western Indonesia

(UWI). Our study filled this gap by sampling three different Public Universities for a balanced report on University Industry Partnership.

A study by Marginson *et al* (2013) established that University of Auckland had an indigenous admission scheme involving support, group tutorials, pre-examination study support, one year foundation certificate programme with the aim of transitioning Maori and Pacifica indigenous students into University Health and Medical Programmes (Marginson *et al*, 2013). A philosophical perspective by Anyalebechi (2015) on barriers to equality of access and educational opportunities revealed that Nigeria had introduced quota system of admission with the intention of narrowing the widening gap in education development of the South and the North (Anyalebechi, 2015).

The study by Marginson *et al* and Anyalebechi on interventions had gaps of interest to this study. The limitation in Australian intervention of indigenous admission scheme by considering the Maori and Pacifica could not give a balanced picture on participation in Science and Technology Programme. The Nigeria intervention of quota system had a limitation of widening access, based on geographical places and ignoring the overall widening of access specifically in Science and Technology Programmes. Our study went beyond the intervention of using indigenous admission scheme and quota system and sought other interventions like exploring those that targeted all groups of students to participate in the specified programmes at Bachelor Level, irrespective of their region of origin or status in society.

Kaing (2016) conducted a study on how Science Technology Engineering Mathematics (STEM) education could help to stimulate economic growth in Cambodia. It established that with financial assistance from US Department of State, Cambodia had established the Golden West Design Lab which offered opportunity to undergraduate engineering students gain practical experience to work as engineers. The lab taught engineering students' practical skills such as 3D printing, computer aided design and fabrications (Kaing, 2016). Oanda & Sall (2016) carried out a study on repositioning higher education in Africa. The study reported that World Bank, European Agency for Space Sciences for Technology and other development partners had pledged for seed funding to kick-start Science and Technology Programmes in Pan African University (PAU) (Oanda & Sall, 2016). The studies by Kaing and Oanda & Sall pointed out how developing countries over-relied on donor funding and goodwill from development partners to actualize the global science and technology agenda. Our study explored other sources of funding, apart from donor funding, like tax waivers, tax rebates and endowment funds which could increase students' participation in Science and Technology Programmes given that these were more expensive.

Dube (2018) did a philosophical qualitative interpretive approach study on Science, Technology, Engineering and Mathematics (STEM) initiatives in the Zimbabwean education system. The study found out that Zimbabwe government paid fees for advanced level STEM students. This initiative motivated qualifying students in Form Four and to those below as they aspired to do well in STEM subjects in order to

benefit in future (Dube, 2018). But, the intervention in Zimbabwe of providing fees for advanced level Science, Technology, Engineering and Mathematics programme had one gap that is, considering secondary students. Consequently, those who qualified after advanced level and lacked fees for University education were not considered. Nonetheless, our study explored such interventions but focused more on students pursuing Bachelor degree programmes in science and technology.

A study by Kahn (2013) on Science, Technology, Engineering and Mathematics education in South Africa reported that between 1995-1999, the Department of Education had put in place a national wide redress programme known as Students and Youth into Science, Technology, Engineering and Mathematics (SYSTEM) which was designed to give students, who had underperformed in science and mathematics in their Senior Certificate Examination (SCE), a second chance to obtain matriculation exception that would allow them to go on to study in higher education. SYSTEM students took an officially recognized one-year programme in physical science, biology, mathematics and, upon completion they would proceed to enter Universities (Kahn, 2013). One of the limitations in the SYSTEM programme was that it was carried out between 1995 and 1999 and then stopped. This study explored similar intervention like SYSTEM but one that was continuous and targeting many students and not just on pilot basis.

Atuahene and Owusu-Ansah (2013) did a study at the University of Cape Coast (UCC) on assessment of access, participation, equity and disparity. The study found out that the University had established remedial science programme, mature

students' entrance examination and concessionary selection of students from Less-Endowed Secondary Schools (LESS). The programme accepted candidates who missed admission requirements but demonstrated the potential to succeed in science in high school education. They were brought to University to take remedial classes before being allowed to pursue Science and Technology Programmes. The study further established that during the 2008/2009 academic year, the University admitted 80 students from a number of LESS schools in the country (Atuahene & Owusu-Ansah, 2013). But it listed only 80 students admitted as a result of this intervention. Our study explored interventions like the one at the University of Cape Coast (UCC) but targeted many students to participate in Science and Technology Programmes in the Public Universities in Kenya.

A study by Mbano and Nolan (2017), on increasing access of female students in Science and Technology Programmes at the University of Malawi (UNIMA), used post hoc design in form of a trace study with no comparison group. It found out that Development Partnerships in Higher Education (DELPHE) project organized bridging camps targeting secondary school girls who were not quite successful in their grades to make it to the University but were good to make it into science programmes at University. They were given exposure to pursue science related programmes through affirmative intervention which increased enrolment of female students in bioengineering, biology, physical science and mathematics fields from 28% to 40% by 2012 (Mbano & Nolan, 2017). Given that tracer studies enable researchers to assess the impact of an intervention programme and try to link it to

specific elements of the curriculum, the study by Mbano & Nolan at the University of Malawi (UNIMA) reported the impact of DELPHE project without suggesting other possible interventions that could increase students' participation in Science and Technology Programmes.

In Mukono and Wakiso Districts of Uganda, Opit (2014) conducted a study on the impact of government science-based University sponsorship policy on girls' participation in the sciences at A-level. The study employed ex-post-facto design and found out that the intervention policy had not helped to eliminate the gender gap in students' participation since more boys than girls continued to enroll and participate better in the sciences at A- level after the inception of the policy (Opit, 2014). These findings corroborated with a descriptive cross-section survey by Obonyo (2013) and a descriptive survey by Mbirianjau (2016) in Kenya. Obonyo (2013) carried out a descriptive cross-section survey on the contributions of affirmative strategies to widening access to Universities for students from Kenya's Arid and Semi-Arid Lands (ASAL). The study found out that admission trends through affirmative action were below the set ceiling of 10 per cent. Mbirianjau (2016) conducted a descriptive survey on enabling interventions for increasing female students' access and participation in Science, Technology, Engineering and Mathematics (STEM) disciplines in Kenyan Public Universities and the survey revealed that, despite the existence of educational gender interventions, female students' enrolment and participation in STEM disciplines was 30 per cent and less than 20 per cent in hard sciences (Mbirianjau, 2016).

The study by Opit in Mukono and Wakiso Districts of Uganda, Obonyo in Kenya and Mbirianjau in Kenya had gaps that were similar to the study by Marginson *et al* (2013) in Australia and Anyalebechi (2015) in Nigeria since there was a tendency of focusing on affirmative interventions to increase participation, especially in Science and Technology Programmes. Our study broadened the scope and explored interventions that could increase students' participation in Science and Technology Programmes, irrespective of gender, region of origin, ethnicity or race.

Odundo *et al* (2015) did a case study at the University of Nairobi (UoN) on the effects of University admissions on non-academic activities. It found out that the University had embarked on diversification of internal sources of revenue which included farming, funeral services, animal clinics, food processing, irrigation schemes, animal and agriculture equipment. The intervention measures on diversification of sources of income enabled the University to complete some of the stalled projects, rehabilitate and purchase physical facilities. This type of Income Generating Activities (IGAs) approach in the case of UoN was also considered in this study.

The limitation in the study by Odundo *et al* (2015) was that it focused mostly on non-academic activities. Yet, University education is the apex of academic pursuit and backbone from which all new knowledge radiates. Our study filled this gap by exploring ways of strengthening mechanisms that facilitate the utilization of research findings in creating new products through academic activities like University-industry linkages and commercializing intellectual property, STEM faculties'

entrepreneurship, professional development Hub (Short Course Centre) and value engineering. It further explored ways of utilizing proceeds from such ventures to improve infrastructure, teaching and learning resources in order to enable many students participate in Science and Technology Programmes at Bachelor Level.

2.6. Summary of Knowledge Gaps

The review of related literature at the global, regional and national levels, including Kenya, indicates a number of knowledge gaps. With regard to status of participation, many reviewed studies focused on trends of participation among minority groups (Yingyi & Liu, 2017; Bagde *et al,* 2016; Koketso, 2015). Another gap was that most studies concentrated primarily on looking at the numbers (massification of higher education) but failed to look at the question of enrolment in Science and Technology Programmes (Sader & Gabela, 2017; Muema & Lavery, 2018; Misaro *et al*, 2013).

With regard to funding and participation, majority of the studies reviewed concentrated on the question of general financing of higher education (Bekir, 2016; Masaiti & Shen, 2013; Sumaworo & Ibrahim, 2015; Kobla *et al,* 2018). This study focused on finance data specifically in Science and Technology Programmes. Another gap with regard to funding was a tendency of comparing the household income and University costs without calculating the cumulative costs per year (Usher & Medow, 2010; Debrah, 2008; Pantah & Asante, 2018). This study considered the cumulative costs for Science and Technology Programmes per year and household income.

Another gap that this study addressed was the failure to come up with the components of infrastructure and workforce resources needed to be strengthened in order to improve participation in these programmes (Barthorpe, 2012; Vibhash, 2013; Fabiyi & Uzoka, 2012; Gadzirayi *et al*, 2016; Mwirichia, *et al*, 2017; Sang *et al*, 2012; Siocha *et al*, 2017; Mwebi & Simatwa, 2013; Ntim, 2016; Matovu, 2018; Etshim, 2017; Thomas, 2014). Our study filled this gap by looking at various components of infrastructure and workforce which needed to be strengthened. Also, several studies reviewed focused on affirmative interventions to increase participation, especially in Science and Technology Programmes (Marginson *et al* 2013; Anyalebechi, 2015; Obonyo, 2013; Opit, 2014; Mbirianjau, 2016). This study broadened the scope and explored interventions that could increase students' participation in Science and Technology Programmes, irrespective of gender, region of origin, ethnicity or race.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This Chapter focuses on the methodology and procedures which were adopted in carrying out the study. Specifically, it provides details of the research design, location of the study, target population, sample and sampling procedure and data collection instruments which were used by the researcher during field work. Finally, pilot study, data collection procedures, data analysis and ethical considerations are discussed.

3.2. Research Design

This study adopted descriptive survey design method to establish the gaps which existed in government policies to guide admission into science and technology bachelor degree programmes and the actual practice during implementation. The design was found appropriate because it assisted the researcher to describe the trend of students' participation, compare KESSP I participation target of 50 per cent and the actual practice during 2013-2017 implementation periods and science and technology participation costs and students' social-economic status. Furthermore, it provided ground for accessing accurate data on aspects of physical infrastructure, teaching and learning resources.

Cohen *et al* (2007) observed that data gathered from descriptive survey served three main purposes, namely: describing the nature of existing conditions, comparing them to certain standards in life and determining the relationship between specific events.

The design mainly employed qualitative data to capture specific voices from respondents and complimented with quantitative data which was used to establish participation trend.

3.3. Location of the Study

The study was carried out in three Public Chartered Universities in Kenya, namely; Technical University of Kenya (TUK), Moi University (MU) and Egerton University (EU). The Universities were purposively sampled based on a number of reasons. First, the University must have been operational during the time of the implementation of 2010 KESSP I admission policy. The policy targeted enrolment of 50% of all students in science and technology related courses (UNESCO, 2010). Secondly, the University had a strong foundation in science and technology demonstrated by high enrolment numbers in these programmes and offering a variety of them including Veterinary Medicine or Manufacturing Engineering at Bachelor's Level.

Technical University of Kenya (TUK) is located in Nairobi County, Central Business District (CBD), and the capital city of Kenya. It was established as a technical institute in 1961 and later renamed Kenya Polytechnic, registered in 1967 by the Ministry of Education, with the principle objective of training largely in technical fields. In 2007, it was converted to Kenya Polytechnic University College as a Constituent College of University of Nairobi, to offer Bachelor's degree programmes in Electrical and Electronic Engineering. In 2013, it was established as Technical University of Kenya, where the concept of Technical University was a new type of

University whose mandate was to offer higher education and research in technology (Republic of Kenya, 2012; Technical University of Kenya, 2016). It has established three Faculties, of which two are offering programmes in science and technology. They are Faculty of Engineering Sciences and Technology (FEST) and Faculty of Applied Sciences and Technology (FAST) with over 5000 students enrolled into engineering programmes. They have the Departments of Mechanical and Process Engineering, offering industrial and manufacturing engineering programmes (Technical University of Kenya, 2016).

Moi University (MU) is located in Uasin Gishu County, Kesses, which is 35 kilometers from Eldoret Town, and 310 kilometers northwest of Nairobi, the capital city of Kenya. It was established in 1984 through Moi University Act, on recommendation of Presidential Working Party on the Second University in Kenya (Mackay Report). The intention was to give it a science, technology and development orientation, by focusing on the problems of rural development in its training and research programmes (Republic of Kenya, 1981; 1985). It has established 14 Schools, of which, eight are offering programmes in science and technology. The eight include: School of Aerospace Sciences, Agriculture and Natural Resources, Biological and Physical Sciences, Dentistry, Engineering, Medicine, Nursing and Public Health. It has mounted Bachelor of Engineering (Manufacturing, Industrial and Textile Engineering) (Moi University, 2016).

Egerton University (EU) is located in Nakuru County, Njoro, which is 25 kilometers southwest of Nakuru Town and 182 kilometers northwest of Nairobi, the capital city

of Kenya. It is the premier agricultural Public University in Kenya, transformed from farm school, founded in 1939 by Lord Maurice Egerton of Tatton, a British settler in Kenya in the 1920s. In 1950, it was upgraded to an Agricultural College offering diploma programmes. The Government of Kenya and the United States Agency for International Development (USAID) funded major expansion of the institution from 1979. In 1986, Egerton Agricultural College was upgraded to a Constituent College of University of Nairobi. In 1987, it became a fully-fledged University through an Act of Parliament, the Egerton University Act of 1987 (Government of Kenya, 1988). The University was chartered in 2013 under the Universities Act of 2012. It has established 10 Faculties, of which six are offering Bachelor's programmes in science and technology. The six are: Agriculture, Science, Engineering and Technology, Environment and Resources Development, Health Sciences and Veterinary Medicine and Surgery. It has mounted Bachelor of Veterinary Medicine and Surgery and Bachelor of Science (Manufacturing Engineering and Technology) (Egerton University, 2019).

A map of Kenya showing the location of the sampled Universities is shown in Figure 3.1:

Figure 3.1: Map of Kenya showing the location of the sampled Universities. Source: Ministry of Devolution and Planning 2013

3.4. Target Population

The study targeted all 31 Public Chartered Universities as units of analysis. The Universities had 114,422 students enrolled into Science and Technology Bachelor Degree Programmes and 4720 lecturers teaching in the same fields (Commission for University Education, 2016). Key respondents constituted students pursuing

Bachelor Degree Programmes in Veterinary Medicine and Manufacturing Engineering at the Public Universities, lecturers teaching in Veterinary Medicine and Manufacturing Engineering Programmes, Heads of Departments (HoDs) and Academic Registrars. The study population included 3179 students, 237 lecturers, 107 HoDs and 31 Academic Registrars.

3.5. Sampling Techniques and Sample Size

Sampling is the selection of a given number of subjects from a defined population as a representative of population (Orodho, 2004). This study utilized purposive sampling to select Universities. Purposive sampling is intentional selection of informants based on their ability to elucidate a specific theme, concept or phenomenon and is often used when working with small samples after the researcher identifies diverse characteristics of the sample selection criteria prior to selecting the sample (Patton, 2002). Out of 31 existing chartered Public Universities at the time of research, three Universities consisting 9.7% were purposively sampled. The three Universities satisfied the selection criteria which included: being operational during the time of the implementation of 2010 KESSP I admission policy that targeted enrolment of 50% of all students in science and technology related courses (UNESCO, 2010); had a strong foundation in science and technology measured by high enrolment numbers in these programmes; and offering a variety of science and technology programmes including Veterinary Medicine or Manufacturing Engineering at Bachelor's Level. On that basis, the three Universities were considered representative of the other Public Universities.

Simple random sampling method was used to select students willing to complete the questionnaire. The method allows all the individuals in the defined population to have equal and independent chance of being selected, thus data that emerges can be generalized (Kombo & Trump, 2006). For that reason, the method was found appropriate. There were a total of 3179 students pursuing Veterinary Medicine and Manufacturing Engineering Programmes (Commission for University Education, 2016). According to Israel (2009), the formula below can be used to determine sample size:

$$n = N/1+N(e)^2$$

$$n=3179/1+3179(0.05)^2$$

Where n= Sample size = 355 students

N= Population size

e= Confidence level (0.05)

This gave a sample of 355 participants which was 11.1% of the population size. According to Kombo & Trump (2006), a minimum sample size of 10% is considered acceptable for a research study in a large population. The 355 students were distributed as follows: Technical University of Kenya (TUK) 25%, Moi University (MU) 25% and Egerton University (EU) 50%. The researcher relied on information about teaching timetables in the Veterinary Medicine and Manufacturing Engineering Programmes across all years of study to select lecture sessions during which students were randomly selected. This procedure was repeated until the target

number was reached. Student respondents were sampled from 2nd, 3rd, 4th and 5th year based on the fact that they had the advantage of participating in Science and Technology Programmes for a longer period and therefore understood funding challenges. The selection of students to respond to issues of funding was based on the fact that they were the ones who understood the cost of University education, their respective family income and challenges they faced while undertaking their studies.

Lecturers, HoDs and Academic Registrars were purposively sampled. When using this technique, a researcher purposely targets a group of people to be relied on for the study (Kombo & Trump, 2006). It was found out that there were 237 lecturers teaching Veterinary Medicine and Manufacturing Engineering Programmes, out of whom 24 (10.1%) participated in the study. They were distributed as follows: Technical University Kenya (TUK) 25%, Moi University (MU) 25% and Egerton University (EU) 50%. Opinions of the lecturers were sought since they were the ones teaching, hence they understood the challenges they faced in terms of physical facilities and student-lecturer ratios.

Out of 107 HoDs in Veterinary Medicine and Manufacturing Engineering at the three Universities, 12 (11.2%) were sampled and distributed as follows: Technical University of Kenya (TUK) 25% , Moi University (MU) 25% and Egerton University (EU) 50%. The HoDs were directly involved in the day-to-day running of the Departments.

Also, out of 31 Academic Registrars, three (9.6%) in the target Universities were purposively sampled. The post was held by a single individual in each University, and they were directly involved in the admission of students. Their views were sought with regard to limitations of funding and University- based interventions for enhancing students' participation in Science and Technology Programmes. The researcher made a prior visit to lecturers, HoDs and Academic Registrars to book an appointment with each one of them on a specific date, time and venue for the interview. In total, the study worked with 394 respondents. Table 3.1 summarizes the study sample.

Table 3.1: Summary of Sample size

Category	**Target population**	**Sample size**	**%**	**Sampling technique**
Universities	31	3	9.7	**Purposive**
Manufacturing and Veterinary students	3179	355	11.1	**Simple random**
Manufacturing and Veterinary lecturers	237	24	10.1	**Purposive**
Academic Registrars in the Sampled Universities	31	3	9.7	**Purposive**
Heads od departments in Sampled Universities	107	12	11.2	**Purposive**
Total	**3554**	**394**		

3.6. Data Collection Instruments

The study utilized four methods to collect data: self-administered questionnaire, open-ended interview, structured observations and document analysis. The use of

different methods to collect the same data overcomes deficiencies of using one method, provides greater understanding of issues under study and increases the accuracy of the findings (Jensen, 2011). This study triangulated instruments since each one had its unique strengths and weaknesses (Saunders *et al*, 2003). Relying on the four instruments enriched the depth and accuracy of data collected. Also, it provided greater understanding of trends of students' participation, funding, infrastructure, teaching and learning resources and increased the accuracy of the findings.

3.6.1 Self-administered Questionnaire for Students

"Questionnaire is a printed form which asks the same questions to all the individuals in the same sample". In the open-ended questionnaire, the themes are highlighted but the respondents are allowed to answer in their own words, giving them flexibility to explain their responses (Cohen *et al*, 2007). The students' questionnaire yielded both qualitative and quantitative data like amount of HELB loan awarded per year, average annual family income, cumulative cost of education per year (quantitative) and main financial challenges and infrastructure, teaching and learning resources availability (qualitative). The choice of this tool was due to the advantage of being flexible, saving time in administration, confidentiality and capturing of variety of data relevant to this study. Anonymous nature of the questionnaire was used to elicit frank responses on sensitive topics and at the same time protected the identity of the respondents. All these aspects were pertinent in obtaining opinions on the aspects of family socio-economic background, and availability of infrastructure, teaching and

learning resources in order to establish the relationship between funding and participation and the effect of teaching and learning resources in Science and Technology Programmes. A questionnaire helps to enhance comparability of answers and reduce variability (Bryman, 2004). It yields feedback from a large number of key respondents cost-effectively (Cohen *et al*, 2007). However, it may not be possible to get clarification on items that may have been misunderstood by the respondents (Cohen *et al,* 2007). In this study, the questionnaire was used to collect information from a sample of 355 students distributed as follows: Technical University of Kenya (TUK) 25%, Moi University (MU) 25% and Egerton University (EU) 50%.

3.6.2. Open-ended Interviews for Lecturers, Heads of Departments and Academic Registrars

"Open- ended interview is an exchange of views between interviewer and interviewee. The interviewer does not strictly follow a formulated list of questions, but asks more open-ended questions, allowing for discussion rather than a straightforward question and answer format" (Getu & Tegbar, 2016). Open-ended interviews yielded mainly crucial information on gaps in the number of students participating in Science and Technology Programmes, aspects of reviewing the curriculum and accreditation of these programmes, availability of physical infrastructure, student-lecturer ratio, teaching pedagogy, splintering of the programmes, institutional interventions and suggested remedial measures that could enhance participation in Science and Technology Programmes at Bachelor Level. Open-ended interviews were used to collect information from lecturers and HoDs

distributed as follows: Technical University of Kenya (TUK) 25%, Moi University (MU) 25% and Egerton University (EU) 50%. They were equally used to collect data from Academic Registrars because of they were flexible, adaptive and offered credible- in-depth responses to compliment quantitative data already captured in the questionnaires and document analysis from a smaller group. Also, it had an advantage over questionnaire in that the respondent could seek clarification over questions that were unclear or ambiguous. It was more insightful than other methods in that respondents provided information from their own perspectives. An interview allows unexpected facts to emerge. It also allows for assessing the respondents' body language, facial expressions and tone of voice (Chris *et al,* 2009). However, open-ended interviews could be time consuming, especially if the population is large (Noble & Smith, 2015).

3.6.3. Structured Observations

This is a method of data collection where the observer is an onlooker. The focus is on small number of specific behavioural patterns, and only those appearing on a pre-defined list are recorded (Kombo & Trump, 2006). Non-participant observations were used in collecting data on non-verbal behaviour where direct observations focused on the physical infrastructures, including laboratory and workshops spaces in each Department visited, availability of apparatus during practical sessions, lecturer-student ratios during lectures, teaching methods during lectures while collecting data. Structured observations were preferred because they allowed for considerable flexibility in the research process and provided for complete and direct

information relating to science and technology and the learning environment in an objective manner. These observations allowed the researcher to put behaviour in context, thereby, understood it better and, consequently, responded to effects of infrastructure, teaching and learning resources on participation in Science and Technology Programmes.

3.6.4. Documentary Reviews

Documentary analysis involves the study of existing documents in order to illuminate deeper meanings which may be revealed by their coverage. Quantitative data was obtained from University records and fees structures for academic programmes, students' enrolments, academic staff numbers, and academic staff distribution by rank, graduation and costs of participating in science and technology programme. Documentary analysis was used as a supplementary method of gathering information, especially from institutional records. Analysis of records has the advantage of being available at low cost. They are also, factual, especially if prepared by professionals, and they contain valuable information and are insightful (Cohen *et al,* 2007). Analysis of the records was utilized to establish the trend of students' participation in Science and Technology Programmes, funding, effect of infrastructure, teaching and learning resources.

3.7. Pilot Study

A pilot study is the small version of the main study and is used to identify flaws in the operationalization of the independent variables, identify imprecise items, and establish the feasibility of data collection methods and procedures (Thabane, 2010). The cases picked for pre-testing should be 10% to 20% of the study sample (Simon,

2011). In this study, Jomo Kenyatta University of Agriculture and Technology (JKUAT) (not part of sample) was selected because it had similar characteristics as the sample sites. Documentary analysis of University records and fees structures was carried out from administration, academics and finance offices. Questionnaire for students involved 50 students in Science and Technology Programmes. The interview schedule involved three lecturers teaching these programmes, two HoDs and the Academic Registrar.

3.8. Validity and Reliability

Validity determines whether the research truly measures that which it was intended to measure or how truthful the results are (Kothari, 2003). Face validity is used to ensure that each item on the research instrument has a theoretical link with a given objective while content validity deals with item assessment if the items completely cover the issues at hand (Kumar,2011). Reliability is the degree to which an assessment tool produces stable and consistent results (Joppe, 2000).

3.8.1. Validity

In this study, both face validity and content validity of the questionnaire and interview schedule were improved through a panel of 10 discussants. The panel discussion was held before the pilot study and each item was scored by each discussants. The content validity of the questionnaire and interview schedule was computed for each item using the formula adopted from Amin (2005) which is:

CV1= Number of times an item is rated as relevant divided by the total number of raters.

An item on which at least 70% of discussants concurred was taken as valid while an item with a score of less than 70% of discussants was modified while others were removed since they were deemed redundant. A pilot was conducted to assess the validity of the tools, hence debriefing was done on respondents in order to ascertain the objectivity of the items, clarity, and time requirements and complete coverage of all the themes. The feedback from the respondents was shared with the panel of the 10 experts during the second panel discussion on the operational ability of the tools. Input from the panel and feedback from the piloting was used to do a final adjustment to enhance the validity of the questionnaire and the interview schedule.

3.8.2. Reliability

In this study, test-retest technique for reliability was used to assess the questionnaire and interview schedules. In test-retest approach, the tool is administered twice to the same group of respondents. The scores from the 1st administration and 2nd administration are then correlated to establish the reliability of the tools. In this study, the data collection tools were to 50 students, three lecturers, two HoDs and Academic Registrar, administered at Jomo Kenyatta University of Agriculture and Technology (JKUAT) twice within a period of two weeks between the first observation (test) and the second observation (retest). The researcher used Pearson's product moment correlation (r) index illustrated below to analyze the tools:

$$r = \frac{\sum(X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum(X - \overline{X})^2}\sqrt{\sum(Y - \overline{Y})^2}}$$

Where r = correlation coefficient, X= the first observation (test) and Y= the second observation (re-test). The analysis of Pearson product moment correlation (r) of the 1st and 2nd observation was calculated using SPSS version 20 computer programme. When computation was done, a correlation coefficient (r) equal to 0.8 was obtained which was higher than 0.75 as recommended by Orodho (2009), implying that the tool was reliable to collect most of the relevant data. The sections with qualitative data such as interventions being employed by Universities were scored manually between 1st observation and 2nd observation, and then compared.

3.9. Data collection procedure

Data collection was organized into two main phases. The first phase was preliminary which involved obtaining official clearance from National Commission for Science, Technology and Innovation (NACOSTI), the County Commissioners and the County Directors of Education, Nairobi, Nakuru and Uasin Gishu Counties and at the University levels of the selected Universities. The second phase consisted of the actual collection of data from the sampled Universities.

3.9.1 Data Collection

Primary data was collected using three tools, namely: Self-administered questionnaire, open-ended interview and structured observations. Secondary data was collected through documentary analysis framework of University records and fees structures. These tools generated both qualitative and quantitative data.

3.9.2 Administering the Questionnaire

The researcher liaised with the HoDs to get teaching timetables in the three target Universities to select lecture sessions during which the researcher, with the help of two research assistants, administered the questionnaire.

3.9.3 Primary Data Collection

The researcher made a pre-visit to the lecturers, HoDs and Academic Registrars to book an appointment with each one of them on a specific date, time and venue for the interview. During such times, the researcher introduced himself and explained the study's expectations to each of the respondents who had voluntarily accepted to participate. A follow-up through phone call was done to confirm the date and time before the actual interview was done. The researcher assured them of confidentiality of the information given. The interviews were conducted with the help of research assistants and data was recorded both manually and electronically.

3.9.4. Secondary Data Collection

Secondary data was drawn from the analysis of relevant institutional documents. Among the documents analyzed included University records and fees structures which focused on academic programmes, students' enrolments, graduation numbers, cost of participating in Science and Technology Programmes, and academic staff distribution by rank.

3.10. Data Analysis

The interest of qualitative research is to discover the bigger picture using different techniques and the main focus is to articulate and understand phenomenon in convergence with measurable data (Hancock, Ockliford, & Windridge, 2009). On the

other hand, quantitative data is concerned with measurement in the form of counts or numbers where each data-set has a unique numerical value associated with it. It's used to answer questions such as "how many?" and "how much?" (Kombo &Tromp, 2006).This study mainly utilized qualitative analysis approach. However, it was complimented by quantitative analysis for data mainly arising from documentary analysis to establish the trend of student participation in Science and Technology Programmes.

3.10.1 Analysis of Quantitative Data

Quantitative data from student enrolment numbers, graduation numbers, academic staff numbers, and academic staff distribution by rank, household incomes, annual participation cumulative costs, and amount of HELB loan received was captured. Also, data of availability of physical infrastructure, student lecturer ratios (University records, fees structures, students and lecturers questionnaires) were coded and analyzed using the Statistical Package for Social Sciences (SPSS) version 20. This software was applied to allow production of consistency checks which helped to eliminate errors in the data entry. Comparative analysis was done at various levels. First, KESSP Science and Technology participation target of 50% and the actual practice during 2013-2017 implementation periods of admission policies. Secondly, the relationship between programme costs and students' social-economic status with respect to science and technology participation was compared. The statistical data was transformed into frequencies, percentages, means, pie charts and bar graphs in order to address the research questions.

3.10.2. Qualitative Data Analysis

The qualitative data analysis focused on description and analysis of data from three research instruments, namely: questionnaire from students, open- ended interview schedules from lecturers, HoDs, Academic Registrars and schedule for observations by the researcher. The tape recorded data from interviews was transcribed and converted into a write-up using pre-determined categories and major themes as per the research objectives. The processing and analysis of qualitative data was done as follows: coding and cataloging of various responses, identifying key responses for various themes, listing and putting together the main responses, identifying patterns emerging from key responses and reaching conclusions. Qualitative responses supplemented the findings in the quantitative data. The voices of the participants validated specific findings from the quantitative data which in turn produced a holistic understanding of the phenomenon. Simple descriptive analysis was utilized where data was grouped and presented in form of narrations and quotations in order to address effects of funding, infrastructure, teaching and learning resources and institutional based interventions on science and technology participation at Bachelor Level.

3.11. Logistical and Ethical Considerations

3.11.1. Logistical Considerations

The data collection commenced after approval of the research proposal and issuance of approval letter by The Graduate School, Kenyatta University. The researcher then obtained a permit from the NACOSTI which was used to obtain authorization from the County Commissioners and the County Directors of Education, Nairobi, Nakuru

and Uasin-Gishu Counties to carry out research in accordance with the requirements for an undertaking of this magnitude. Also, permission and consent were sought from relevant authorities at the target Universities to be allowed to collect data. The researcher trained the research assistants on procedure of collecting data and ethical considerations before commencement of the process.

3.11.2. Ethical Considerations

Each stage of research might raise the issue of ethics because carrying educational research, involves dialogues that is informed by the social and moral frameworks (Bush, 2002). In implementing such research, contravening the rights of participants involved must be avoided. In this study, three ethical issues of informed consent, voluntary participation and confidentiality were observed. On informed consent and voluntary participation, the respondents were given a copy of the research permit and adequate information on the aim of the research. In addition, the respondents were free to withdraw their participation. To ensure anonymity, the data collection tools did not contain identification details of the respondents. The tools were serialized to enable follow up on particular respondents when required. To maintain confidentiality, the raw data remained available only to the researcher and to supervisors on request.

CHAPTER FOUR

PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1. Introduction

This Chapter presents the findings, interpretations and discussion of the study. Specifically, it provides details of the demographic information of the participants, trend of students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in line with government of Kenya admission policies, relationship between funding of University students and participation, effects of infrastructure, teaching and learning resources on students' participation and institutional based interventions which could enhance these programmes. The Chapter closes with the section on summary of the findings and some conclusions drawn.

4.2. Demographic information of student participants in sampled Universities

The study sought to establish the gender of respondents and programme enrolled into. This background information was relevant in identifying the gaps that existed in the stated government policies on admission and the actual practice during implementation of the stated policies, the impact of the actual practice during implementation of the policies on student participation and interventions to enhance students participation in science and technology bachelor degree programmes which were the major concerns of the current study. Table 4.1 presents students respondents frequency by gender in each programme of study.

Table 4.1: Students' responses' frequency by gender in each programme of study

Gender							
Programme	**Male**		**%**	**Female**	**%**	**Total**	**Total %**
	Veterinary	59	17	28	8	87	25
	Engineering	203	58	60	17	263	75
Total		263	75	87	25	350	100

Source: Data obtained from students respondents during field inquiry, 2019

Table 4.1 above shows students' responses frequency distribution by gender per programme. 28(8%) and 60(17%) of respondents pursuing Veterinary and Engineering respectively were female. 203(58%) and 60(17%) of respondents pursuing Veterinary and Engineering respectively were male. In summary, 25% of respondents were female while 75% were male; implying that the programmes were male dominated. These findings were strengthened by Opit (2014) on impact of Uganda Government science-based University sponsorship policy on girls' participation in sciences at A-level which revealed that the gender gap in students still existed. Moreover, this pattern has been mirrored in Botswana by Koketso (2015) on gender disparity in enrolment and graduation in post-secondary education which revealed that female enrolment in Engineering and Technology stood at 20% and that male students were 60% more likely than female students to receive associates degree in STEM- related fields.

In summary, the researcher interacted with majority of sampled respondents who provided valuable data. These were students 98%, lecturers 83%, HoDs 83% and Academic Registrars 100%. Of the student respondents, 8% in Veterinary and 17%

in Engineering were females, while 17% in Veterinary and 58% in Engineering were males, bringing the total of females at 25% and males at 75%. This information formed the basis for data analysis and discussion presented in this Chapter.

4.3 Trends in students' Participation in Science and Technology Bachelor Degree Programmes at sampled Universities

The first objective of this study was to explore trends in students' participation in Science and Technology Programmes at Bachelor Level in Public Universities. To achieve this objective, analysis of enrolment into all Bachelor degree programmes between 2013 and 2017 academic years was done in the three target Universities. The participatory trends were based on documentary analysis of admission records, graduation records and those showing a variety of programmes on offer. Thereafter, there was an in-depth analysis of specific voices from open-ended interviews with lecturers, HoDs and Registrars (Academic).

4.3.1. Trends in Students' Enrolment at Bachelors' Level between 2013 and 2017 at Technical University of Kenya (TUK)

A general trend in student enrolment into bachelor degree programmes at TUK was analyzed and the findings are presented in Figure 4.1:

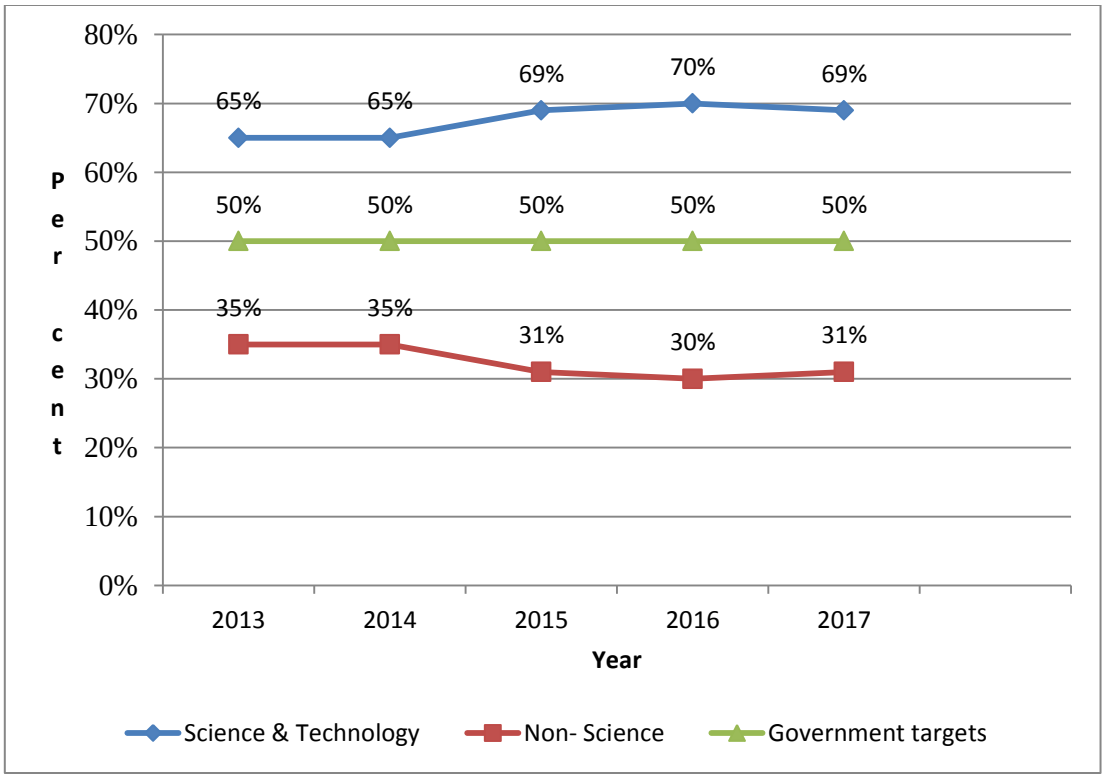


Figure 4.1: TUK general trend in students' enrolment at Bachelor's Level between 2013 and 2017

Source: Official records of student enrolment at TUK, 2019

From Figure 4.1 above, enrolment into non-science programmes gradually dropped from 35% in 2013 and 2014 to 30% in 2016 bringing the average to 32.4% while science and technology oscillated between 65% and 70% with the lowest witnessed in 2013 and 2014 at 65% and the highest of 70% in 2016. The average enrolment into Science and Technology Programmes was therefore 67.6%, superseding the government enrolment target of 50% by 17.6 percentage points.

A general trend in students' enrolment into Bachelor degree programmes at Moi University was analyzed and the findings are presented in Figure 4.2:

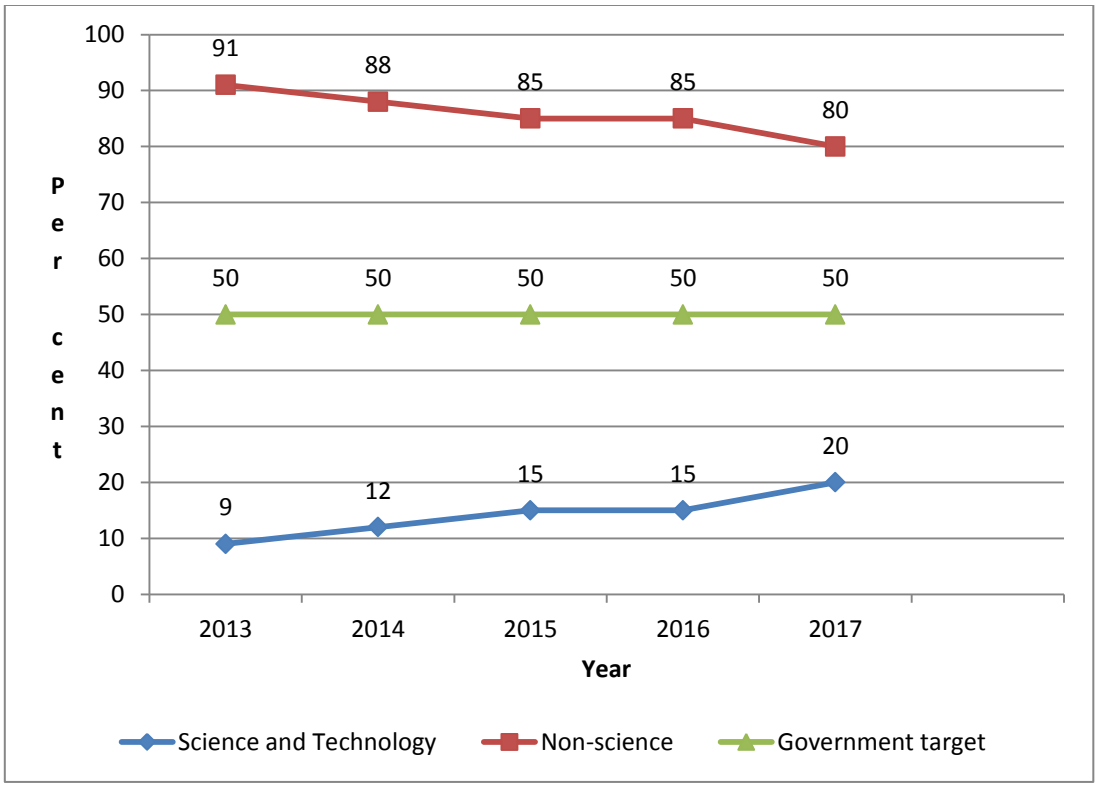


Figure 4.2: MU government-sponsored general students' enrolment trend at Bachelor's Level between 2013 and 2017

Source: Official records of student enrolment of Moi University, 2019

From Figure 4.2 above, enrolment into non-science programmes gradually dropped from 91% in 2013 to 80% in 2017, making the average of 85.8%, while enrolment into science and technology gradually increased from 9 % in 2013 to 20 % in 2017. The average enrolment into Science and Technology Programmes was, therefore, 14.2 %, missing the government target of 50% by a big margin of 35.8 percentage points. In this connection, one HoD explained:

> By their nature, Science and Technology Programmes demand for significant investment to establish, maintain, and expand and the capital required is often prohibitively expensive. When Universities are confronted with significant pressure to expand admissions, there

> has been a tendency to push more students towards non-science programmes. (Male, HoD, November 2019)

Averagely, 41% of students enrolled into science programmes at Technical University of Kenya (TUK) and Moi University (MU) in the period between 2013 and 2017, implying that the government target was missed by 9 percentage points. In conclusion, if this low enrolment trend is not addressed and appropriate evidence-based intervention measures implemented to reverse it, it is most likely that it will continue to the detriment of the Government of Kenya target. Thus, by implication, Kenya would be failing to attain the industrialized status as envisaged in Kenya Vision 2030. Additionally, 41% enrolment meant that any likely benefits accruing from increased productivity and social economic development might be difficult to be realized. These findings were reinforced by Sam-Amoah *et al* (2016) and Atuahene & Owusu-Ansah (2013) that at University of Cape Coast (UCC), the enrolment ratio of science and technology and arts and humanities was 28:72 which was below the government projection of 60:40. Equally, Kasozi (2016) revealed that in Uganda, 26% enrolled in Science and Technology Programmes compared to 74% in Arts and Humanities.

To further address objective one of the study about enrolment trends, the researcher collected data on enrolment into different clusters. Secondary data on enrolment in different clusters from Universities admission records was collected and the findings from TUK are presented in Table 4.2:

Table 4.2: Enrolment trends into different clusters at TUK for the period 2013-2017

Cluster	**Year**										
	2013		**2014**		**2015**		**2016**		**2017**		**Avr %**
	F	%	F	%	F	%	F	%	F	%	
Engineering Technology	984	31.1	1087	29.4	915	27.3	1055	29.3	674	27.4	29
Architecture	425	13.4	436	11.8	553	16.5	590	16.4	396	16.1	14.7
Humanities and Social Sciences	566	18.0	638	17.3	503	15	489	13.6	405	16.6	16
Life and Physical Sciences	403	12.7	645	17.4	580	17.3	653	18.2	423	17.2	16.6
Mathematics	77	2.4	90	2.4	96	3	105	2.9	91	3.7	2.82
Business	540	17.1	643	17.4	549	16.4	581	16.2	364	14.8	16.4
Medical and Health Sciences	168	5.3	159	4.3	151	4.5	122	3.4	103	4.2	4.3
Total	**3,163**	**100**	**3,698**	**100**	**3,347**	**100**	**3,595**	**100**	**2,456**	**100**	**100**

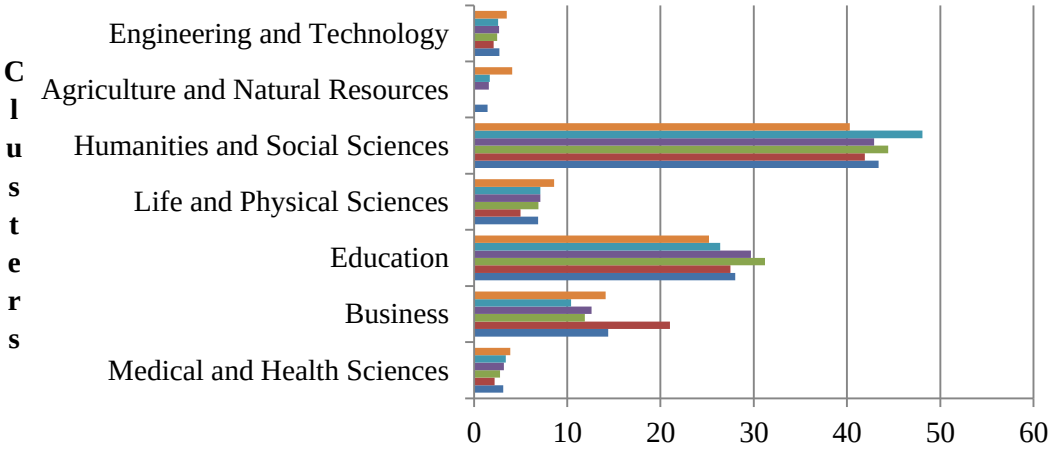
Source: Official records of student enrolment of TUK, 2019

Table 4.2 above indicates that engineering and technology cluster had the highest overall enrolment of 31.1%, being highest in 2013, and the least of 27.3% in 2015 bringing the average enrolment to 29%. Life and Physical Sciences followed with highest of 18.2% in 2016 and lowest of 12.7% in 2013 making the average to be 16.63%. Business had the highest enrolment in 2014 at 17.4% and lowest of 14.8% in 2017. Its average was 16.47%. Humanities and Social Sciences had the highest of

18.0% in 2013 and lowest in 2016 at 13.6%. The average was 16% while Architecture had the highest enrolment of 16.5% in 2015 and lowest of 11.8% in 2014, making the average to be 14.76%. The least enrolments were recorded in Mathematics which oscillated between 2.4% in 2013 and 2014 and 3.7% in 2017, making the average to be 2.82% followed by Medical and Health Sciences with 5.3% highest in 2013 and 3.4% lowest in 2016, making the average to be 4.32%.

This meant that although the general picture indicated highest enrolment into science and technology clusters, some other science and technology clusters like Medical and Health Sciences (4.32%) and Mathematics 2.82% were largely underrepresented. Furthermore, some non- science clusters like Business (16.47%) and Humanities and Social Sciences (16%) were fairly well represented.

The findings for the enrolment trends into different clusters at MU are presented in Figure 4.3 below:



	Medical and Health Sciences	Business	Education	Life and Physical Sciences	Humanities and Social Sciences	Agriculture and Natural Resources	Engineering and Technology
2017	3.9	14.1	25.2	8.6	40.3	4.1	3.5
2016	3.4	10.4	26.4	7.1	48.1	1.7	2.6
2015	3.2	12.6	29.7	7.1	42.9	1.6	2.7
2014	2.8	11.9	31.2	6.9	44.4	0	2.5
2013	2.2	21	27.5	5	41.9	0	2.1
Average	3.12	14.38	28.03	6.89	43.4	1.46	2.72

Figure 4.3: Enrolment trend into different clusters at MU for the period 2013-2017

Source: Official records of student enrolment of Moi University, 2019

Information in Figure 4.3 indicates that the lowest enrolment was in Agriculture and Natural Resources which recorded 0% in 2013 and 2014 respectively. It gradually increased from a paltry 1.6% in 2015 to 4.1% in 2017. Averagely, 1.46 % enrolled into Agriculture and Natural Resources. Low trend was recorded in Engineering and Technology which gradually increased from 2.1% in 2013 to 3.5% in 2017. The average enrolment was at 2.72%. Medical and Health Sciences cluster gradually

increased from 2.2% in 2013 to 3.9% in 2017, putting the average at 3.12%. Life and Physical Sciences cluster enrolment increased from 5% in 2013 to 8.6% in 2017, placing the average at 6.89%. Relatively, higher enrolment was recorded in Humanities and Social Sciences, oscillating between 40.3% lowest in 2017 and 48.1% highest in 2016. This resulted into an average of 43.4%. Enrolment into Education cluster oscillated between 25.2% lowest in 2017 and 31.2% highest in 2014. This brought the average to 28.03%. Business cluster recorded the highest enrolment of 21% in 2013 and 10.4% lowest in 2016. The average enrolment for this cluster was, therefore 14.38% for the period reviewed.

From the findings above, most students enrolled into Arts, Social Sciences and Humanities, Education and Business clusters which constituted 85.81%. This meant that only 14.19% were enrolled into Science and Technology Programmes, missing the government target of 50% by 35.81 percentage point. In conclusion, there exist systematic imbalances between the number of science-based and arts based students. In this connection, one HoD explained:

> Some of science and technology Schools like Agriculture and Natural Resources and Life and Physical Sciences were initially domiciled at Chepkoilel Campus which eventually became chartered into a fully-fledged University of Eldoret forcing MU to mount these programmes afresh amidst lack of infrastructure, teaching and learning resources. This probably explains low enrolments recorded. (Male, HoD, September, 2019)

The findings were supported by Karimi (2015) who observed that there was oversubscription of students in the categories of Humanities and Commerce while Engineering, Architecture and Life and Natural Sciences were not being adequately

offered in East African Universities. Moreover, Mpehongwa (2014) established that, in Tanzania, enrolment in Sciences had decreased to 17.6% while that of Arts and Humanities had increased up to 82% between 2006 and 2011.

The researcher equally collected data from Universities admission records and interviews with HoDs on enrolment into specific Engineering programmes. The findings from TUK are presented in Table 4.3 below:

Table 4.3: TUK enrolment trend into Engineering Programmes for the period 2013-2017

Cluster	**Year**										
	2013		**2014**		**2015**		**2016**		**2017**		**Average**
	F	%	F	%	F	%	F	%	F	%	%
Electrical Engineering	317	32.2	297	28	269	30.2	287	27.9	173	27.8	29.3
Civil Engineering	201	20.4	346	32.6	235	26.5	323	31.4	189	30.4	28.2
Mechanical Engineering	224	22.7	228	21.5	218	24.5	204	19.8	134	21.5	22
Chemical Engineering	40	4.1	97	9.2	91	10.2	107	10.5	74	11.9	8.9
Aeronautical Engineering	99	10	59	5.6	38	4.3	61	5.9	24	3.9	6.1
Geospatial Engineering	105	10.6	33	3.1	37	4.2	46	4.5	28	4.5	5.4
Total	**986**	**100**	**1060**	**100**	**888**	**100**	**1028**	**100**	**622**	**100**	**100**

Source: Official records of student enrolment of TUK, 2019

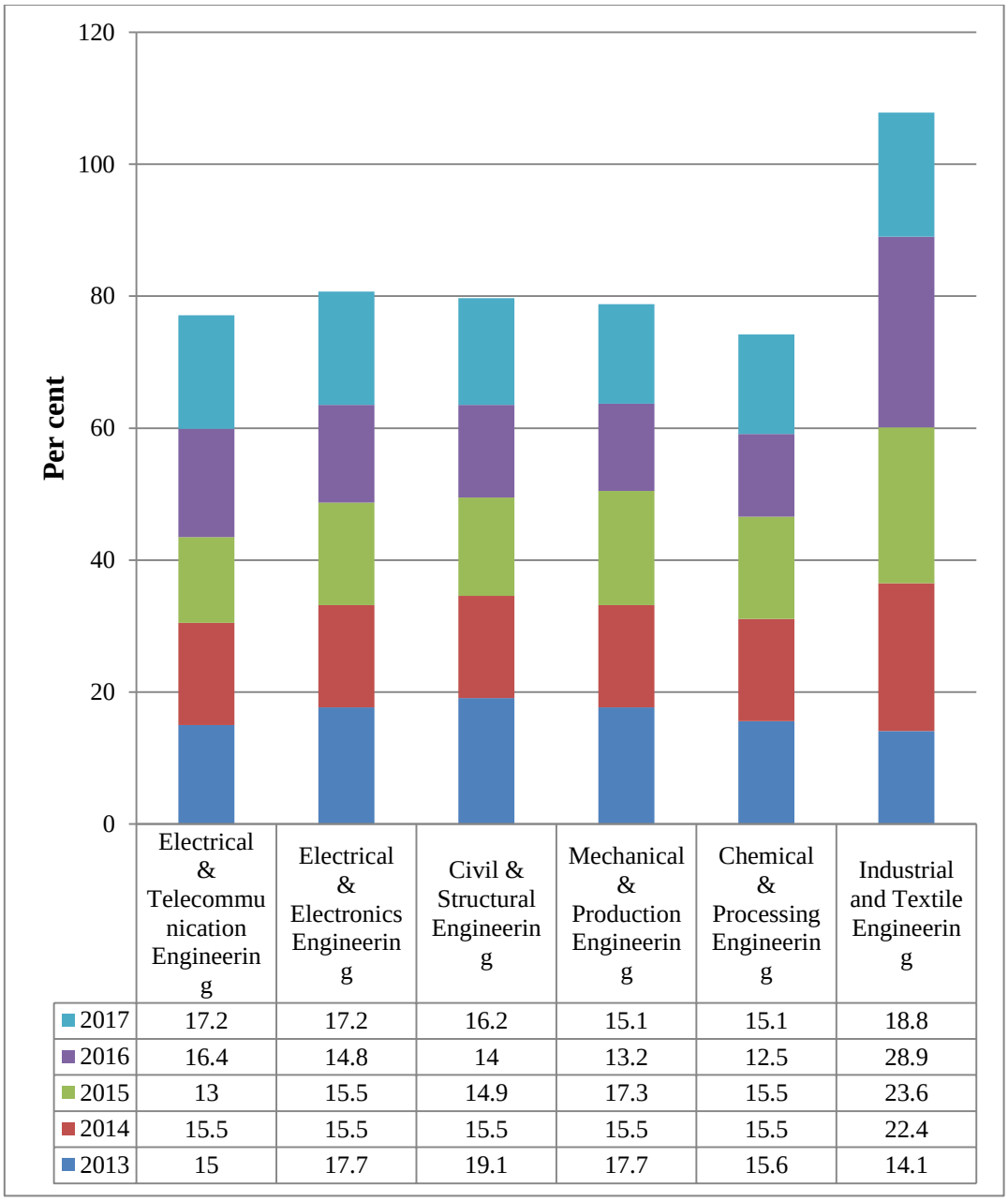
Table 4.3 above shows that the highest enrolment was in Electrical Engineering, recording the highest of 32.2% in 2013 and lowest of 27.8 % in 2017, with an

average to be 29.3%. This was followed by Civil Engineering, recording the highest of 32.6% in 2014 and lowest of 20.4% in 2013, bringing the average at 28.22%. Mechanical Engineering followed with the highest of 24.5% in 2015 and lowest of 19.8% in 2016, averaging at 22%. The least represented programmes were Geospatial Engineering oscillating between 10.6% highest in 2013 and 3.1% lowest in 2014 making the average to be 5.43%, followed by Aeronautical Engineering with highest of 10% in 2013 and 3.9% lowest in 2017, thus the average of 6.13%. Chemical Engineering had the highest enrolment of 11.9% in 2017 and lowest of 4.1% in 2013, making the average to be 8.92%. This meant that Electrical Engineering and Civil Engineering, combined, constituted a lion's share of 57.52% of enrolments into Engineering Programmes. On the question of enrolment into specific Engineering programmes, one HoD explained:

> Due to the relative closeness in objectives between industrial and manufacturing engineering, the two fields of engineering are usually found close and complementary to each other in the solution of respective engineering problems. Therefore in industrial and manufacturing engineering as such, there is some opportunity to study industrial and manufacturing engineering as part of programmes in School of Mechanical and Process Engineering. (Female, HoD, December, 2019)

What can be deduced from this sentiment is that enrolment into Manufacturing Engineering was low, given that it was amalgamated into Mechanical Engineering which only averaged 22%.

The findings from MU are presented in Figure 4.4:



	Electrical & Telecommunication Engineering	Electrical & Electronics Engineering	Civil & Structural Engineering	Mechanical & Production Engineering	Chemical & Processing Engineering	Industrial and Textile Engineering
2017	17.2	17.2	16.2	15.1	15.1	18.8
2016	16.4	14.8	14	13.2	12.5	28.9
2015	13	15.5	14.9	17.3	15.5	23.6
2014	15.5	15.5	15.5	15.5	15.5	22.4
2013	15	17.7	19.1	17.7	15.6	14.1

Figure 4.4: MU enrolment trends into Engineering Programmes for the period 2013-2017

Source: Official records of student enrolment of Moi University, 2019

Figure 4.4 above shows that Industrial and Textile Engineering recorded the highest enrolment, ranging between 28.9% highest in 2016 and 14.1% lowest in 2013,

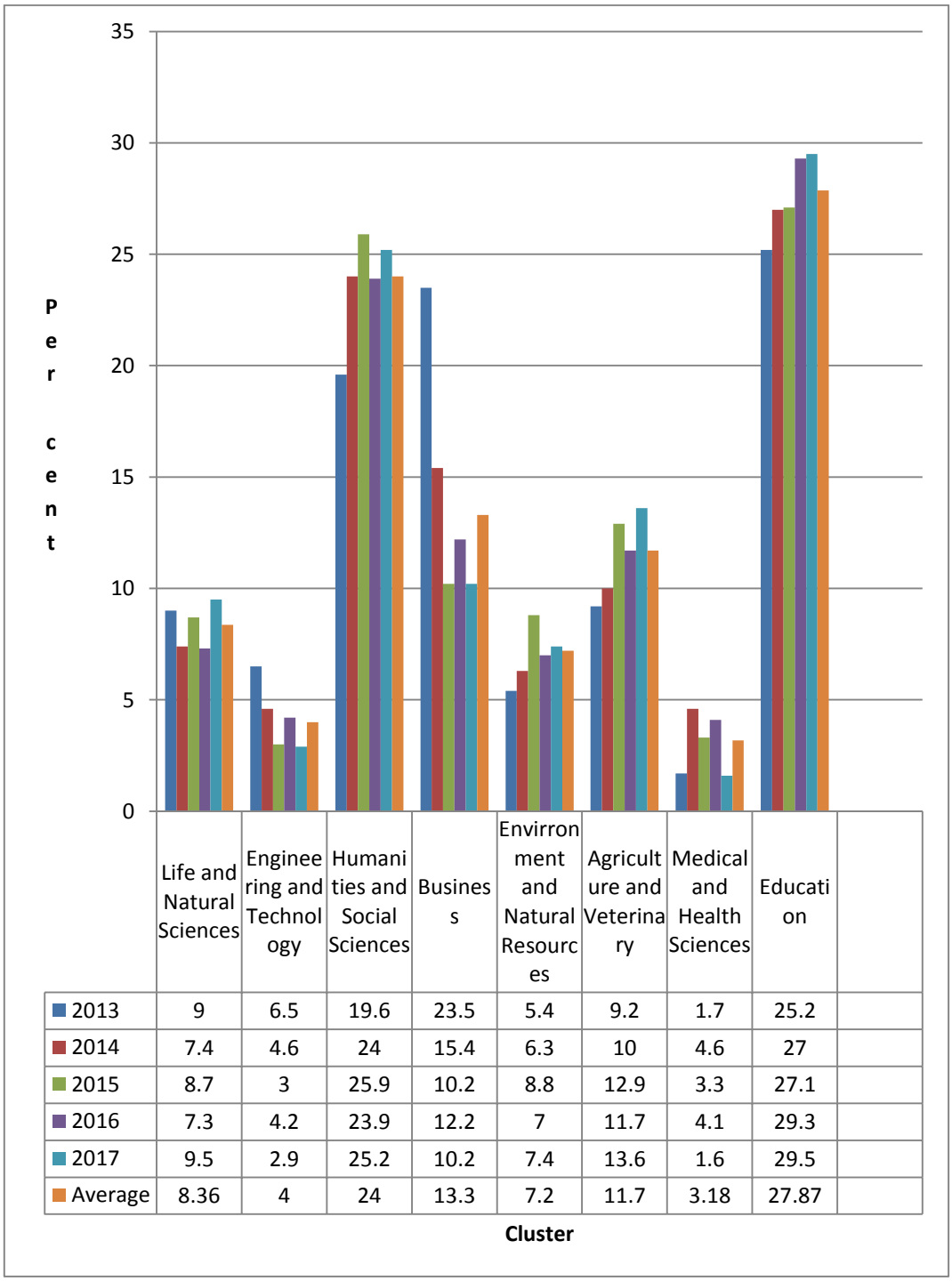
averaging 21.33%. Electrical and Electronic Engineering enrolment oscillated between 17.2% highest in 2017 and 14.8% lowest in 2016. This brought the average enrolment to 16.27%. Civil and Structural Engineering recorded the lowest enrolment of 14% in 2016 and the highest 19.1% in 2013. The average enrolment in this programme was 16%. The least represented was Chemical and Processing Engineering which recorded the lowest enrolment of 12.5% in 2016 and highest in 16.6% in 2013, hence averaging 14.93%. Mechanical and Processing Engineering oscillated between 13.2% lowest in 2016 and 17.7% highest in 2013, bringing the average enrolment to 15.87%. Electrical and Telecommunication Engineering recorded 13% lowest enrolment in 2015 and 17.2% highest in 2017, putting average enrolment at 15.6% for the reviewed period.

Electrical and Telecommunication and Electrical and Electronics Engineering are closely related and when combined, resulted into the highest enrolment of 31.87%. Overall, the research established that there was low enrolment into various Engineering programmes. This finding was strengthened by Garwe (2015) on trends in students' enrolments in Agricultural degree programmes in Zimbabwe which established that, despite the increase in number and variety of Agriculture-related programmes, the share of enrolments in those programmes compared to overall enrolments showed a downward trend.

4.3.2 Trends in students' graduation at Bachelors' Level between 2013 and 2017 at the sampled Universities

The researcher sought to find out participation of students pursuing Science and Technology Programmes based on graduation trends. These were analyzed, based on

cluster of study areas in Bachelor degree programmes between 2013-2017 academic years. The findings from Egerton University are shown in Figure 4.5 below:



	Life and Natural Sciences	Engineering and Technology	Humanities and Social Sciences	Business	Environment and Natural Resources	Agriculture and Veterinary	Medical and Health Sciences	Education
2013	9	6.5	19.6	23.5	5.4	9.2	1.7	25.2
2014	7.4	4.6	24	15.4	6.3	10	4.6	27
2015	8.7	3	25.9	10.2	8.8	12.9	3.3	27.1
2016	7.3	4.2	23.9	12.2	7	11.7	4.1	29.3
2017	9.5	2.9	25.2	10.2	7.4	13.6	1.6	29.5
Average	8.36	4	24	13.3	7.2	11.7	3.18	27.87

Figure 4.5: EU Comparative graduation trends between 2013-2017 academic years for different clusters

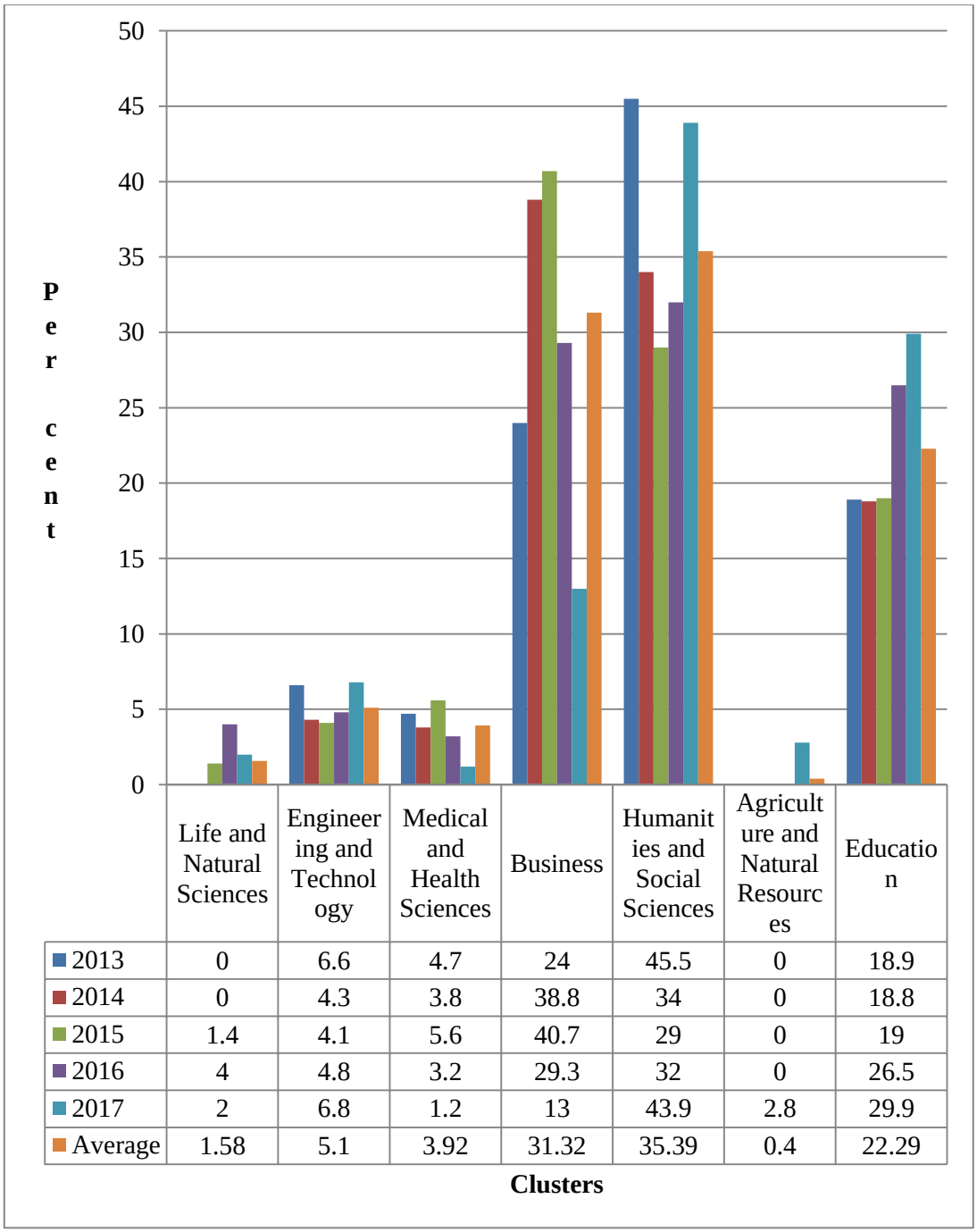
Source: Researchers' compilation from Egerton University graduation booklets 2013-2017

The comparative graduation trends appearing in Figure 4.5 show that Medical and Health cluster recorded the lowest number of graduates at 1.6% as lowest in 2017 and 4.6% as highest in 2014, making an average of 3.18%. Engineering and Technology, with an average of 4.0% was the second with least graduates at 2.9% in 2017 and highest of 6.5 % in 2013. Environment and Natural Resources was third least represented averaging at 7.2% with the highest of 8.8% in 2015 and lowest of 5.4% in 2013. Life and Natural Sciences came fourth, averaging at 8.36%, with the highest of 9.5% in 2017 and least of 7.3% in 2016. Agriculture and Veterinary Medicine, averaging at 11.77%, was the fifth least represented with 13.6% as highest in 2017 and least of 9.2% in 2013.

The cluster which recorded the highest number of graduates was Education, averaging at 27.87% with the highest of 29.3% in 2017 and least of 25.2% in 2013. Humanities and Social Sciences were the second highest with the average of 24%. They recorded the highest of 25.9% in 2015 and lowest of 19.6% in 2013. Business cluster was third, averaging at 13.3% with highest number of graduates at 23.5% in 2013 and lowest of 10.2% in both 2015 and 2017. This meant that Education, Humanities and Social Sciences and Business clusters, combined, constituted the lion's share of graduates at 65.17%. By implication, therefore, Egerton University

produced only 34.83% of their graduates in Science and Technology Programmes for the entire period of 2013 to 2017.

Graduation trends for different clusters at Moi University were analyzed and the findings are presented in Figure 4.6:



	Life and Natural Sciences	Engineering and Technology	Medical and Health Sciences	Business	Humanities and Social Sciences	Agriculture and Natural Resources	Education
2013	0	6.6	4.7	24	45.5	0	18.9
2014	0	4.3	3.8	38.8	34	0	18.8
2015	1.4	4.1	5.6	40.7	29	0	19
2016	4	4.8	3.2	29.3	32	0	26.5
2017	2	6.8	1.2	13	43.9	2.8	29.9
Average	1.58	5.1	3.92	31.32	35.39	0.4	22.29

Clusters

Figure 4.6: MU comparative graduation trends between 2013-2017 academic years for different clusters

Source: Researchers' compilation from Moi University graduation booklets 2013-2017

The comparative graduation trends appearing in Figure 4.6 above on average show that Agriculture and Natural Resources cluster was the least represented with a paltry 0.4%, only graduating students in 2017 at 2.8%. Life and Natural Sciences was second least represented with an average of 1.58%. The highest in this cluster was 4.0% in 2016 and the least of 0% in both 2013 and 2014. Medical and Health Sciences at an average of 3.92% was third least represented with the highest of 5.6% in 2015 and lowest of 1.2% in 2017. Engineering and Technology, at an average of 5.1%, was fourth least represented with highest of 6.8% in 2017 and 4.1% in 2015. Humanities and Social Sciences cluster was the highest represented with the average of 35.39%, recording the highest of 45.5% in 2013 and lowest of 29% in 2015.

Business cluster, averaging at 31.32%, was second highest with 40.7% in 2015 and lowest of 13% in 2017. Education, averaging at 22.29%, was third recording the highest of 29.9% in 2017 and lowest of 18.8% in 2014. This meant that Education, Humanities and Social Sciences and Business clusters combined, constituted the lion's share of graduates at 89%. By implication, therefore, Moi University produced only 11% of their graduates in Science and Technology Programmes for the entire period of 2013 to 2017. Averagely, 23% of graduates were from Science and Technology Programmes while non-science areas dominated at 77% during the period reviewed.

These findings were reinforced by one Registrar (Academic) who argued that:

> Low numbers of students graduating in Science and Technology Programmes is largely attributed to the fact that sciences require

> heavy investments like laboratories, technology and libraries which are very inadequate. (Male, Academic Registrar, November, 2019)

The graduation trends in the Faculty of Veterinary Medicine at Egerton University were analyzed and the findings are presented in Table 4.4:

Table 4.4: Egerton University graduation trend in Animal Health Management between 2013-2017 academic years

Year	Number that graduated	Per cent
2013	05	9.43
2014	09	16.99
2015	09	16.99
2016	05	9.43
2017	25	47.16
Grand Total	**53**	**100**

Source: Researchers compilation from Egerton University graduation booklets 2013-2017

Table 4.4 above indicates that a total number of 53 students graduated in Animal Health Management Programme between 2013-2017 academic years with the highest number in 2017 where 25 graduated, representing 47.16%, followed by 2014 and 2015 where 9 students graduated, each representing 16.99%. The least was in 2013 and 2016 where only five students graduated, each representing 9.43%. In summary, only 53 students graduated from this critical area of Veterinary Medicine and Surgery.

In this connection, one lecturer explained:

> There is low number of students graduating in the Faculty of Veterinary Medicine and Surgery because, out of two Bachelor degree programmes offered, only one was graduating students. The

> inaugural class of Veterinary Medicine and Surgery are in their fifth year of study. Further, those low graduating numbers reflected the low numbers of students enrolling. (Female, Lecturer, November 2019)

The findings for graduation trend in Engineering Programmes at Egerton University are presented in Table 4.5:

Table 4.5: Graduation trends in Engineering Programmes between 2013-2017 academic years at Egerton University

Programme	**Year**										
	2013		**2014**		**2015**		**2016**		**2017**		**Average**
	F	%	F	%	F	%	F	%	F	%	%
Agriculture Engineering	15	9	24	16.1	37	23.7	56	29.3	29	27.1	21.9
Water Environmental Engineering	29	17.5	31	20.8	34	21.8	46	24.2	28	26.2	22.1
Manufacturing Engineering	23	13.9	31	20.8	33	21.2	44	23	22	20.6	19.9
Instrumental and Control Engineering	37	22.3	37	24.8	33	21.2	40	20.9	27	25.2	22.8
Civil Engineering	07	4.2	07	4.7	14	8.9	01	0.5	0.1	0.9	3.9
Industrial Technology	55	33.1	19	12.8	05	3.2	04	2.1	-	-	10.2
Total	166	100	149	100	156	100	191	100	107	100	100

Source: Researchers' compilation from Egerton University graduation booklets 2013-2017

Table 4.5 above indicates that Instrumentation and Control Engineering had the highest number of graduates averaging at 22.88%. It recorded the highest of 25.2% in 2017 and lowest of 20.9% in 2016. It was followed by Water and Environmental

Engineering which recorded the highest of 26.2% in 2017 and lowest of 17.5% in 2013, making an average of 22.1%. Agriculture Engineering was third with an average of 21.94%, recording the highest of 29.3% in 2016 and lowest of 9% in 2013. Manufacturing Engineering had the highest of 23% in 2016 and lowest of 13.9% in 2013, bringing the average to 19.9%. The least represented was Civil Engineering oscillating between 0.5% in 2016 lowest and 8.9% in 2015 highest, making the average to be 3.9 %, followed by Industrial Technology with the highest of 33.1% in 2013 and lowest of 0% in 2017, bringing the average to 10.79%.

On Manufacturing Engineering, one lecturer pointed out:

> The graduating numbers in Manufacturing Engineering is still low considering the important role that this sector is expected to play in order to meet the country's development agenda. (Male, Lecturer, September, 2019)

Moi University graduation trend in Engineering and Aerospace Sciences Programmes between 2013-2017 academic years is shown in Table 4.6 below:

Table 4.6: Graduation trends in Engineering and Aerospace Sciences Programmes between 2013-2017 academic years at Moi University

Programme	**Year**										
	2013		**2014**		**2014**		**2016**		**2017**		**Average**
	F	%	F	%	F	%	F	%	F	%	%
Electrical and Electronic Engineering	58	22.3	62	23.5	96	32.8	82	26.1	61	23.3	25.7
Civil and Structural Engineering	48	18.5	44	16.6	43	14.7	60	19.1	50	19.1	17.6
Electrical and Telecommunication Engineering	39	15	51	19.3	32	10.9	40	12.7	47	17.9	15.2
Mechanical and Production Engineering	55	21.1	40	15.2	34	11.6	47	15	25	9.5	14.5
Chemical & Process Engineering	33	12.7	28	10.6	35	11.9	46	14.6	47	17.9	13.5
Industrial and Textile Engineering	18	6.9	19	7.2	31	10.5	36	11.5	24	9.2	9.1
Agricultural and Biosystems Engineering	09	3.5	14	5.3	11	3.8	-	-	-	-	2.5
Aerospace Science	-	-	06	2.3	11	3.8	03	01	08	3.1	2.0
Total	**260**	**100**	**264**	**100**	**293**	**100**	**314**	**100**	**262**	**100**	**100**

Sources: Researchers' compilation from Moi University graduation booklets 2013-2017

Table 4.6 above shows that Electrical and Electronic Engineering produced the highest percentage of graduates for the period reviewed. The highest was 32.8% in

2015 and lowest of 22.3% in 2013 making an average of be 25.77%. It was followed by Civil and Structural Engineering with highest of 19.1% in both 2016 and 2017 and lowest of 14.7% in 2015, making an average of 17.59%. Electrical and Telecommunication Engineering was third, recording the highest in 19.3% in 2014 and lowest of 10.9% in 2015, averaging at 15.2%. Mechanical and Production Engineering had the highest of 21.1% in 2013 and lowest of 9.5%, averaging at 14.43%.The least represented was Aerospace Sciences with the highest of 3.8% in 2015 and 0% in 2013, making an average of 2.01%. Agricultural and Biosystems Engineering recorded the highest of 5.3% in 2014 and lowest of 0% in both 2016 and 2017, making an average of 2.2%. Industrial and Textile Engineering recorded the highest of 11.5% in 2014 and lowest of 6.9% in 2013, making an average of 9.19%. Chemical and Process Engineering had the highest of 17.9% in 2017 and lowest of 10.6% in 2014, bringing the average to 13.5%.

Electrical and Electronic Engineering and Electrical and Telecommunication Engineering combined, constituted the bulk of engineering graduates at 40.77%. It could be argued out that, given the similarity and closeness of the two Engineering fields, then, the University was over-emphasizing them at the expense of other Engineering Programmes. Yet, those others equally played a pivotal role towards attaining the envisaged nation's development agenda.

These findings were further reinforced by one HoD who stated:

> Low numbers in Aerospace Sciences is attributed to the fact that this is a recently mounted programme which has not yet attracted many

> students while Agricultural and Biosystems Engineering has since been phased out as a result of restructuring School of Engineering Programmes. (Male, HoD, October 2019)

In summary, sampled Universities were churning out students mostly in Business, Arts and Humanities who constituted 77% of all students who graduated and a paltry 23% in Science and Technology Programmes. By implication, too much concentration on non-science was likely to disadvantage some key national development sectors which emphasized science and technology as key requirements for growth and the attainment of their aspirations. These observations were supported by OECD (2015) which noted that member countries had three times more Humanities and Social Science graduates than Science Technology Engineering and Mathematics (STEM) graduates. Moreover, this seemed similar to the findings that in Latin America and the Caribbean, many countries posted lower graduation numbers in Engineering, Manufacturing and Construction clusters (World Bank, 2017). Furthermore, Street (2016) in Trinidad and Tobago found out that Government Assistance for Tuition Expenses (GATE) had led to oversupply of graduates in accounting and management and shortage in critical areas such as nursing, medicine and technical skills.

4.3.3 The number of Bachelor Degree Programmes on offer in the target Universities

In relation to objective one of this study, secondary data on the number of Bachelor degree programmes on offer in the target Universities were analyzed. The findings are presented in Figure 4.7 below:

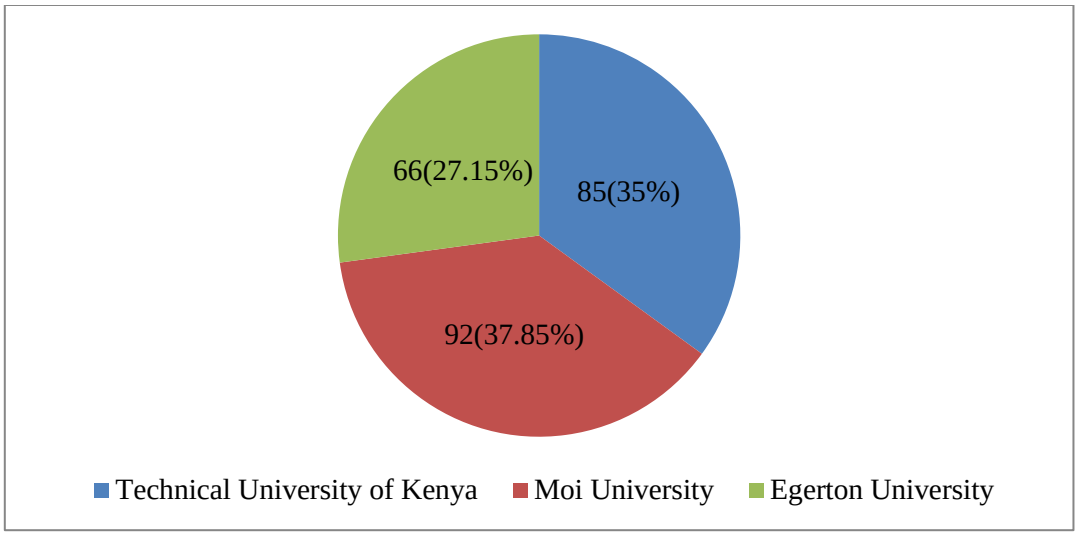


Figure 4.7: Total number of Bachelor Degree Programmes on offer in the target Universities

Source: Official records of academic programmes in sampled Universities

Figure 4.7 above shows that MU had the bulk of the programmes at (92) 37.85%, followed by TUK with (85) 35% while EU had (66) 27.15%. Regarding the aspect of academic programmes on offer, one Academic Registrar pointed out:

> The programmes on offer are largely determined by a number of factors like the nature of the institution's establishment, market forces, and controls by Commission for University Education and other professional bodies, availability and adequacy of space, facilities, and teaching staff among others.(Male, Academic Registrar, November 2019)

Also, closely related academic disciplines were grouped into clusters and data on the total number of Bachelor degree programmes per cluster was collected. The findings are presented in Table 4.7:

Table 4.7: The total number of Bachelor Degree Programmes per cluster in the target Universities

Cluster	Number of Academic programmes			Grand total	%
	TUK	MU	EU		
Architecture, Engineering and Technology	39	6	5	50	20.58
Life and Physical Sciences	15	12	8	35	14.40
Arts, Humanities and Social Sciences	13	50	16	79	32.51
Business	8	3	3	14	5.76
Agriculture, Veterinary and Fisheries	-	4	11	15	6.18
Medical and Health Sciences	7	8	6	21	8.64
Education	-	7	9	16	6.59
Environment and Natural Resources	3	2	8	13	5.34
Total	**85**	**92**	**66**	**243**	**100**

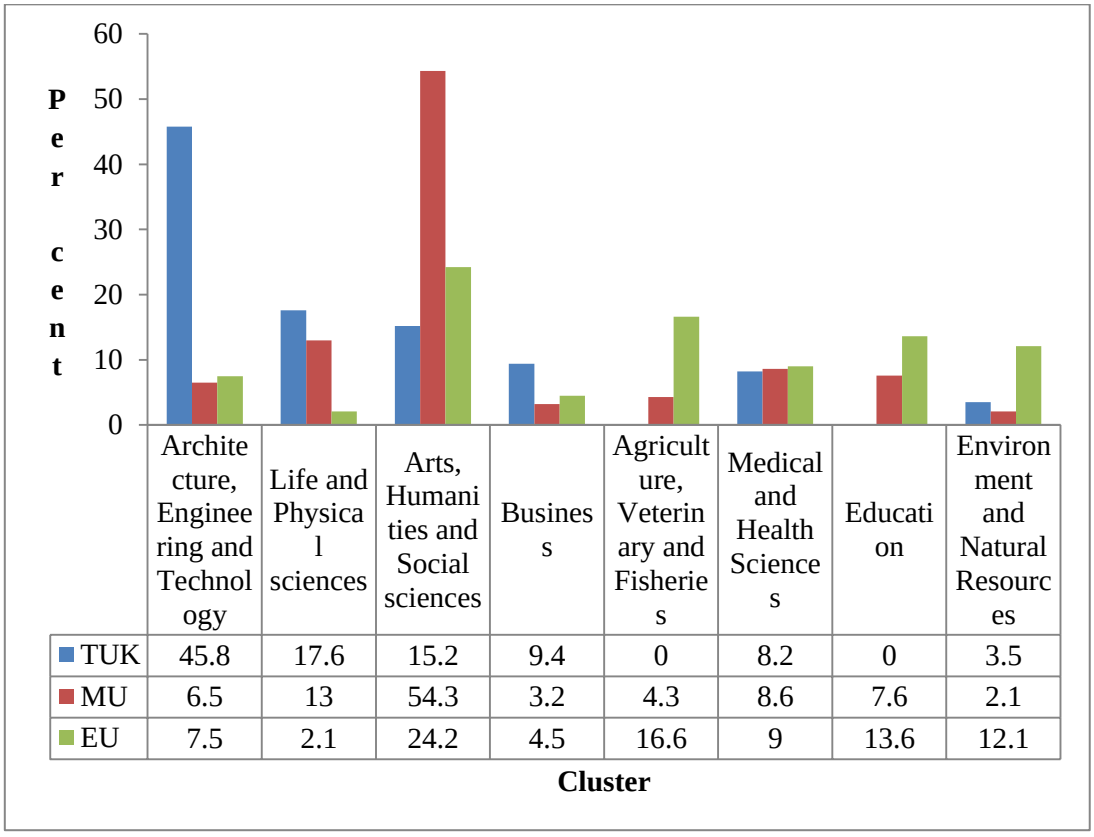
Source: Official records of academic programmes in sampled Universities

The total number of Bachelor degree programmes in Table 4.7 above indicates that the most popular cluster was Arts, Humanities and Social Sciences. This cluster had 79 programmes out of the total 243 programmes representing 32%. It was followed by Architecture, Engineering and Technology at (50) 20.58%, Life and Physical Sciences at (35) 14.4%. But the least represented clusters were Environment and Natural Resources at (13) 5.34%, Business at (14) 5.76%, Agriculture, Veterinary and Fisheries at (15) 6.18%, Education at (16) 6.59% and Medical and Health Sciences at (21) 8.64%.

Therefore, Science and Technology clusters had a total of 134 programmes out of 243, representing 55.2%, while non-science programmes were 109 representing 44.8%. Hence, these Public Universities in Kenya have attempted to prioritize programmes in science and technology clusters. In this regard, one HoD explained:

> There has been an increase in the number of Engineering Programmes at Egerton University. We largely offered Agriculture Engineering Programme in the Faculty of Agriculture but in the recent past, we have significantly expanded this programme into a full-fledged Faculty of Engineering and Technology now offering six Bachelor's degree programmes. (Male, HoD, September, 2019)

The number of Bachelor degree programmes per cluster in each target University is shown in Figure 4.8 below:



	Architecture, Engineering and Technology	Life and Physical sciences	Arts, Humanities and Social sciences	Business	Agriculture, Veterinary and Fisheries	Medical and Health Sciences	Education	Environment and Natural Resources
TUK	45.8	17.6	15.2	9.4	0	8.2	0	3.5
MU	6.5	13	54.3	3.2	4.3	8.6	7.6	2.1
EU	7.5	2.1	24.2	4.5	16.6	9	13.6	12.1

Figure 4.8: The number of Bachelor Degree Programmes per cluster in each target University in 2019

Source: Official records of academic programmes in sampled Universities

Figure 4.8 shows that TUK had the bulk of its programmes in Architecture, Engineering and Technology cluster at 45.8%, followed by Life and Physical Sciences at 17%, and Arts, Humanities and Social Sciences at 15.2%. Environment and Natural Resources was at 3.5%, Medical and Health Sciences at 8.2% while Business was at 9.4%. Education and Agriculture, Veterinary and Fisheries clusters were not represented. Moi University had the bulk of their programmes in Arts, Humanities and Social Sciences at 54.3%, followed by Life and Physical Sciences at 13%, Medical and Health Sciences at 8.6%, Education at 7.6%, Architecture, Engineering and Technology cluster at 6.5%, Agriculture, Veterinary and Fisheries at 4.3%, Business at 3.2%. Environment and Natural Resources was the least represented at 3.5%.

Egerton had 24.2% of its programmes in Arts, Humanities and Social Sciences, 16.6% in Agriculture, Veterinary and Fisheries, 13.6% in Education, 12.2% in Environment and Natural Resources, 12.1% in Life and Physical Sciences, 9.0% in Medical and Health Sciences, 7.6% in Architecture, Engineering and Technology cluster. The least represented cluster was Business with 4.5%. Overall, TUK had prioritized 75.2% in science and technology clusters and 24.8% in non-science cluster. Moi University had 34.7% of its programmes in science and technology and 65.3% in non-science clusters while Egerton University had 57.5% of her

programmes in science and technology and 42.5% in non-science clusters. Regarding the aspect of academic programmes on offer, one Academic Registrar stated:

> Due to the fact that sciences require heavy investment in terms of laboratories and technologies, Universities previously focusing on science and technology are moving towards more generic applied sciences areas. (Male, Academic Registrar, November 2019)

A lecturer lamented:

> We offer Bachelor of Engineering in Civil Engineering, Bachelor of Technology in Civil Engineering Technology and Bachelor of Philosophy in Technology Civil Engineering. Similarly, we offer Bachelor of Engineering in Mechanical Engineering, Bachelor of Technology in Mechanical Engineering and Bachelor of Philosophy in Technology Mechanical Engineering. Definitely, market forces determine the programmes on offer. (Male, Lecturer, November 2019)

Another lecturer pointed out:

> We have split Electrical Engineering into Electrical and Electronic Engineering, Electrical and Computer Engineering and Electrical and Telecommunication Engineering. Market trends largely influences this concept. (Male, Lecturer, November 2019)

These sentiments allude to the fact that marketing trajectory has forced Universities to offer programmes perceived to have market for attracting students. However, they are limited due to lack of infrastructure, teaching, and learning resources. Consequently, "programmatic isomorphism"- a concept where Universities gradually shade off their technical orientation in favour of Arts and Humanities degree programmes has ensued. A second and apparent contradiction is the tendency of programmes duplication within same institution and "course splintering". In summary, although many Science and Technology Programmes are on offer, the emerging picture if unchecked could eventually reverse the trend and programmes

which are critical to the realization of the development agenda and Vision 2030 would, therefore, not be adequately achieved in the long run.

These findings were supported by Sam-Amoah *et al,* (2016) & Owusu-Ansah (2013) in Ghana who documented that there was poor enforcement of policy targets for Science and Technology Programmes by higher education institutions where the science-based had expanded the number of Arts and Humanities Programmes offered. Also, Oanda & Sifuna (2016) and Ochuodho (2016) established that Universities offering Science and Technology Programmes in Kenya tended towards splintering. Moreover, Valeta *et al.* (2016) in Malawi found out that several new programmes with a lot of specialization had been established and concluded that this practice made the over specialized graduates to lack versatility.

In summary, Technical University of Kenya (TUK) had recorded 67.6% enrolment into Science and Technology Programmes and 32.4% in non-science programmes while Moi University 14.2% in science and technology programmes and 85.8% in non-science areas bringing the average to 41% science and technology areas and 59% non-science areas. 43.76% of enrolment at TUK was Engineering and Architecture, 16.63% in Life and Physical Sciences, 16.47% Business, 16% Humanities and Social Sciences and 4.32% in Medical and Health Sciences. At Moi University, 2.72% were enrolled into Engineering, 6.89% in Life and Physical Sciences, 14.38% in Business, 43.4% Humanities and Social Science, 28.03% Education, 3.12% Medical and Health Sciences and 1.46% in Agriculture and Natural Resources. On average, Humanities and Social Sciences had the highest

enrolment at 29.7%, then Education followed at 28.03%, Engineering at 23.24%, Business at 15.4%, Life and Physical Sciences at 13.17%, Medical and Health Sciences at 3.7% and Agriculture and Environmental Sciences at 1.46%. Within Engineering Programmes at TUK, Manufacturing Engineering which is incorporated into Mechanical Engineering was at 22% enrolment, while at MU Manufacturing Engineering, offered through Industrial and Textile Engineering was at 21.33%, making an average of 21.66%.

As regards graduation trends, only 34.88% and 11% of those who graduated from Egerton University and Moi University were in Science and Technology Programmes respectively, bringing the average to 23%. Also, only 53 students graduated from the Faculty of Veterinary Medicine and Surgery. 19.9% graduated with Manufacturing Engineering at Egerton University while 9.19% graduated in Industrial and Textile Engineering from Moi University, making an average of 14.5%. As per the programmes, TUK had 75.2% of them in science and technology and 24.8% non-science programmes. Egerton had 57.5% programmes in science and technology and 42.5% of them in non-science. Moi University had 34.7% in science areas and 65.3% in non-science. Therefore, Universities had prioritized 55.2% of their programmes in science cluster while 44.8% were in non-science clusters. Emerging trend of converting technical institutions to academic institutions by increasing generic applied sciences, duplication within same institutions and course splintering was evident.

In conclusion, contrary to the Government of Kenya admission policy target of 50:50 enrolment ratios for programmes in science and technology and non-science, the average ratio was 41: 59, missing the target by 9 percentage points. Also, the distribution of students in academic programmes was not aligned to the government policy. Regarding graduation trends, low numbers indicated that the government was not producing enough graduates to realize her aspiration of using science and technology to underpin economic development. However, sampled Universities had prioritized programmes in science and technology. Nevertheless, emerging trends like commercialization of programmes, increasing offer of generic applied sciences, duplications and splintering could most likely reverse the trend if unchecked and, in the long run, the government might not attain her development aspirations.

4.4: Relationship between funding of University students and participation in Science and Technology Programmes at the sampled Universities

The second objective of this study sought to establish the relationship between funding of University students and participation in Science and Technology Programmes. To achieve this objective, analysis of government capitation in different programmes, amount of Higher Education Loans Board (HELB) loan awarded and students' social economic status were carried out. The relationship was based on documentary analyses of government capitation, student enrolment records, fees structures and, thereafter, an in-depth analysis of specific voices from the students' questionnaires, open-ended interviews with lecturers, HoDs and Academics Registrars, followed.

4.4.1. Government capitation and student participation in Science and Technology Programmes at the Sampled Universities

Effort was made to compare government capitation based on the available data of the old flat rate formula used in 2017/2018 and Differential Unit Cost (DUC) used in 2018/2019 academic year. The findings are shown in Figure 4.9:

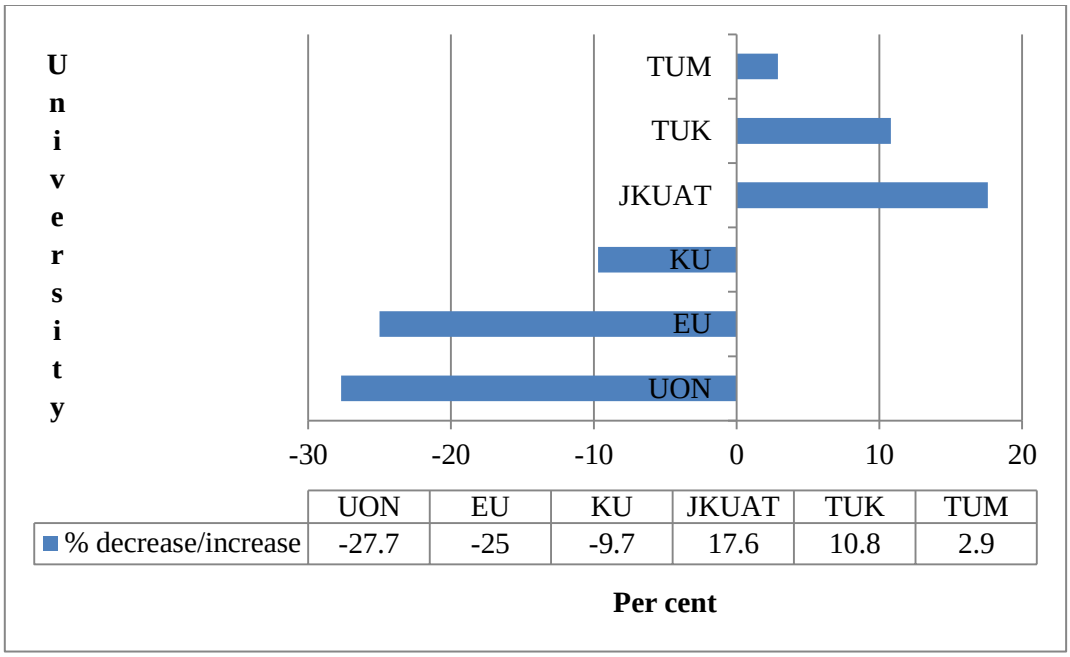


Figure 4.9: Comparative government capitation using the old flat rate formula in 2017/2018 and Differential Unit Cost in 2018/2019 academic year

Source: Official records from Universities Funding Board (UFB)

Figure 4.9 above shows that University of Nairobi (UoN) recorded a decrease of 27.7%, Egerton University (EU) 25% and Kenyatta University (KU) recording a decrease of 9.7%. Yet Jomo Kenyatta University of Agriculture and Technology (JKUAT) received an increase of 17.6%, Technical University of Kenya (TUK) 10.8% and Technical University of Mombasa (TUM) 2.9%. In this connection, another Academic Registrar explained:

> Some Universities received increased capitation and this is attributed to the technical nature of the programmes they offer and high enrolment numbers in the same programmes. On the other hand, some Universities received decreased capitation because they offer more non-science programmes. (Female, Registrar, September, 2019)

To further understand this concept of capitation, data on enrolment numbers through Government Sponsored Programme (GSP) into Medical and Health Sciences, Humanities and Social Sciences at Moi University (MU) for the period 2013-2017 was sought and the findings are presented in Figure 4.10:

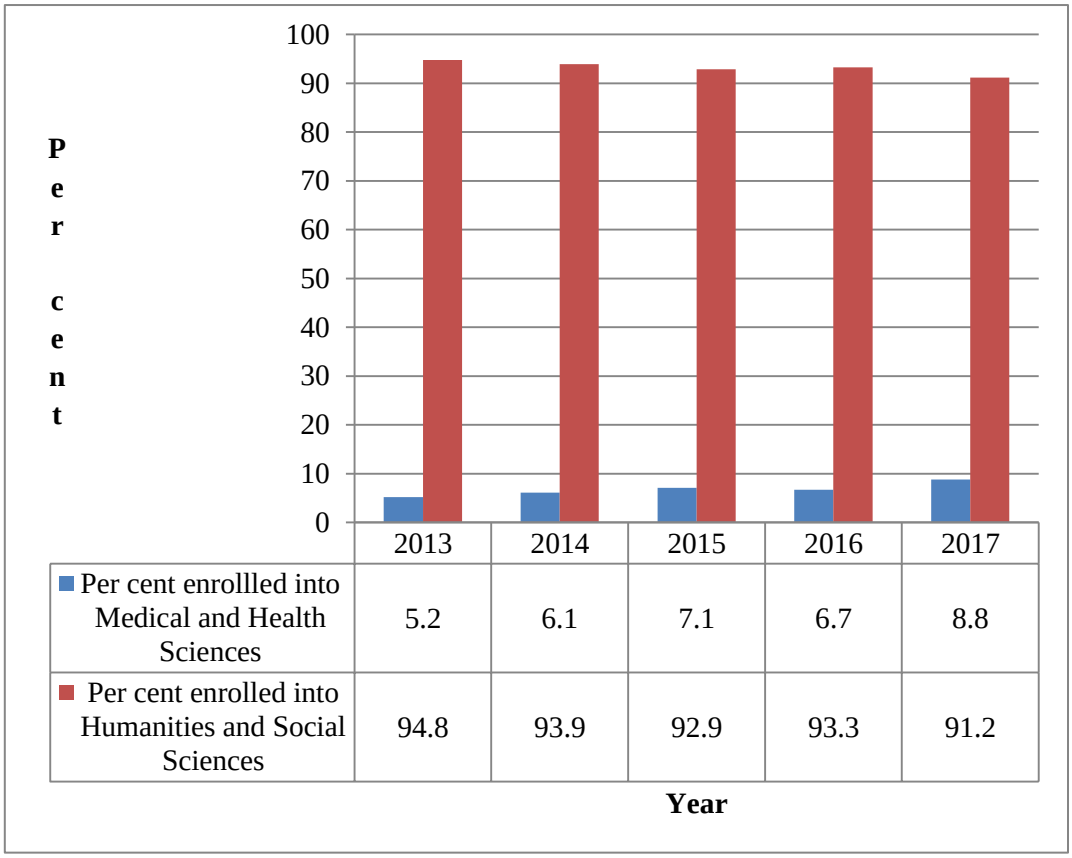


Figure 4.10: Comparative enrolment numbers of government sponsored students into Medical and Health Sciences and Humanities and Social Sciences at MU for the period 2013-2017

Source: Researchers' compilation from Moi University official admission records

Figure 4.10 above indicates that enrolment into Medical and Health Sciences was ranging between 5.2% lowest in 2013 and 8.8% highest in 2017. But, Humanities

and Social Sciences oscillated between 91.2% lowest in 2017 and 94.8% highest in 2013. Averagely, only 6.78% enrolled into Medical and Health Sciences which apparently were the schools targeted for the highest capitation while a lion's share of 93.22% enrolled into Humanities and Social Sciences which received the lowest capitation using Differential Unit Cost (DUC) formula.

Records from Universities Funding Board (UFB) revealed that in 2019, the unit cost for Dental Surgery was Ksh. 720,000/= per year, Ksh. 720,000/= for Bachelor of Medicine and Surgery per year, Ksh. 504,000/= for Bachelor in Pharmacy per year, Ksh. 396,000/= per year for Engineering and Ksh. 564,000/= for Veterinary Medicine per year. Comparatively, Humanities and Arts-based courses varied between Ksh. 180,000/= and Ksh. 144,000/= per year (Universities Funding Board, 2019; Oduor, 2017).

What this one meant was that if the trend of enrolling fewer students into Science and Technology Programmes would continue as the current practice, then DUC formula had a net effect of decreasing capitation. Consequently, lack of enough funding had led to shortage of basic learning resources and teaching staff, thus raising the question of quality. In conclusion, DUC was not working since by their nature, Science and Technology Programmes demanded a significant investment to establish, maintain and expand the engine of physical infrastructure. With decreasing capitation, Universities will be unable to expand their resources to support participation. In this regard, the study by Mukhwana *et al*. (2016), on state of University education in Kenya, corroborated our findings in that Universities were

operating on a deficit which led to skewed development and mounted programmes which ignored the more expensive Science and Technology Programmes. Mbirithi (2013) found out that insufficient funds were the biggest management challenge to Universities since it affected all the areas of research, teaching and learning. Furthermore, Kobla *et al* (2018) in Malawi established that the government had reduced the amount of money allocated to Bunda College.

4.4.2. Entry criteria through Government Sponsored Programme (GSP) into Science and Technology programmes

In order to establish the relationship between funding of University students and participation in Science and Technology Programmes, the study sort to explore the entry criteria through GSP mode. Coordination and placement of Government-sponsored students to Universities is done by KUCCPS which is a State Corporation established under Universities Act, 2012. The placement policy requires that programmes must be identified as a priority area by the government (KUCCPS, 2014).

In this connection, KUCCPS records indicate:

> The placement of GSP students to Universities is coordinated by KUCCPS and the placement policy requires that programmes for placement must be identified as a priority area by the government. KUCCPS considers the number of available slots in Kenyan Universities and the maximum performance index per cluster for all students and subjects, raw cluster performance index per cluster for all subjects enrolled, aggregate performance index and maximum performance index recorded in KCSE year preceding admission year. These are then used to calculate the cut off points required to pursuing a particular degree programme in each University. The maximum possible cluster points are 48 and the cut-off points are known at the end of placement. (KUCCPS records, 2019).

One Registrar stated:

> After placement exercises, applicants who do not make it to their programmes are given a second and third chance to reapply. The limitation with second and third window is that applicants are restricted to programmes that were not filled during the first selection and given the competitive nature of Science and Technology Programmes, it's a common occurrence that prospective applicants do not get placement in the Universities and programmes of their choices through GSP during the second and third placement, their KCSE performance notwithstanding. (Male, Registrar Academic, 2019).

Another Registrar expressed the following:

> KUCCPS normally gives one month window for students to request review of their placement through inter-University transfer. The window normally ends when students have already reported to the University. Our registration is normally synchronized to the first week of September and, therefore, by the time this student's application for University transfer succeeds, the classes will have covered in excess of a third of the semester work making it extremely difficult to register such student. Majority of the applicants fail to transfer and find themselves stuck in the programmes they wished to change from. Consequently, they take offense not with the process but with the admission office. (Male, Academic Registrar, November 2019).

The sentiments above allude to the fact that Government Sponsored Programme (GSP) admission policy only considers placement of applicants who sat for the KCSE examination in the year preceding the admission year. Secondly, very few applicants succeed at second and third revision as well as the inter-University transfer window to enroll into Science and Technology Programmes, their KCSE performance and cut-off points notwithstanding. The implication is that, if qualified students miss entry into a programme of interest in a given year, they are not considered during subsequent placements. Furthermore, the criteria exclude the

possibilities for credit transfer among Universities. In conclusion, the GSP admission criterion is so rigid that it results into many qualified students not being enlisted.

To further understand the admission through GSP mode, the researcher used the cut-off points for Manufacturing Engineering and Veterinary Medicine points and the maximum possible cluster points (48) to calculate the programme's competitiveness. Table 4.8 shows the competitiveness for Manufacturing Engineering between 2015 and 2018.

Table 4.8: The competitiveness for Manufacturing Engineering between 2015 and 2018 at Sampled Universities

University	**Maximum CoP**	**Year**							
		2015		2016		2017		2018	
		Cop	% Comp	CoP	% Comp	CoP	% Comp	CoP	% Comp
TUK	48	41.216	85.9	41.573	86.6	41.083	85.6	40.941	85.3
MU	48	43.162	86.7	38.627	81.1	38.592	80.4	38.901	81.0
EU	48	34.074	71	34.868	72.6	33.959	70.7	36.337	75.7

Key: TUK- Technical University of Kenya **EU**-Egerton University **MU**- Moi University **Comp-** competitiveness **CoP-** Cut-off Points

Source: Official records from KUCCPS

From table 4.8 above, EU recorded competitiveness of 75.7% in 2018 and 70.7% in 2017, bringing average competitiveness to 72.5%. TUK had 86.6% in 2016 and 85.3% in 2018 averaging at 85.85%, while MU recorded competitiveness of 86.7% in 2015 and 80.4% in 2017, making an average of 82.3%. Therefore, TUK was the most competitive with 85.85%, followed by MU at 82.3% and then EU came third with 72.5% for Manufacturing Engineering.

The findings revealed that competitiveness in each programme at University keeps changing every year. Also, apart from minimum entry qualification known by the applicant, cut-off points are only known at the end of placement exercise. This means that applicants can only rely on cut-off points from previous intakes to predict the chances of placement into programmes. Hence, the entire process subjects applicants to mere speculation of what mainly constitutes entry requirements. Consequently, this failure to enlist students with minimum University entry grades by subjecting them to a speculative process implies that qualified students are shunted from enrolling into Science and Technology Programmes. Yet GSP admission policy requires that programmes for placement must be identified as a priority area.

These findings pointed to a disconnect between what the Government of Kenya has been articulating over time on the need to enroll many students in Science and Technology Programmes (Republic of Kenya, 1974; 1976; 1979; 1981; 2006; UNESCO, 2010). Moreover, the GSP KUCCPS placement policy requires that programme for placement must be identified as a priority area by the government (KUCCPS, 2014). Furthermore, the findings sharply contrast with those by Kahn (2013) in South Africa which revealed that Department of Education had put in place a nationwide redress programme to give students who had underperformed in Sciences and Mathematics, in their senior certificate examination, a second chance to obtain matriculation exemptions that would allow them to go on to higher education.

4.4.3. Entry criteria into Science and Technology Programmes through Self Sponsored Programmes (SSP) at sampled Universities

With regard to admission to science and technology through SSP, the study sought to understand the entry criteria. In this connection, one Registrar (Academic) stated:

> SSP students are admitted by individual University using criteria set and approved by the Senate. To be eligible for admission into Veterinary Medicine, we have four admission channels, namely: KCSE qualifications, A-Levels or equivalent qualifications, diploma holders, and holders of degree in biological sciences. Further, credit transfer and exceptions for non-veterinary medicine courses may be considered. (Female, Registrar Academic, October, 2019)

This sentiment revealed that SSP admission process considered placement of applicants who possessed either KACE or KCSE examination qualifications or their equivalent and the minimum entry qualifications were known by the applicant. This implied that these criteria provided clear avenues for students to matriculate anytime they were ready by promoting entry through properly coordinated middle level education and training institutions. For example, accumulations of credit at diploma levels and transfers of degree programme, pre-University programmes and alternatives and continuing education. Entry mode directed students into programmes of their choices since minimum entry qualification was known.

Figure 4.11 shows enrolment trends into Bachelor of Mechanical Engineering through GSP and SSP between the period of 2013 and 2017 at TUK:

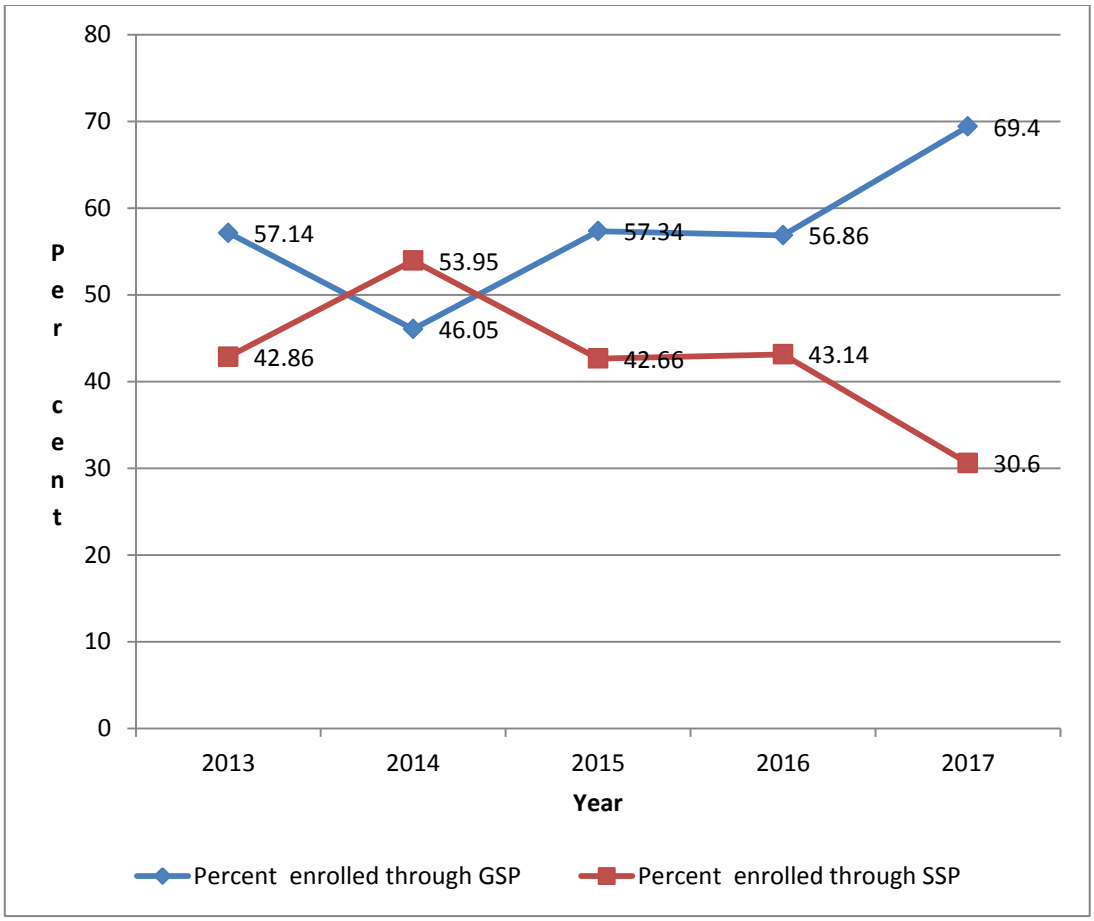


Figure 4.11: Enrolment trends into Bachelor of Mechanical Engineering through GSP and SSP between the period of 2013 and 2017 at TUK:

Source: Official TUK admission Records

The results from Figure 4.11 above shows that the highest enrolment through GSP was 69.4% in 2017 and lowest of 46.05% in 2014, making the averages to be 57%. The highest enrolment through SSP was 53.95% in 2014 and lowest of 30.6% in 2017 bringing the average to 43%. In 2014, 53.95% enrolled through SSP surpassing those enrolled through GSP. This meant that although GSP admission process set cut-off points based on capacity, and whereas the enrolment was highly constrained and shunting many qualified students, SSP entry mode allowed applicants to gain

admission into same programmes that they were probably denied through GSP admission process.

In this connection, one lecturer argued that:

> This SSP entry mode crafted by Universities through adjusting on admission criterion may be attributed to the aim of Universities to create access modes that accommodate those who can make direct payments of tuition fees thus creating a financial boost. (Male, Lecturer, October 2019).

This sentiment allude to the fact that SSP entry mode had the potential of allowing students to enroll into competitive programmes which they may have not managed to access through competitive GSP. Also, in situations where students paid for their education, the need to attract, retain and satisfy customers could be met at the expense of quality education provided to them by ignoring the declared capacities. Consequently, the academic merit in determining access to Science and Technology Programmes was slowly waning in preference for financial capacity. In conclusion, SSP admission processes applied double standards, raising the question of fairness, accountability and quality on the part of University administration. These findings were reinforced by Yokoski & Birubaum (2013) and Oanda (2013) who pointed out that some Public Universities had reduced the number of vacancies for government sponsored students.

4.4.4. Effects of cumulative cost in both GSP and SSP modes of admission

The study sought to establish the cumulative cost of participating in Science and Technology Programmes through both GSP and SSP entry modes. The annual participation costs were captured based on documentary analysis of fees structures,

and the analysis of specific voices from the students' questionnaires followed. Table 4.9 shows the cumulative amount charged per item for the five-year Veterinary Medicine and Surgery Bachelor Degree Programme through GSP and SSP at EU.

Table: 4.9 Comparative cumulative costs for GSP and SSP Bachelor's Degree in Veterinary Medicine and Surgery at Egerton University

Description	**GSP Cumulative cost in Ksh.**	**Per cent**	**SSP cumulative cost in Ksh.**	**Per cent**
Tuition	80,000	22.2	1,200,000	81
Registration	7,500	2.1	7,500	0.5
Medical	12,500	3.5	12,500	0.8
Caution Money	2000	0.6	2000	0.1
Material Development	21,000	5.8	21000	1.4
Library	12,500	3.5	12,500	0.8
Examinations	18,500	5.1	18,500	1.2
Activity	6000	1.7	6,000	0.4
Student ID	500	0.1	500	0.03
Student Union	2000	0.6	2,000	0.1
Field attachment	13360	3.7	13,360	0.9
Vaccinations	12500	3.5	12,500	0.8
Laboratory	12,500	3.5	12,500	0.8
Catering services	90,000	25	90,000	6.0
Books	45,000	12.5	45,000	3.0
Accommodation	25,000	6.9	25,000	1.7
Total	**360,860**	**100**	**1,480,860**	**100**

Source: Official Egerton University Fees structure, 2019

Table 4.9 above shows that a total of 16 items were charged. The cumulative cost in GSP was Ksh. 360,860/=. The most expensive items were catering services which accounted for 25% of the total cost, followed by tuition fee which was 22% and books constituting 12.5%. All other remaining 13 items combined, constituted 40.5% of the total cost. But the cumulative cost in SSP was Ksh. 1,480,860/= and the most

expensive item was tuition which accounted for 81% and the remaining 15 items combined constituted only 19% of the total cost.

Comparatively, pursuing Veterinary Medicine as SSP student was more expensive and, cumulatively, it cost four times more than pursuing the same programme through GSP. Moreover, tuition fees took the bulk of the cost at 81% in SSP while it only accounted for 22% of GSP.

The comparative cumulative cost in both GSP and SSP entry modes in Bachelor of Engineering Programmes at MU are presented in Table 4.10 below:

Table 4.10: Comparative cumulative cost for GSP and SSP Bachelor of Engineering Programme at Moi University

Description	**GSP cumulative cost in Ksh.**	**Per cent**	**SSP cumulative cost in Ksh.**	**Per cent**
Tuition fees	40,000	12	850,000	77.2
Direct charges	40,000	12	-	-
Registration	2,000	0.6	2,000	0.2
Student organization	500	0.2	500	0.05
Student ID	250	0.08	250	0.02
MUSO annual subscription	2500	0.8	2,500	0.2
Caution money	1000	0.3	1,000	0.1
Medical fee	7500	2.3	7,500	0.7
Examination	6000	1.8	6,000	0.5
Activity fee	5,000	1.5	5,000	0.5
Amenity	5,000	1.5	5,000	0.5
Computer	10,000	3.0	10,000	0.9
Field attachment/ workshop practices	50,100	15.2	50,100	4.6
Catering services	90,000	27.3	90,000	8.2
Books	45,000	13.6	45,000	4.1
Accommodation	25,000	7.6	25,000	2.3
Total	**329,850**	**100**	**1,099,850**	**100**

Source: Official Moi University fees structure, 2019

Table 4.10 above shows that a total of 16 items were charged. The cumulative cost in GSP was Ksh. 329,850/=. The most expensive items were catering services which accounted for 27.3% of the total cost, followed by field attachment/workshop practices at 15.2%. Books constituted 13.6%, tuition fees and direct charges tallied at 12% each. All other remaining 11 items, combined, constituted 19.9% of the total cost. But, the cumulative cost in SSP was Ksh. 1,099,850/= and the most expensive

item was tuition which accounted for 77.2%. The remaining 15 items, combined, constituted only 22.8% of the total cost.

Comparatively, pursuing Engineering programme through SSP mode is more expensive and, cumulatively, it costs three times more than pursuing the same programme through GSP. Moreover, tuition fees took the bulk of the cost at 77.2% in SSP while it only accounted for 24% of GSP cumulatively. This finding was reinforced by one HoD who opined that:

> The tuition fee is more expensive in SSP than GSP. This situation is exacerbated by the fact that Science and Technology Programmes call for differences in the cost of specialized equipment and training tools. (Male, HoD, September, 2019)

The analysis from the fees structures and specific voices revealed that same programmes in the same University were priced at different rates and the cost through SSP was much higher than GSP. Therefore, apart from certifying entry criteria, enrolments through SSP largely depended on affordability. This implied that the philosophical and ethical considerations in mounting these programmes aimed only at those in society who could afford. In summary, the SSP admission policy catered for students who could afford to pay the prevailing market fees. This had negatively impacted on enrolment of students who scored the minimum University entry qualifications but came from low socio-economic backgrounds. Therefore, the criteria discriminated learners since those living in poverty were the most likely to be excluded.

This finding was similar to one by Gichuhi (2015), on alternative methods of financing higher education in Central Kenya, which concluded that education expenditures were major components in the consumption of households with children in school. Consequently, as the government funding reduced in higher education, it affected access especially for the poor. Moreover, it was in line with the findings of House of Lords (2012) in Britain which established that repayable tuition loans policy in higher education discouraged students from entering science and technology subjects because they were generally more expensive. Furthermore, Masaiti & Shen (2013), on cost sharing policy in Zambia's public Universities, established that the economic fee (self-sponsored stream) was so expensive that many parents had no capacity to pay.

4.4.5. Relationship between Higher Education Loans Board (HELB) and participation in Science and Technology Programmes

In order to address Objective Two, the study sought to establish the relationship between HELB and participation in Science and Technology Programmes. Student respondents were asked to indicate whether they applied for HELB loans or not, and if yes, whether they receive the loan and how much per year. With regard to loan application, the findings are presented in Figure 4.12:

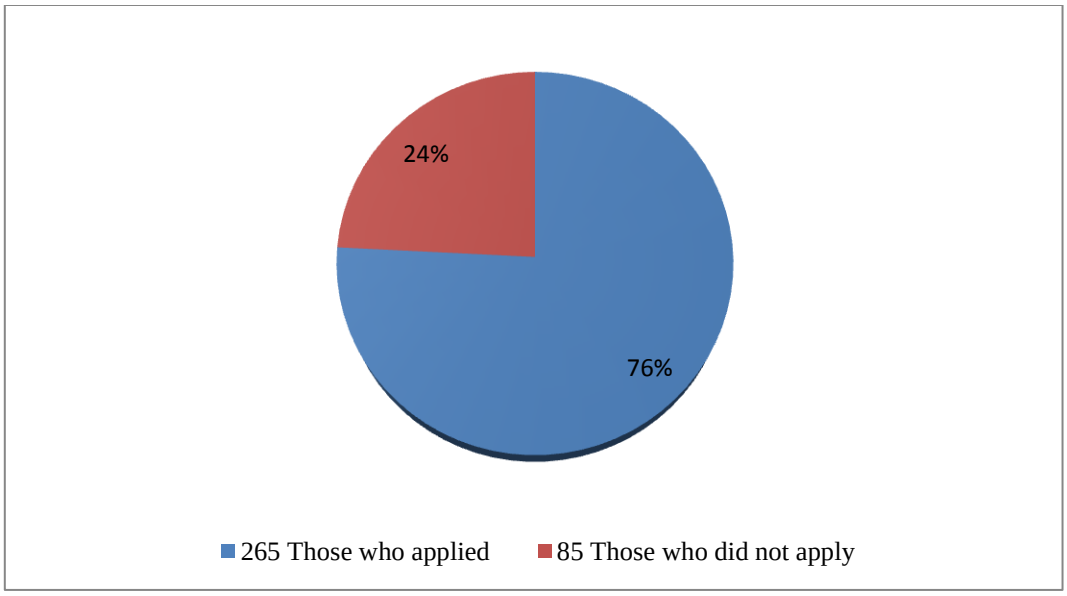


Figure 4.12: Student respondents' frequency on whether they applied for HELB loans or not

Source: Data obtained from students respondents during field inquiry, 2019

Figure 4.12 above shows that 265 (76%) of the respondents applied for HELB loans while 85 (24%) did not apply. One student respondent wrote the following answer to an open ended question in a questionnaire:

> I do not apply for HELB loan because my parents afford to finance my University education without HELB loans. (Female, Student, October, 2019)

Another one lamented:

> I only applied and received during my first year of study. But during the subsequent application, I was not considered because I lacked guarantors. Furthermore, I was also blacklisted that I gave false information thus I stopped applying in subsequent years. (Male, Student, October, 2019)

This showed that majority of students in Science and Technology Programmes applied for the HELB loans. Those who did not apply could afford to finance their

education, given that even those who missed guarantors were still participating. This implied that they had paid. For the HELB loans, the findings are presented in Figure 4.13 below:

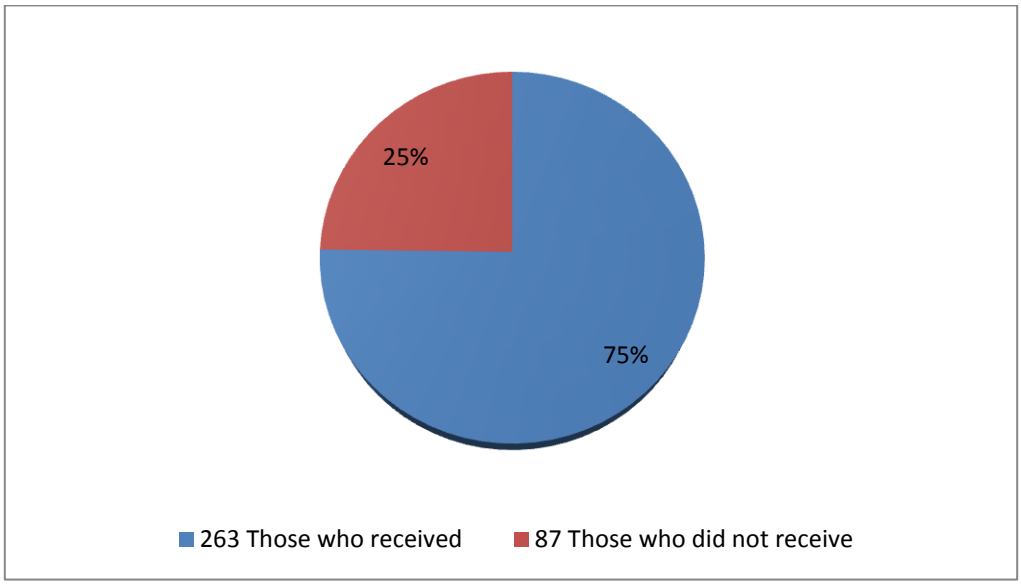


Figure 4.13: Students' responses' frequency on whether they received HELB loans or not.

Source: Data obtained from students respondents during field inquiry, 2019

Figure 4.13 above shows that 263(75%) of the HELB loan applicants received the loans while 87 (25%) of them were not successful. In this connection, a student respondent wrote the following in a questionnaire:

> I was unsuccessful because during the application time, I had not attained 18 years of age hence did not have an Identification Card (ID) which is critical document for loan awarding and also applying after the set deadline. (Female, Student, October, 2019)

This meant that majority of the applicants were successful and the few who did not, probably never met the stipulated conditions.

On the amount of HELB loans, student respondents were asked to approximate the annual amount they received. The findings are presented in Figure 4.14:

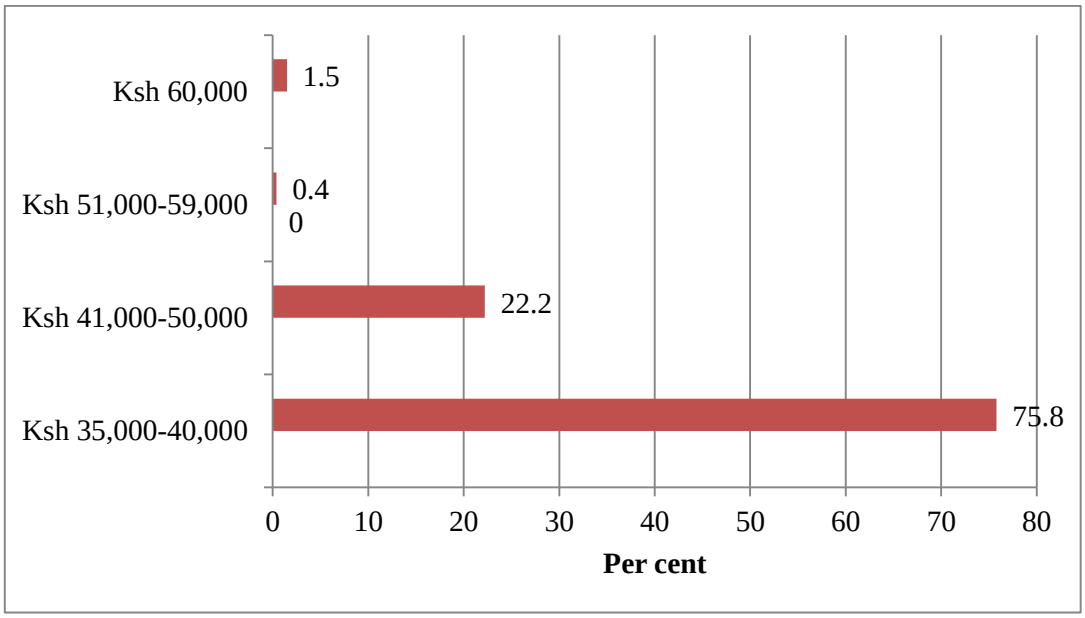


Figure 4.14: Approximate annual amount received from HELB

Source: Data obtained from students respondents during field inquiry, 2019

Figure 4.14 above indicated that 201(75.8%) of the loan recipients' received between Ksh. 35,000/= and Ksh.40, 000/=. A further 59 (22.2%) received between Ksh.41, 000/= and Ksh. 50,000/=. Only one recipient (0.4 %) got between Ksh. 51,000/= and Ksh. 59,000/= while 4 (1.5%) received above Ksh. 60,000/=. The majority got between Ksh. 35,000/= and Ksh. 40,000/=, making the mean loan awarded to be Ksh 37,500/= and cumulatively Ksh187, 500/=.

Given that it cumulatively costs Ksh.360, 860/= to pursue Veterinary Medicine, through GSP mode and Ksh. 1,480,860/= through SSP mode, and Ksh. 329,850/= to pursue Engineering Programme through GSP mode and Ksh 1, 099,850/= through

SSP, then the average HELB loan awarded of Ksh. 187,500/= is equivalent to 52% of GSP Veterinary Medicine cost and 57% of GSP Engineering cost. Equally, it was equivalent to 12.5% of SSP Veterinary Medicine and 17% of SSP Engineering cost. The implication was that the amounts extended were too small. Therefore, HELB loan was an inadequate mode of financing Science and Technology University education for majority of poor students who did not have reliable alternative financing mechanisms. Arguably, HELB loans had no relationship then with the type of programme to pursue. Subsequently, students should look for other sources of finance to bridge the gap between loan awarded and fees charged. The findings of this study are in line with those of Akumu *et al* (2017) which revealed that there was no significant relationship between HELB loan amount and the choice of programme of study by self-sponsored students in Public Universities.

Respondents were asked to indicate the sources of their finances, and the findings are presented in Figure 4.15 below:

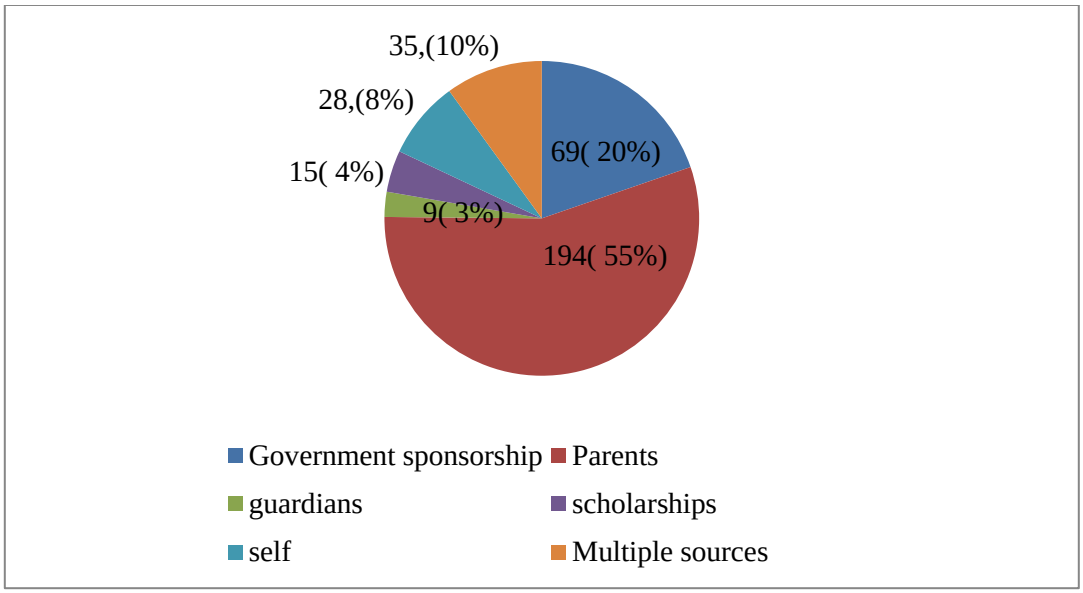


Figure 4.15: Sources that finance University students

Source: Data obtained from students respondents during field inquiry, 2019

Figure 4.15 above shows that 194 (55%) of the respondents were financed by parents, followed by 69 (20%) sponsored by government. 35 (10%) indicated multiple sources, 28 (8%) were self-financing, 15 (4%) scholarships while 9 (3%) were financed by guardians. The parents, guardians and self-financing, combined, constituted a total of 66% financing University education. This, therefore, implied that parents, guardians and students' socio-economic status played a pivotal role in financing students in Science and Technology Programmes. The findings corroborate those by Debrah (2008), on financial challenges for students at the University of Ghana, which established that the main source of funds which majority of students at the University depended on came from parents.

4.4.6. Student's socio-economic status and participation in Science and Technology Programmes

In order to determine the students' socio-economic status, information was sought from respondents on the type of secondary school attended, mode of access, parent/guardian highest level of education, parents/ guardians major sources of income, and approximate monthly income of the parent/guardian. With regard to the type of secondary school attended, student respondents were asked to indicate the category of secondary school they attended. The findings are presented in Figure 4.16 below:

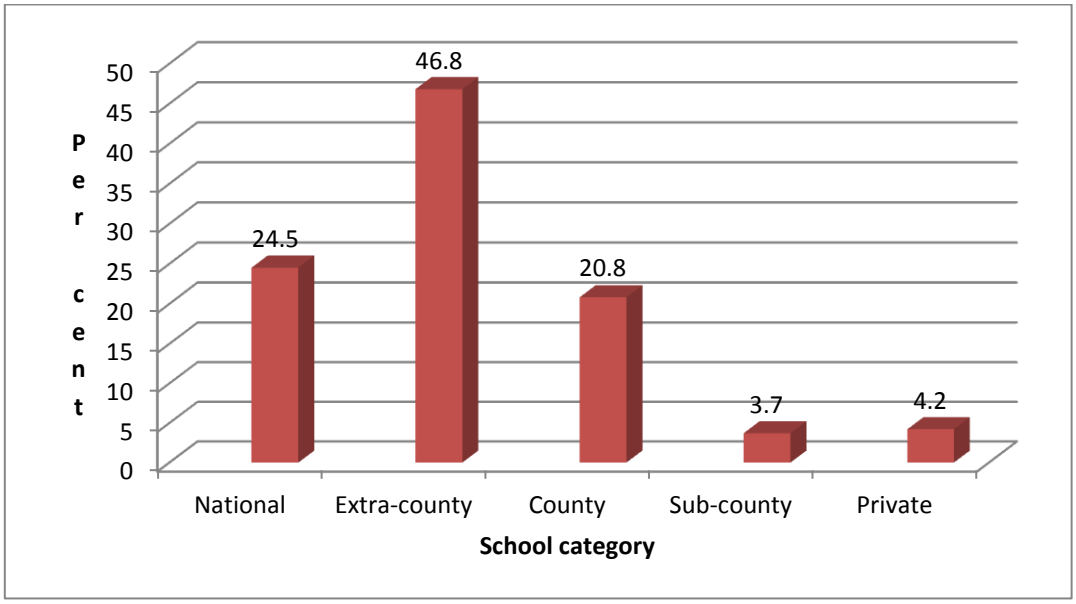


Figure 4.16: Categories of secondary schools attended by students pursuing Science and Technology Programmes

Source: Data obtained from students respondents during field inquiry, 2019

Figure 4.16 shows that 86 (24.5%) attended national schools, 164(46.8%) extra-County schools, 73(20.8%), County schools, 13(3.7%) sub-County schools and 14(4.2) private schools. Therefore, national schools and extra-County schools

combined contributed the bulk of the students at 71.3% while County schools and sub-County schools contributed 24.5%. In this connection, one HoD stated the following:

> Our students attended either national, extra-County, County, sub-County or private schools. National schools mostly have infrastructure, teaching and learning resources and they charge the highest amount of fees among government schools. Extra- County schools are second highest fees charging while County schools are third highest in terms of fees. Sub-County schools charge the least amount of fees mostly only lunch fee among government schools with limited infrastructure; teaching and learning resources. Private schools are not government owned and the fees vary greatly, some charging more than national schools. (Female, HoD, September, 2019)

Another HoD argued that:

> Most of our students in our Department attended top secondary schools in the country. This is as a result of such schools having better facilities like equipped laboratories, trained teaching staff and good examination preparations leading to higher grades that guarantee University admission to competitive programmes. (Male, HoD, September, 2019)

Seemingly, enrolment into Science and Technology Programmes was heavily skewed to those who attended national and extra-County schools. Such schools charged higher fees and had better facilities, teaching and learning resources which guaranteed good performance. This implied that those who attended them largely came from middle and high socio-economic status backgrounds since they could afford. As a result, Science and Technology Programmes were increasingly becoming elitist and discriminatory against students from disadvantaged economic backgrounds. These observations were similar to those by McCowan (2016) who

established that in Brazil, chances of passing competitive examinations for one to join Science and Technology Programmes were linked to prior attendance at high quality primary and secondary schooling and fee-paying preparatory course, all of which were out of reach of most lower-income students. Caner & Okten (2013), in Turkey, established that students from low income families found it difficult to compete in competitive entrance examinations for Science and Technology Programmes with applicants from advantaged backgrounds which had more resources to spent on high quality primary and secondary schooling, private tuition and examination preparations. Moreover, Galukande *et al* (2018), in Uganda, found out that access to training for health profession was skewed to the elite and well-to-do who had attended the top ten secondary schools with infrastructure, teaching and learning resources.

This study further sought to establish the relationship between enrolment modes and students' participation in Science and Technology Programmes. In this connection, one Registrar (Academic) had this to say:

> Students access our programmes through GSP, SSP or affirmative action mode. But on the question of socio-economic background, majority of them are from middle or high socio-economic backgrounds. They originated from elite secondary schools where they could afford fees. (Male, Registrar, September 2019)

Student respondents were asked to indicate their access mode and the findings are presented in Table 4.11 below:

Table 4.11: Access modes to Science and Technology Programmes at Sampled Universities

Mode of access	Frequency	Per cent
Self- Sponsored Programme	85	24.2
Government Sponsored Programme	248	71
Affirmative admission	17	4.8
Total	**350**	**100**

Source: Data obtained from students respondents during field inquiry, 2019

The findings in Table 4.11 above shows that 248 (71%) accessed programme through GSP, 85 (24.2%) through SSP while 17 (4.8%) through affirmative admission. Therefore, the bulk enrolled through GSP. Given that those from low socio-economic status were already eliminated at secondary levels, it could be argued that both GSP and SSP modes targeted those from middle or high socio-economic backgrounds in society. Moreover, only 4.8% accessed through GSP affirmative action and this meant that application of affirmative placement policy had not helped much to increase access. These findings concur with Obonyo (2013) who documented that University admission trends through affirmative action for students from Kenya's ASAL were below the set ceiling of 10 %. Moreover, Mbirianjau (2016) established that despite the existence of educational gender interventions, female students' participation in hard sciences was less than 20%.

With regard to parents'/guardians' highest level of education, the findings are presented in Figure 4.17 below:

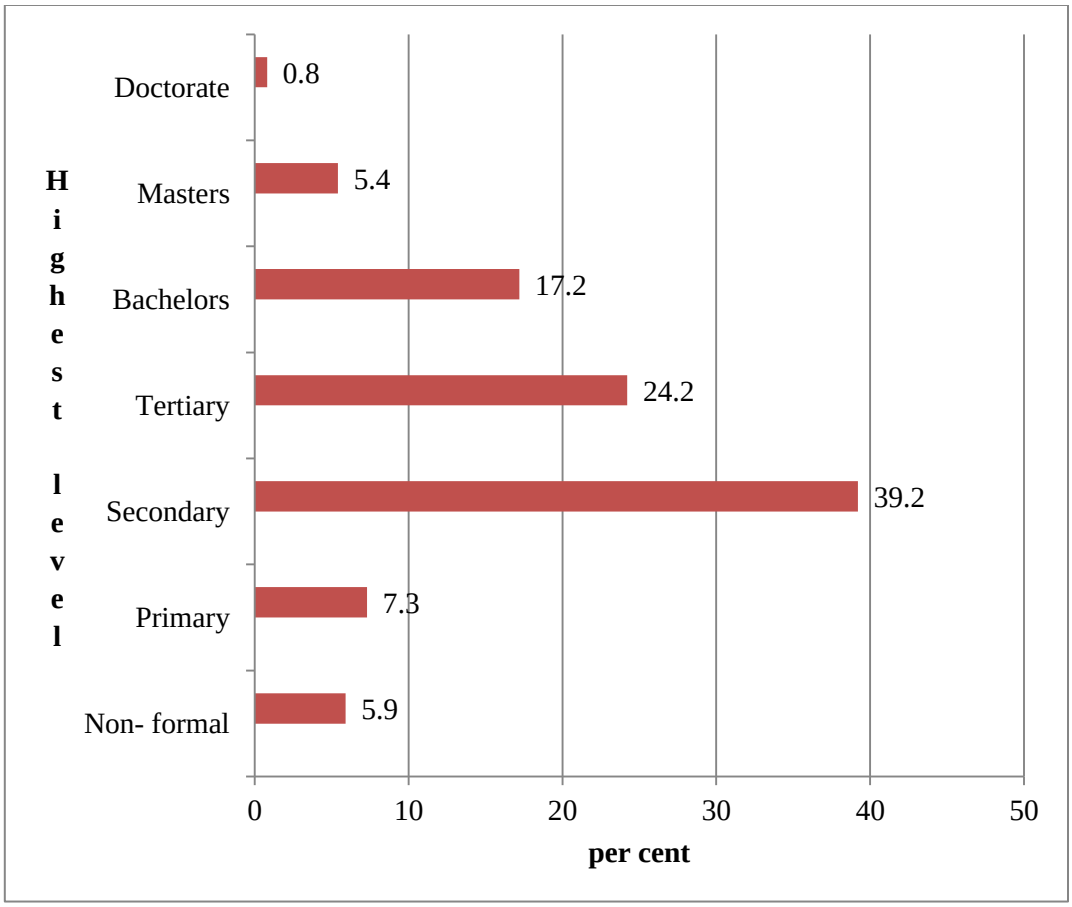


Figure 4.17: Students' responses' frequency about their parents'/guardians' highest level of education at sampled Universities

Source: Data obtained from students respondents during field inquiry, 2019

Figure 4.17 revealed that 137 (39.2%) of parents or guardians had secondary education as the highest level of education. 88 (24.2%) had tertiary level, 60 (17.2%) had bachelors. The least represented was doctorate at 3 (0.8%), followed by masters at 19 (5.4%), non-formal at 20 (5.9%) and primary at 26 (7.3%). A total of 304 (86.8%) of the parents/guardians had secondary and above level of education. In this connection, one HoD indicated:

> From the students' background information that we have, most of their parents/guardians had various levels of education including non-

> formal, primary, secondary, tertiary, bachelors, masters and even doctorate. Those with at least secondary level are in position to guide their children/wards on careers. (Male, HoD, October, 2019)

This meant that majority of the parents/guardians had minimum level of education indicating middle or upper socio-economic status. Still on the question of students' socio-economic status, student respondents were asked to indicate the parents'/guardians' major sources of income. The findings are presented in Figure 4.18 below:

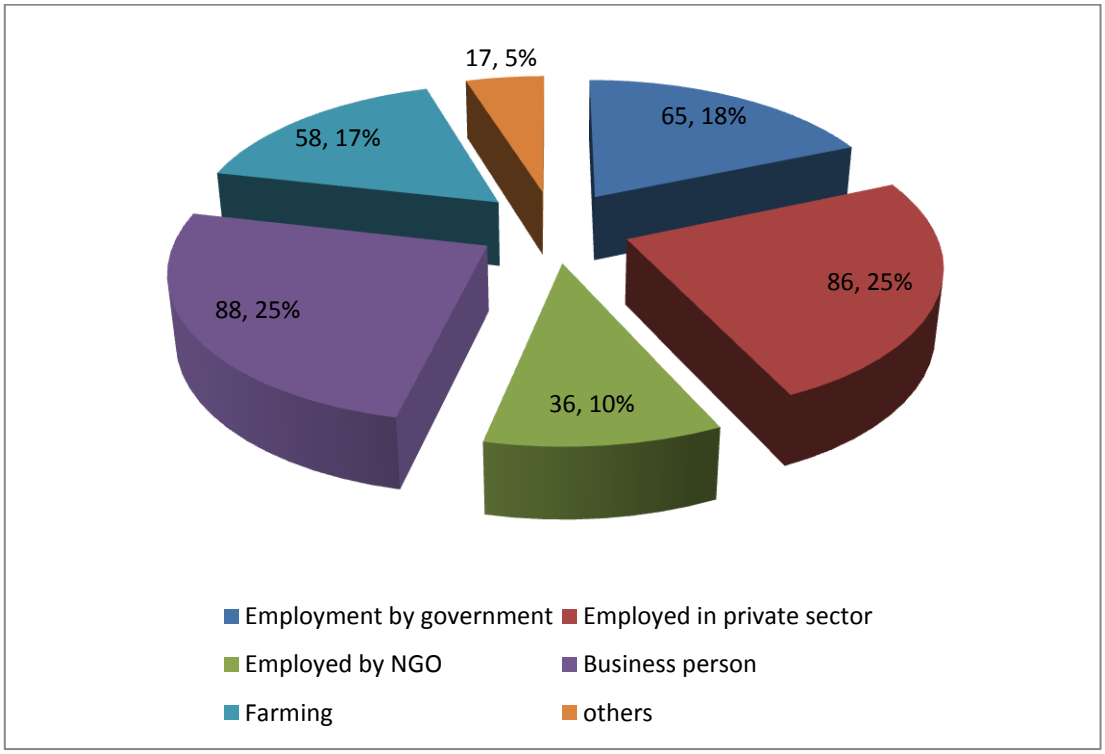


Figure 4.18: Students' responses' frequency about their parents'/guardians' major sources of income

Source: Data obtained from students' respondents' during field inquiry, 2019

Figure 4.18 showed that 25% of respondents' parents/ guardians were business people. A further 25% were employed in the private sector, 18% employed by government, 17% were farmers while 5 % indicated 'others'.

In summary, 95% of parents/guardians were in formal employment, business or farming, meaning they were in middle or upper socio-economic backgrounds.

For purposes of understanding students' socio-economic status, respondents were asked to approximate their parents/guardians monthly income in Kenya shillings. The findings are presented in Figure 4.19 below:

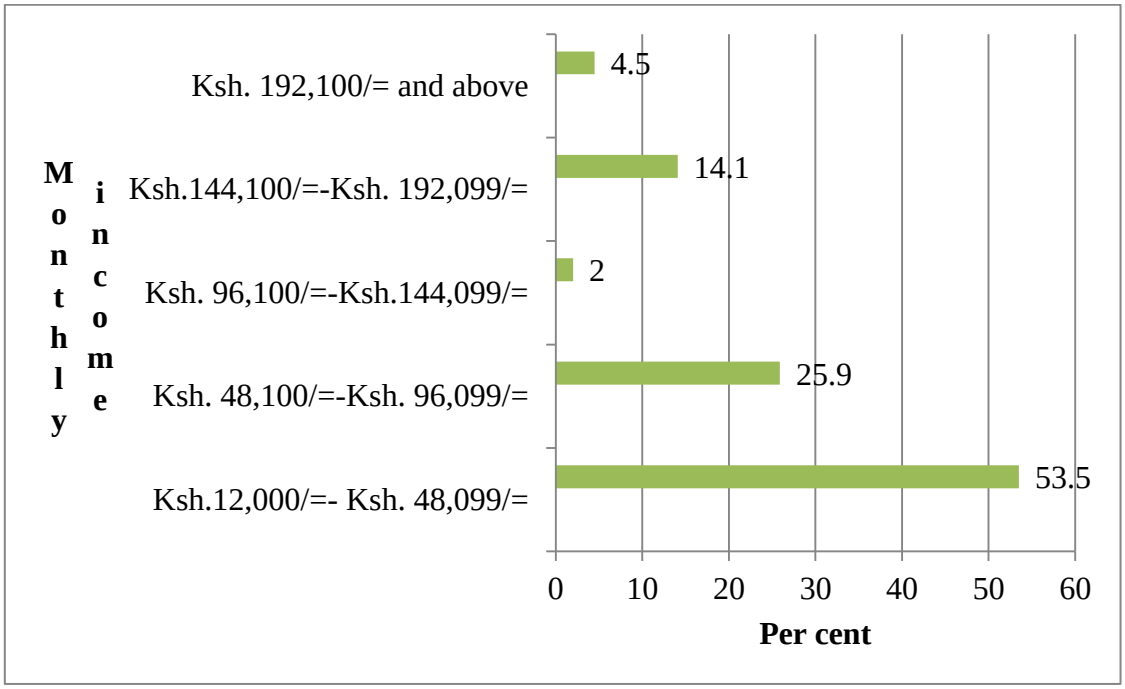


Figure 4.19: Parents'/guardians' monthly approximate income in Ksh. In 2019

Source: Data obtained from students' respondents' during field inquiry, 2019

Figure 4.19 shows that 187 (53.5%) earned a monthly income of between Ksh. 12,000/= and Ksh. 48,000/=. 91 (25.9%) earned between Ksh. 48,100/= and Ksh. 96,000/=. A further 49 (14.1%) had income of between Ksh. 144,100/= and Ksh. 192,000/=. 16(4.5%) earned above Ksh. 192,000/=. Only 7 (2.0%) earned between Ksh.96, 000/= and 144,000/=. The picture that emerged showed that all the parents/guardians had a monthly income. Also, 79.4% of the respondents' parents and guardians earned between Ksh.12000/= and Ksh. 96,000/=. Arguably, this group was able to access loan facilities and make savings to fund science and technology education. The amount was sufficient to finance children/wards, especially those who accessed education through GSP.

Overall, Science and Technology Programmes were populated by students from the middle and upper socio-economic levels in society. This meant that income was strongly correlated with participation where individual and household financing capacities were a major determinant. Coupled with declining public funding, majority of the masses from lower socio-economic strata might indeed continue being eliminated. Consequently, the government admission policies pay little attention to questions of poverty in favour of those who can already afford. In the long-run, greatest admission breach of discriminating learners based on social class are committed. These findings seem to imply that participation in science and technology is restricted to privileged few with underrepresentation of many groups like lower-income earners (Sifuna & Oanda, 2014; Mulongo, 2013).

In summary, this study established that DUC formula had reduced capitation by 22.7% at UoN, 25% at EU and 9.5 at KU, and increased by 17.6% at JKUAT, 10.8% at TUK and 2.9% at TUM (Universities Funding Board, 2019). Hence, the formula had a net effect of decreasing capitation. Qualified students missed entry into Science and Technology Programmes due to punitive and restrictive GSP admission policy while SSP mode was very flexible and targeted well-to-do in society. Overall, SSP was four times and three times more expensive than GSP in Veterinary Medicine and Engineering respectively. In Veterinary Medicine, the most expensive item, through GSP, was catering services accounting for 25% of the total cost, followed by tuition at 22%. Tuition was the most expensive item through SSP, accounting for 81%. In Engineering, catering was most expensive item at 27.2%, followed by attachment/workshops practices at 15.2%, while tuition remained the most expensive accounting for 77.2 % in the SSP.

On average, the HELB loan awarded was equivalent to 53% and 15% of Science and Technology cost through GSP and SSP per year respectively. It was further established that 69% of the students were financed by parents. On socio-economic status, 71.3% attended national schools and extra-County schools, 20.8% County, 3.7% sub-County schools. 71% enrolled through GSP, 24.2% under SSP and only 4.8% enrolled through Affirmative Action. 86.8% of the parents/guardians had secondary education and above. 95% of them were in formal employment, business or farming. All parents /guardians had a monthly income, with 79.4% earning between Ksh. 12000/= and Ksh. 96,000/=.

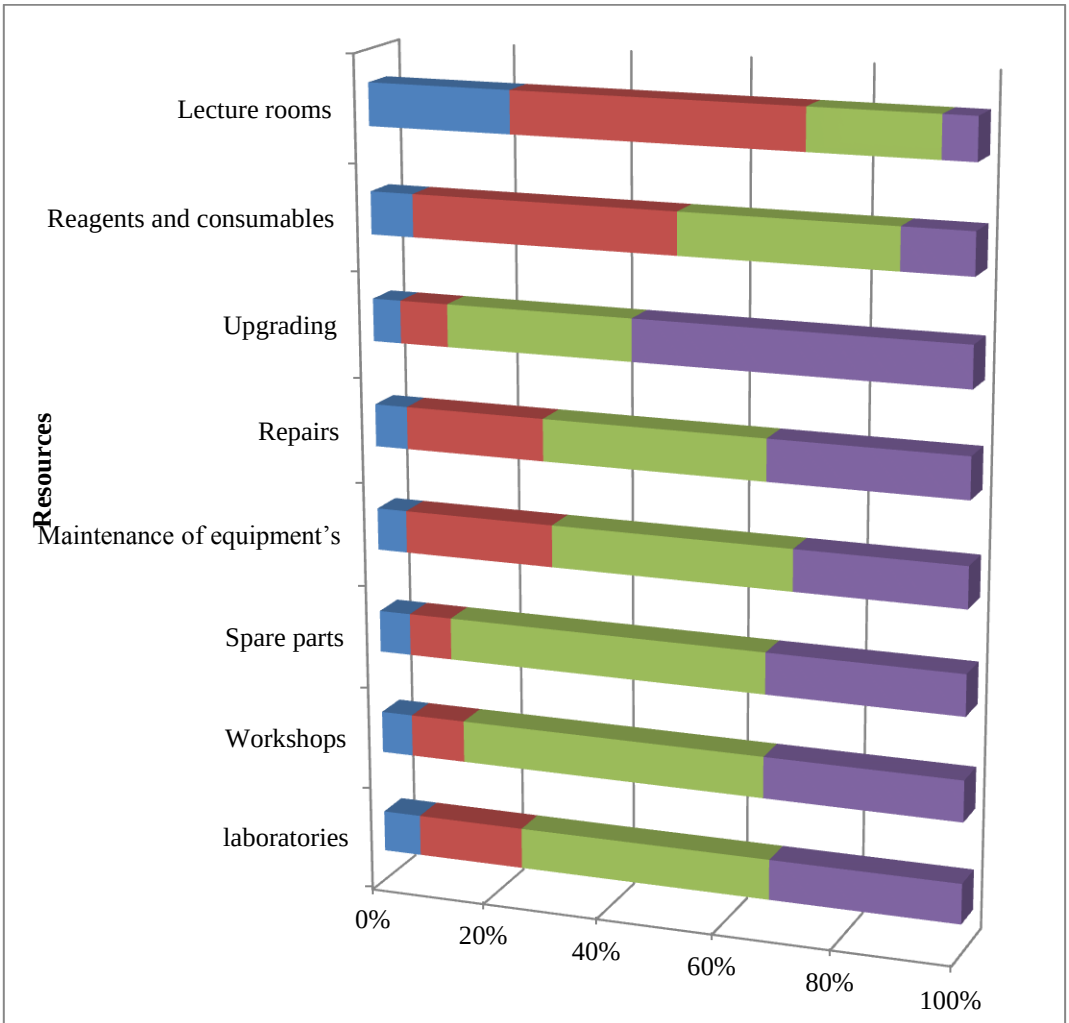
In conclusion, DUC was not working as expected especially if the trend of enrolling few students in Science and Technology Programmes persisted. The GSP admission process was too rigid that it resulted into a scenario of shunting many qualified students from enrolling. This was contrary to the government's admission policy which targeted enrolment of 50% of all students into Science and Technology Programmes. SSP, on the other hand, applied double standards by allowing those from well-to-do backgrounds who could pay market fees proceed, thus discriminating learners based on socio-economic status. Consequently, this raised the question of fairness, accountability and quality on the part of University administration. On HELB loans, the amount was rather inadequate to finance science and technology education for majority of poor students. Moreover, HELB had no relationship with the type of programme to pursue. The affirmative placement policy had not helped much since household financing capacities determined participation in Science and Technology Programmes.

4.5. Effects of infrastructure, teaching and learning resources on students' participation in Science and Technology Programmes at sampled Universities

The third objective of this study sought to establish the effect of infrastructure, teaching and learning resources on students' participation in Science and Technology Programmes. To achieve this objective, analysis on availability of physical infrastructure and human resources was undertaken. The analysis was based on the University documentary records, observation guide and in-depth analysis of specific voices of respondents.

4.5.1. Students' perceptions on the extent of availability of physical facilities

For purposes of understanding availability/adequacy of physical infrastructure resources, student respondents were asked to rate the adequacy/inadequacy of physical facilities. The findings are presented in Figure 4.20:



	laboratories	Workshops	Spare parts	Maintenance of equipment's	Repairs	Upgrading	Reagents and consumables	Lecture rooms
Very adequate %	6.5	5.4	5.4	5.1	5.6	4.8	7.3	24.2
Adequate %	18.3	9.3	7.3	25.6	23.7	8.2	44.8	48.7
Inadequate %	43.1	52.1	54.4	40.8	37.7	31.5	36.1	21.4
Very inadequate %	32.1	33.2	33	28.5	33	55.5	11.8	5.6

Figure 4.20: Students' perceptions about adequacy/inadequacy of physical infrastructure

Source: Data obtained from students' respondents' during field inquiry, 2019

Figure 4.20 above shows that 43.1 % of the respondents perceived laboratories as inadequate while 32.1 % perceived them as very inadequate. 6.5 % indicated laboratories as very adequate as 18.3 % indicated that they were adequate. This implied that 75.2% viewed laboratory resources as inadequate or very inadequate. On workshops, 52.1 % indicated that they were inadequate while 33.2% showed that they were very inadequate. 5.4 % thought that they were very adequate as 9.3% thought that they were adequate. Therefore, 85.3 % found workshops inadequate or very inadequate. With regard to spare parts, 54.4 % perceived them as inadequate as 33% indicated that they were very inadequate. But 5.4 % showed that they were very adequate as 7.3 % indicated that they were adequate. Those with the view that they were either inadequate or very inadequate constituted 87.4 %. On maintenance of equipment, 40.8 % viewed it as inadequate as 28.5% showed it was very inadequate. 5.1% found it very adequate as 25.6% perceived it as adequate. Therefore, 69.3% found maintenance of equipment as either inadequate or very inadequate.

As far as repairs were concerned, 37.7% held the view that they were inadequate while 33% held that they were very inadequate. 5.6% contended that they were very adequate as 23.7% contended that they were adequate. 70.7%, therefore, had the view that repairs were either inadequate or very inadequate. On upgrading, 55.5% indicated that it was very inadequate. A further 31.5% indicated that it was inadequate. However, only 4.8% showed it as very adequate as 8.2 % found it

adequate. Therefore, 87% found upgrading as either very inadequate or inadequate. 44.8% held the view that reagents and consumables were adequate as 7.3% contended that they were very adequate. 11.8% believed that they were very inadequate while 36.1% thought that they were inadequate. A total of 52.1 % thought that reagents and consumables were either adequate or very adequate as 47.9% thought that they were either inadequate or very inadequate. On lecture rooms, 48.7% held the view that they were adequate as 24.2% found them very adequate. 21.5% found them inadequate as 5.6% found them very inadequate. A total of 72.7% found lecture rooms either adequate or very adequate while 27.1% found them very inadequate or inadequate.

On average, 68.7% indicated inadequacy of physical facilities. The most lacking were spare parts at 87.4%, followed by upgrading at 87%, workshops at 85.3%, laboratories at 75.2%, repairs at 70.7%, maintenance at 69.3%. Lecture rooms and reagents were the only adequate resources at 72.7% and 52.1% respectively. In this connection, a student respondent wrote the following response to an open ended question in a questionnaire:

> We have inadequate reagents and chemicals, inadequate live animals and dead carcasses, no veterinary clinic that can serve the students and the community. We lack exposure in diagnosis and surgery and do not know how to even suture wounds and handle cases apart from theory. (Female, Student, October 2019)

From open-ended interviews with lecturers and HoDs, on the adequacy/inadequacy of physical facilities, the findings are depicted in Table 4.12 below:

Table 4.12: Lecturers and HoDs perceptions of the extent of availability of physical facilities

Adequacy/inadequacy of Physical Facilities	Frequency	Per cent
Inadequate reagents and consumables	28	93.3
Inadequate spare parts	27	90
Inadequate upgrading	26	86.7
Inadequate workshops	24	80
Inadequate laboratories	23	76.6
Inadequate repairs	22	73.3
Lack of maintenance of equipment	21	70
Inadequate lecture rooms/halls	19	63.3

Source: Data obtained from respondents' during field inquiry, 2019

Table 4.12 above indicates that reagents and consumables were the most inadequate at 93.3% followed by spare parts at 90%, upgrading at 86.7%, workshops 80%, and laboratories at 76.6%. Other inadequate resources were repairs at 73.3%, maintenance of equipment at 70% and lecture rooms at 63.3%. Averagely, physical infrastructure inadequacy stood at 79.2%. In this connection, one lecturer lamented:

> Our laboratories are inadequately equipped, while the workshops available lack space. Most of them have broken down machines and tools that have been left unrepaired for several years. For instance, we only have three lathe machines of which two are stalled. Materials needed for practical lessons are not supplied at all or in few cases where they are made available, they either supply at wrong time or even wrong material. It's quite despicable that we have 6th year students on campus, yet our programmes run for five academic years. They were supposed to have cleared their programmes in the last academic year, but they are still around due to lack of materials for their 5th year projects. (Male, HoD, October, 2019)

Another HoD during the interview supported the views that:

> Our laboratories are poorly equipped for conducting practicals in areas like anatomy and physiology. We have been conducting them from UoN since they have modern facilities like ultra-sound scanning machine and advanced surgery rooms. However, they suddenly increased their charges which became difficult to pay and now we have opted for Agriculture Development Corporation, Kitale and Kenya Society for the Protection and Care of Animals, Naivasha. (Female, HoD, October, 2019)

In summary, the inadequacy of infrastructure averaged 74%, painting a picture of woefully inadequate laboratories and workshops. The tools and equipment available were few, deteriorated or obsolete, leading to congestion in the laboratories and workshops. Also, the equipment lacked resemblance with the current equipment in the industry. The research concludes that the practical elements are considerably undermined due to inadequacy of physical facilities, thus throwing quality in jeopardy. These findings were similar to Gudo *et al* (2011) who had established that there was shortage of physical facilities in Public Universities. Mwebi & Simatwa (2013) found out that the quality of physical facilities were low for provision of quality education. Moreover, Gadzirayi *et al.* (2016) in Zimbabwe established that there was dearth of infrastructure to support Sciences and Mathematics, while Osei-Asibeyi (2015) in Ghana pointed out that TVET had inadequate tools, equipment and obsolete and broken down facilities.

4.5.2. Lecturers, HoDs and Academic Registrars views on Science and Technology curriculum in the sampled Universities

On the aspect of curriculum in Science and Technology Programmes, information was sort from lecturers, HoDs and Academic Registrars on how curriculum was being reviewed. All the 33 (100%) respondents indicated that the process of

curriculum design and development was left to individual Universities. In this connection, one HoD explained that:

> Faculty committees ought to systematically and comprehensively review curriculum after every complete cycle of five years based on feedback from various stakeholders including students, alumni, industry players/employers, lecturers, community, government through regulatory bodies, using trends and international standards to ensure training programmes are responsive to the needs of the society. (Male, HoD, December, 2019)

The study sought to establish whether this procedure was being followed especially coordination with industry players. The findings are presented in Figure 4.21:

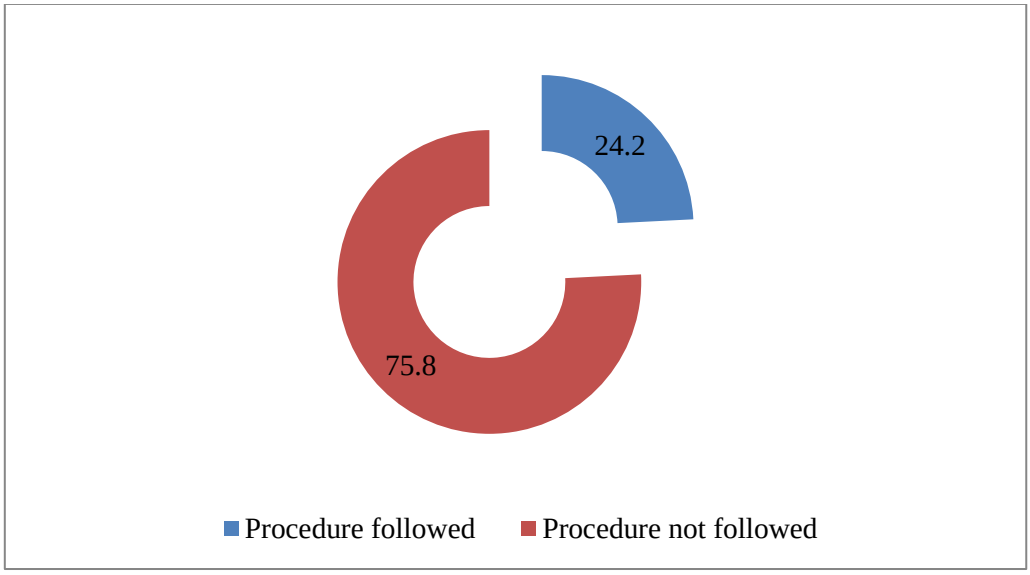


Figure 4.21: Lecturers, HoDs and Academic Registrars' frequency on whether there was coordination with industrial players in curriculum review and design

Source: Data obtained from respondents during field inquiry, 2019

Figure 4.21 above shows that 75.8% indicated that the procedure was not followed while 24.2% had the view that the procedure was followed. In this connection, one lecturer had the following to say:

> The School of Engineering needs to review its current curriculum so that it reflects and suits the needs of modern industry. There is also need to examine the possibilities of supplying some latest machinery to the School of Engineering laboratories that will help learners in skills development and capacity development. (Female, Lecturer, October 2019)

Another lecturer decried:

> We are offering surface irrigation in Kenya as if it is a new concept. The truth of the matter is that it's an old age concept in a country like Israel. The use of tractors for field operations is also old school as people have embraced greenhouse farming and the use of drones during field practices like application of fertilizers, herbicides and pesticides. This makes it difficult for our curriculum to cope up with international trends and standards. (Male, Lecturer, October, 2019)

This finding showed that majority at 75.8% was not adhering to the laid down procedures for curriculum review, implying that the curriculum was highly deficient and, in some cases, outdated and irrelevant.

4.5.3. Lecturers, HoDs and Registrars (Academic) views on University- Industry Partnerships

On the aspect of University-Industry Partnerships, information was sought from lecturers and HoDs regarding the extent to which Universities were collaborating with industries. All 33 respondents (100%) revealed that all Universities were attempting to link with industries through industrial attachments. In that regard, one HoD confirmed:

> All engineering students proceed for industrial attachment in 2nd, 3rd, and 4th years of study for 8weeks each as stipulated in curriculum. The first attachment in the second year is internal while those in the third and fourth years undertake attachments externally in industries. (Male, HoD, September, 2019)

Another HoD explained that:

> Students from 1st year to 4th year always proceed for a two month field attachment. Further, they are required to undertake a successful one year internship programme after fifth year under supervision of a registered Veterinary Surgeon and pass pre-registration examination organized by the Kenya Veterinary Board. (Female, HoD, September, 2019)

One HoD stated:

> We have mooted various partnerships with industry players with the aim of delivering hands-on industrial skills, linked to market demands to our students. For example, we have partnered with Safaricom Ltd where students receive hands-on training at the facilities of the company and they undergo 12 weeks of external industry based learning. (Male, HoD, September, 2019)

The findings revealed that all sampled Universities attempted to link with industries through industrial attachments. This finding was similar to Rujibussalim (2017) in Indonesia who established that Industry Based Learning Programme promotes STEM education.

The study sought to establish the ease of securing industrial attachment. The findings are shown in Figure 4.22:

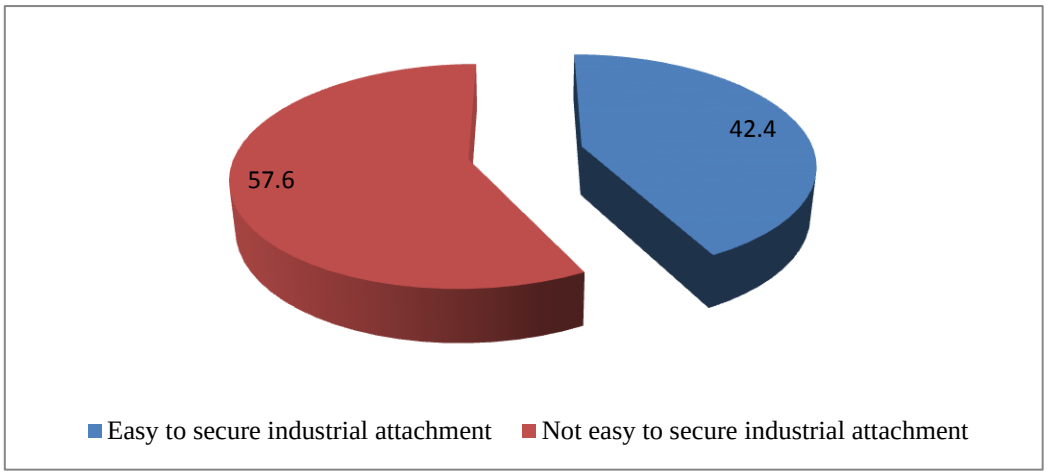


Figure 4.22: Lecturers, HoDs and Academic Registrars' responses' frequency on whether securing industrial attachment is easy or not

Source: Data obtained from respondents during field inquiry, 2019

Figure 4.22 above shows that 42.4% of the respondents held views that securing industrial attachment was easy. But 57.6% thought that it wasn't.

In this connection, one lecturer explained:

> It's not easy to find attachment places for students because of limited vacancies. Admittedly, they want to undertake their attachments in certain industries with the hope of securing employment in the same industry after graduating hence the attachment period is also rightfully used for networking and given that many institutions are sending learners for attachment in the same industries limits the vacancies. In most cases, it takes the lecturer's personal initiative to get them places for attachment. (Male, Lecturer, October, 2019)

Another lecturer lamented:

> Kenya has a huge shortage of engineers yet the country aspires to attain Vision 2030. What is funny is that our engineering graduates are jobless amidst shortage of engineers and yet the industry tells us that they want engineers. Although Engineering programmes remain popular among students, they are bound to discover that there is no reason to pursue them when they cannot get jobs in the industry. If we don't do something, to avert the current trend of theoretical training of engineers, it's just a matter of time and we shall start losing engineering students to religion and history because they won't find value in our programmes. The solution is with academia-industry linkage and partnerships. (Male, Lecturer, October, 2019)

This research established that 57.6% of students did not easily secure attachment opportunities in industries they wished to proceed to. Also, the attachment duration varied from one University to another where some institutions proceeded for 8 weeks per year while others went for 12 weeks. The picture that emerged was that most Universities grounded their students mostly in theory with limited exposure to

practical industrial training. These findings corroborated with the study by Valeta *et al.* (2016) in Malawi which found out that the curriculum at Lilongwe University of Agriculture and Natural Resources (LUANAR) was largely theoretical and lacking industrial orientation. The industrial attachments were only done once in third year of study and for only 4 weeks, as opposed to 8 weeks stipulated in the curriculum, due to monetary limitations associated with attachments.

4.5.4. Students, Lecturers and HoDs views on field/ industrial visits

The study sought for students', lecturers', and HoDs' views on industrial visits. All lecturers and HoDs 33 (100%) concurred that field trips were supposed to be incorporated into the curriculum. In this connection, one HoD explained:

> Our programmes lay a heavy emphasis on the practical application of theoretical knowledge achieved through extensive industrial visits. We normally visit industries like Kibos Sugar and Allied Industries Limited Companies which have the advantage of single stop learning in a number of areas as it operates other subsidiary companies within the same area. (Male, HoD, September, 2019)

Another HoD stated:

> We have established partnerships with KQ and Safaricom Ltd and other stakeholders in the field of Aerospace and Aviation and our Engineering students have been receiving hands-on training at the facilities through academic group visits. (Male, HoD, September, 2019)

Student respondents were asked to indicate what was lacking in their respective schools/faculties and 305(87%) revealed few or total lack of field trips. In this connection, a student respondent wrote the following to an open ended question in a questionnaire:

> We need our own faculty bus in order for us to undertake academic trips because this University has few buses that cannot serve the entire University. Some University buses were auctioned for non-payment of debts. (Male, student, October, 2019)

The views of lecturers and HoDs regarding the adequacy/inadequacy of field/industrial visits were registered and the findings are presented in Figure 4.23:

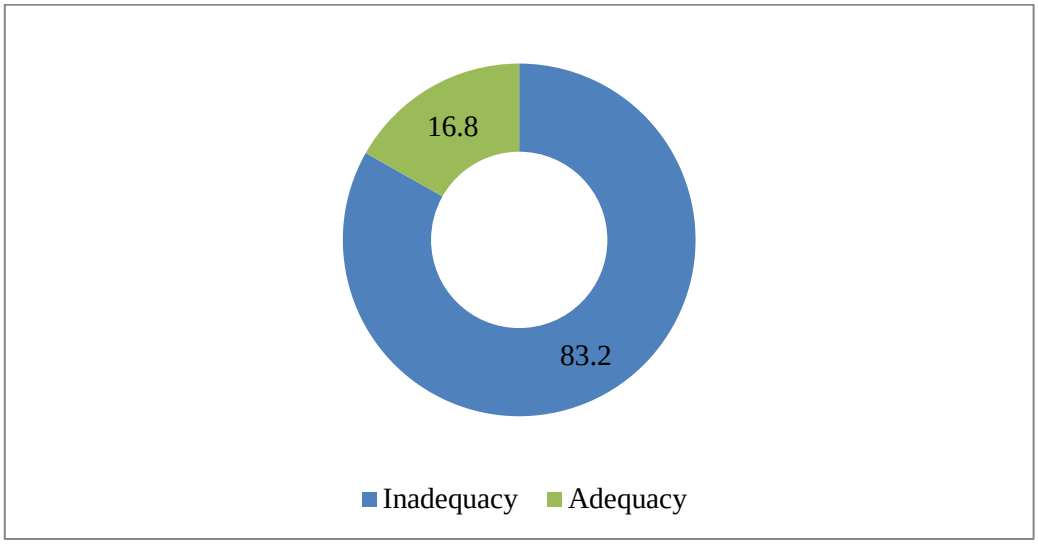


Figure 4.23: Lecturers' and HoDs' views on the adequacy/inadequacy of field/industrial visits

Source: Data obtained from students' respondents during field inquiry, 2019

Figure 4.23 above shows that majority at 83.2% held the view that field/industrial visits were inadequate while 16.8% thought that they were adequate.

In that regard, a lecturer during an open ended interview indicated:

> We no longer go for field trips because of lack of funds. For instance, I had lined up two academic trips in the last semester but none of them materialized. We completed the semester, administered examinations, marked and graded students minus field trip component. (Male, Lecturer, October, 2019)

100% of the respondents concurred that Universities were making some effort to incorporate field/industrial visits in the curriculum. Nevertheless, 87% of student respondents and 83.2% of lecturers, HoDs making the average of 85.1% indicated inadequacy of such trips. The research concluded that Universities were not achieving the practical application of theoretical knowledge through field visits as emphasized in the curriculum and consequently cast doubt on the quality being offered in these programmes. Similarly, Sam-Amoah *et al* (2016) and Atuahene & Owusu-Ansah (2015) in Ghana found out that there were limited field trips due to funding constraints which largely compromised quality.

4.5.5. Lecturers and HoDs views on the mode of delivery

As regards the mode of delivery, information was sought from lecturers and HoDs on the teaching method commonly used. Majority of the respondents indicated the use of dictation and writing notes on boards or giving out handouts. In that regard one HoD opined that:

> In some cases, it's difficult to undertake practicals and demonstrations due to limited laboratory facilities and little resources such as laboratory supplies or spaces. Even digital platform is difficult due to limited capacity and short of equipment in this digital platform. (Male, HoD, September, 2019)

One lecturer lamented:

> The main method of teaching is "face to face lectures" in which lecturers dictate notes and write them on board at the same time especially equations and technical terms and this method is quite tiring and boring. The students equally study from hand-outs that are given by the lecturers as soft copies or hard copies. (Female, Lecturer, October, 2019)

In summary, the common teaching method was dictating notes and reading from handouts with very few discussions, practicals and demonstrations, tutorials and seminar work. In other words, transmission pedagogy dominated lecture halls, making learning to be largely passive with too much theory, few practicals, less practice and, subsequently, raising the question of quality.

4.5.6. Lecturers and HoDs opinions on students' assessment at the sampled Universities

As regards students' assessment, information obtained from opened-ended interviews for lecturers' and HoDs indicated that all 30(100%) respondents followed University examinations procedures on this as stipulated in the Statutes of the University.

In view of these, one lecturer had the following:

> In Engineering Programmes, Unit assessment constitutes 30% Continuous Assessment Test and 70% final end of semester examinations. The CAT constitutes 10% practical work while 20% is sit-in theory examinations while end of semester examinations are theory examinations. (Male, Lecturer, October, 2019)

Another lecturer explained:

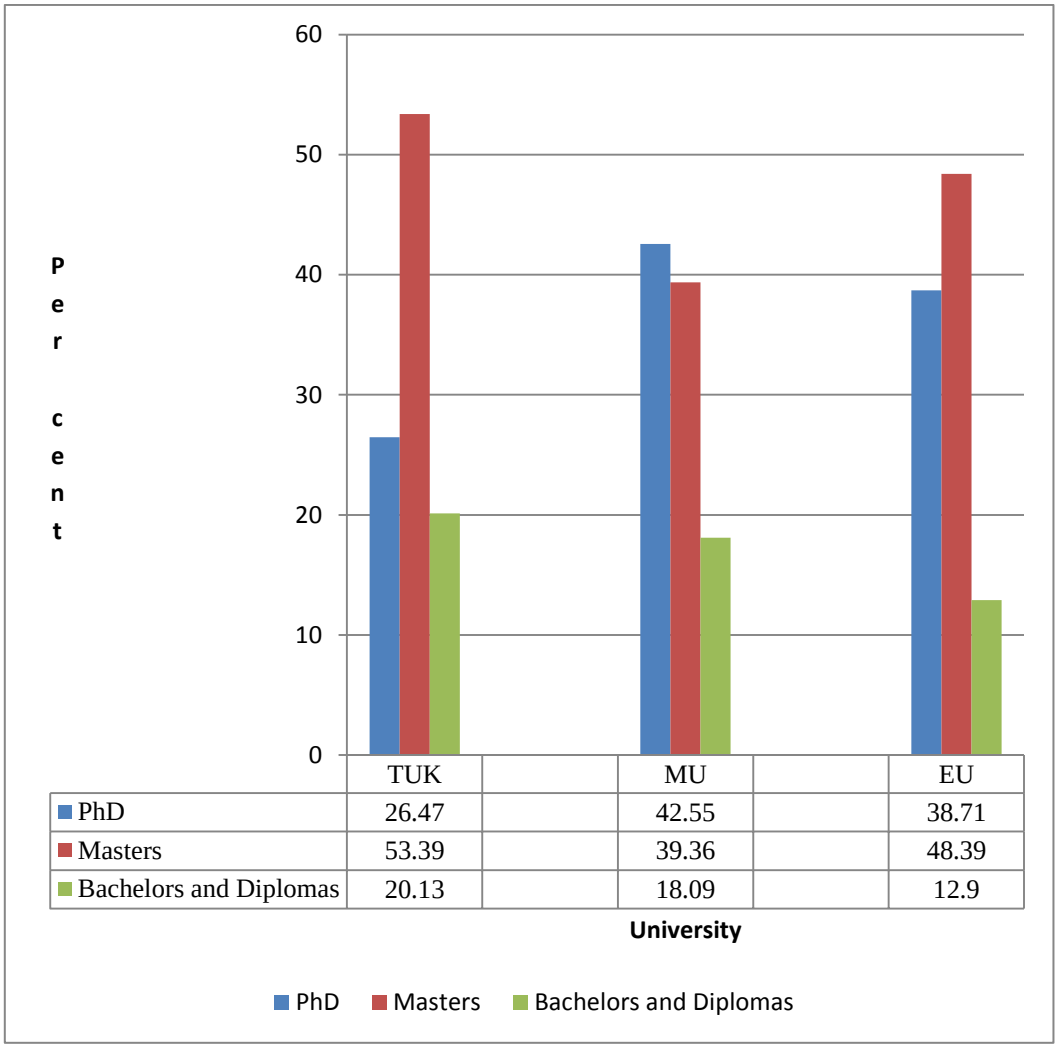
> For Bachelor of Veterinary Medicine, the CATs constitute 30%, final end of semester examinations 60% while oral examination constitutes 10%. An oral examination entails each student appearing before a panel of three lecturers and responding to oral random questions. (Female, Lecturer, October, 2019)

In summary, out of the total 100% total marks, practical examinations ranges between 10% and 30% while theory ranges between 70% to 90%. This meant that the whole assessment is largely theoretical, which is contrary to the need for programmes in science and technology to be hands- on. These findings echoed those

by Valeta *et al* (2016) in Malawi who documented that practical and laboratory sessions only contributed 10% to 30% of the overall assessment.

4.5.7. Distribution of academic staff by qualification in Science and Technology Programmes at the sampled Universities

Regarding objective three of the study, secondary data on the distribution of academic staff by qualification in Science and Technology Programmes were analyzed. The findings are presented in Figure 4.24:



	TUK		MU		EU
PhD	26.47		42.55		38.71
Masters	53.39		39.36		48.39
Bachelors and Diplomas	20.13		18.09		12.9

Figure 4.24: Distribution of academic staff by qualifications in the School/Faculty of Engineering at Sampled Universities

Source: Researchers' compilation from official human resource records in sampled Universities

Figure 4.24 above shows the distribution of academic staff by qualification in the School/Faculty of Engineering at the sampled Universities. At TUK, 53.39% had Masters' qualifications, followed distantly by PhD at 26.47%. Bachelors and Diplomas were the least represented at 20.13%. Masters and Bachelors combined, therefore, constituted the bulk of the teaching staff at 73.52%. At Moi University, 42.55% had PhDs, followed by Masters' at 39.3% and Bachelors at 18.09%. Therefore, Masters and Bachelors, combined, constituted the majority at 57.45%. For Egerton University, 48.39% had Masters, followed by PhDs at 38.7% and Bachelors at 12.9%. Masters and Bachelors, combined, constituted the bulk at 61.29%, meaning that only 38.71% had PhD qualifications in the entire Faculty.

The distribution of academic staff by qualifications in the Faculty of Veterinary Medicine of Egerton University was analyzed. The findings are presented in Figure 4.25 below:

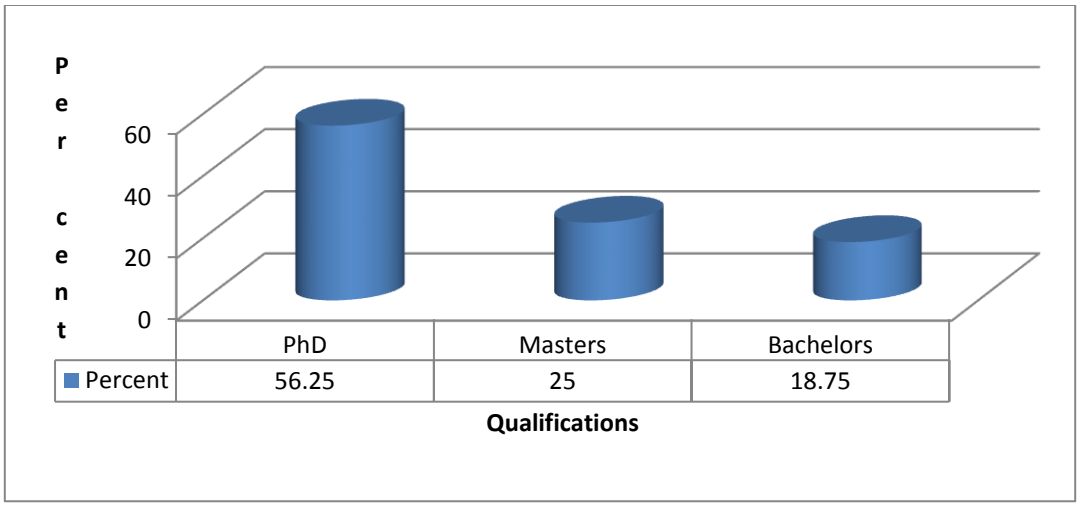


Figure 4.25: Egerton University distribution of academic staff by qualifications in the Faculty of Veterinary Medicine

Source: Researchers' compilation from Egerton University official human resource records

Figure 4.25 above shows that the highest number of teaching staff had PhD qualifications at 56.25%, followed by Masters at 25% while Bachelors were the least represented at 18.75%. Masters and Bachelors qualifications holders, combined, therefore, constituted 43.75% of the teaching staff. In summary, 64.2% had Masters and Bachelors qualifications in Engineering Programmes. However, Veterinary Medicine had 56.25% with PhDs, 43.75% with Masters and Bachelors. This meant that only 35.8% in Engineering had PhD qualifications hence a dire shortage of staff with PhD qualifications contrary to CUE PhD teaching regulations. These findings were reinforced by one lecturer who lamented that:

> We have insufficient and ill prepared staff in general. We are largely affected in areas that call for specialization. The University has no strategy to replace qualified staffs who exit service through natural attrition. Once a qualified staff exits, they just pick somebody enrolled for Masters and assign him or her teaching responsibility

> without even basic orientation in teaching. (Female, Lecturer, September, 2019)

One HoD pointed out that:

> We are yet to reach an ideal state as concerns staffing. Many members of the teaching staff are registered for Masters since those with PhDs are very marketable and easily find lucrative jobs elsewhere hence attracting, recruiting and retaining them is very difficult. In 2016, we advertised vacancies for teaching jobs but there were no applicants partly because PhD holders in our area want to work in Nairobi City where they can equally do consultancy work. (Male, Lecturer, September, 2019)

Another HoD argued:

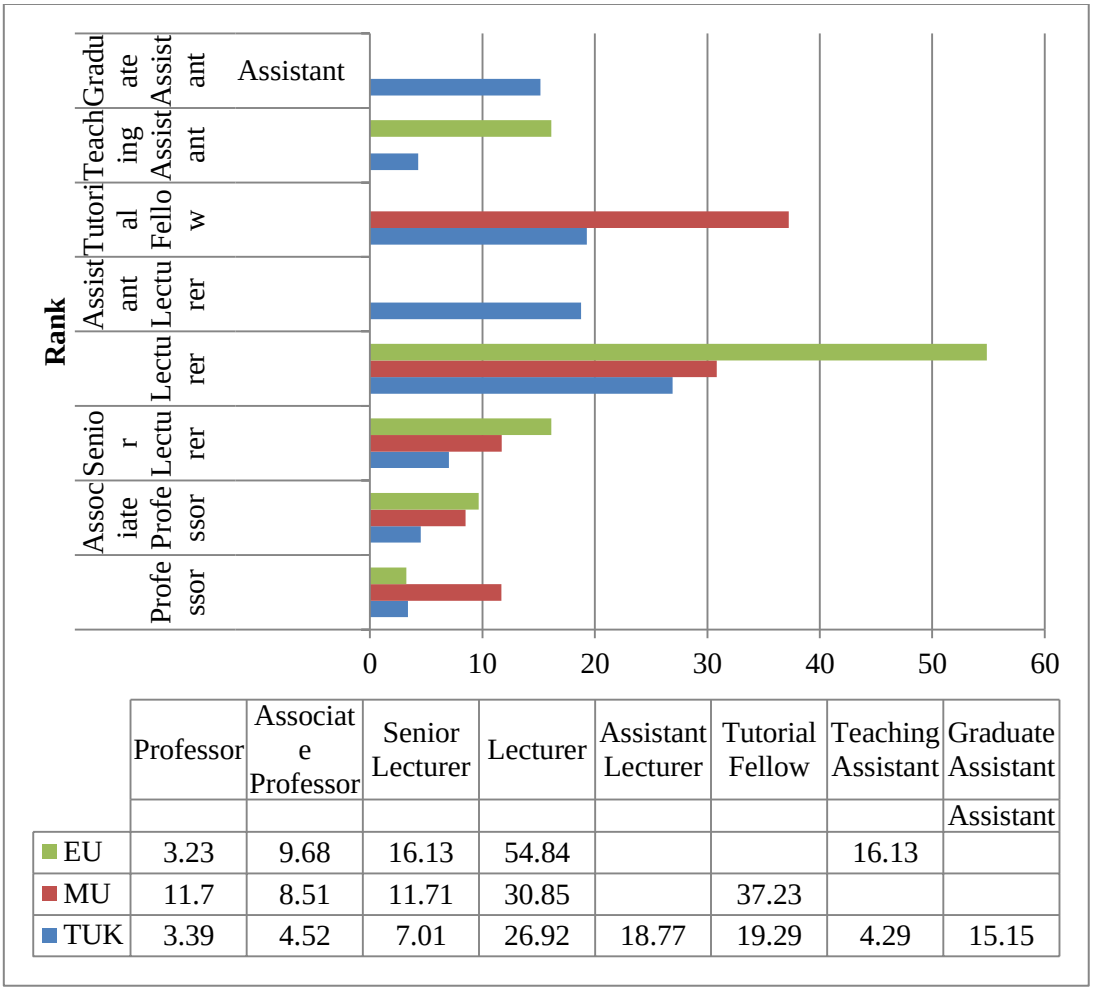
> We have only three members of staff with PhD qualifications in our Department. I know of my two colleagues, one who went to UK while another to South Africa eight years ago for their PhD programmes but since then they have overstayed until their salaries have been stopped. I doubt if they are still pursuing their PhDs and if they will ever come. We have also embraced recruiting staff on contract and this makes exit very easy since you cannot force one to renew a contract. Our Staff Development Programme is not working either. Recently, we recruited our First Class Honours student as a Graduate Assistant with a starting salary of about Ksh. 87,000/= but even before settling, he got a job at Olkaria Geothermal Company earning close to Ksh. 400,000/= per month. I'm very sure that you will leave even if it were you. (Male, HoD, September, 2019)

These sentiments paint a picture of insufficient number of qualified candidates to fill teaching vacancies, a scenario attributed to loss of many highly qualified staff to other sectors of the economy due to unattractiveness of academic career since conditions of service in Universities fall behind those in other sectors of the economy. Moreover, opportunities outside the country beckon some of the brightest minds with PhD qualifications. The situation is further compounded by low incentives. Hence, it's not easy to attract competent staff from abroad. In conclusion, significant proportion of teaching staff do not have the minimum academic

qualification of PhD and, therefore, those with Master's degrees forms the bulk of the teaching staff, contrary to Commission for University Education (CUE) PhD requirement for teaching (Commission for University Education, 2016). These observations corresponded to Thomas (2014) on academic staff views of higher education quality in Somaliland which revealed that, most institutions employed significant number of Professors with only a Bachelor's qualification as those with Master's degree or higher were few.

4.5.8. Distribution of teaching staff by rank in Science and Technology Programmes

The research sought to analyze the distribution of teaching staff by rank in the Faculty/School of Engineering in the sampled Universities. The findings are presented in Figure 4.26 below:



	Professor	Associate Professor	Senior Lecturer	Lecturer	Assistant Lecturer	Tutorial Fellow	Teaching Assistant	Graduate Assistant
								Assistant
EU	3.23	9.68	16.13	54.84			16.13	
MU	11.7	8.51	11.71	30.85		37.23		
TUK	3.39	4.52	7.01	26.92	18.77	19.29	4.29	15.15

Figure 4.26: Distribution of teaching staff by rank in Faculty/School of Engineering in the sampled Universities.

Source: Researchers' compilation from official human resource records in sampled Universities

Figure 4.26 above shows that at TUK, 26.92% were in the rank of Lecturer, 19.23%, Tutorial Fellows, 18.77% Assistant Lecturers and 15.15% Graduate Assistants. The least represented cadre was Professor at 3.39 %, followed by Teaching Assistant at 4.29%, Associate Professor 4.52% and Senior Lecturers at 7.01%. Those in the rank of Assistant Lecturer and below, combined, constituted the majority at 58.11% of the teaching staff. At Moi University, the bulk of teaching staff were in the rank of

Tutorial Fellow at 37.23%, followed by Lecturers at 30.85%, and Professors tallied with Senior Lecturers at 11.7% each. The least represented cadre was Associate Professors at 8.51%. Therefore, senior staff in the rank of Professor, Associate Professor and Senior Lecturer, combined, constituted only 31.9% of the academic staff. At Egerton University, majority of teaching staff were in the rank of Lecturer at 54.84%, followed by Senior Lecturer and Teaching Assistant tallying at 16.13%, and Associate Professor at 9.68%. The least represented cadre was Professor at 3.23%. Hence, only 29.04% of the academic staff was in the rank of Professor, Associate Professors and Senior Lecturers.

In connection to distribution of the teaching staff by rank, one lecturer commented:

> Surely, I'm a Teaching Assistant with Lecturers' load. You can imagine how difficult it can be to do my research. At the same time, I have remained a Graduate Assistant since attaining my Master's degree yet I expected to be promoted to the position of Assistant Lecturer. (Male, Lecturer, November, 2019)

One HoD explained that:

> This situation is further amplified by the fact that the staff who are supposed to be academic leaders in the rank of Senior Lecturers, Associate Professors and Professors quite often look for more lucrative opportunities in University administration, business world, research institutions and consultancy, eventually making the junior staff members take the burden of teaching in an environment lacking mentorship. (Male, HoD, September, 2019)

In summary, only 25.28% were in the rank of Professor, Associate Professor and Senior Lecturer. This meant that 74.72% were in the rank of Lecturer and below, implying that more teaching workload was passed to junior staff. This was a cause for worry as it meant that there were very few academic leaders to mentor scholars in

the sector. Consequently, the anxiety that came with such a burden in a context demanding high standards of research productivity, eventually discouraged potential academicians. Furthermore, the question of accountability on promotions criteria was evident. This, certainly, demotivated trained staff and negatively impacted on quality. These findings corresponded to observations by Matovu (2018) in Uganda which established that Higher Education Institutions (HEIs) had less academic staff and those highly qualified (Professors and Associate Professors) moved to other parts of the world for greener pictures.

4.5.9. The ratio of academic staff to students in Science and Technology Programmes

Based on the Commission for University Education, the recommended lecturer-student ratio should be 1: 20 for practical-based courses (Commission for University Education, 2016). An attempt was made to analyze the lecturer student ratio in Engineering and Veterinary Medicine Programmes from University records. The results are presented in Table 4.13:

Table 4.13: Academic staff to student ratios in Engineering and Veterinary Medicine Programmes at Sampled Universities

University	Faculty/School	Number of teaching staff	Number of students enrolled	Ratio
TUK	Engineering	236	4756	1:20
MU	Engineering	86	741	1:9
EU	Engineering	31	769	1:25
	Veterinary	16	473	1:30
Total		**369**	**6739**	**1:18**

Source: Researchers' compilation from sampled Universities official human resource and admission records

The results in Table 4.13 above revealed that MU had academic staff to student ratio of 1:9 and TUK 1: 20 in the Faculty of Engineering. EU had a ratio of 1:25 and 1:36 in the Faculty of Engineering and Faculty of Veterinary Medicine respectively. Overall, the ratio was 1:18 indicating that the academic staff to student ratio was sufficient to meet recognized standards by CUE. Arguably, these impressive ratios might not be sustainable in the long run, especially if remedial measures targeting training, recruitment and retention of staff shall not be initiated. Nevertheless, these findings contrast sharply with those by Ntim (2016), in Ghanaian higher education, which observed that in Public Universities, the ratio of academic population to student population was six times more than the required internationally accepted student-to teacher ratio.

In summary, the overall inadequacy of physical facilities was 74%. The most inadequate components were 88.7% spare parts, 86.6% upgrading, 82.6% workshops, 75.9% laboratories, 70.6% reagents and consumables, 72% repairs and 69.6% maintenance. Only lecture rooms were found adequate at 54.7%. 75.6% of the Curriculum Review and Design procedure had not been followed. 57.6% found that securing industrial attachment was difficult as 85.1% of industrial visits were lacking. In addition, the common teaching method was dictation and reading from handouts, while practicals and demonstrations, discussions, tutorials and seminar work were quite minimal. Assessment was largely theoretical, with practical and

laboratory sessions contributing only 10% to 30% of the total assessment, while theory ranged between 70% and 90%. With regard to academic staff qualifications, 41% had PhDs, 59% had Masters, Bachelors or Diplomas. With respect to academic staff by rank, 6.1% were Professors, 7.5% Associate Professors and 11.6% Senior Lecturers. The lecturer-student ratio was 1:18.

In summary, Universities were experiencing acute shortage of facilities to the extent that they had not reached the minimum acceptable level. Consequently, practical elements in curricula were extremely undermined. The curriculum was found to be highly deficient, outdated and irrelevant as there was little coordination between its designs and industries. Hence, students were majorly grounded in theory at the expense of practical industrial training. Moreover, transmission pedagogy dominated lecture halls, making learning largely passive. Furthermore, there was non-compliance with the CUE requirement for University academic staff to have PhD qualifications. Shortage of senior academic staff was evident, raising the question of quality in Science and Technology Programmes. Nonetheless, the lecturer-student ratio was sufficient to meet recognized CUE standards.

4.6. Institutional based interventions that could increase students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya.

The fourth objective of this study sought to establish the institutional based interventions that could increase students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in Kenya. To achieve this objective, analysis of government measures and University-based interventions were

carried out. These were based on in-depth analysis of specific voices from open-ended interviews with lecturers, HoDs and Registrars (Academic).

4.6.1 Inter- governmental cooperation, linkages and agreements in Sampled Universities

Information was sought from lecturers, HoDs and Academic Registrars on whether inter-governmental cooperations were part of government interventions employed to enhance participation. 100% (33) of the respondents indicated that the government had made efforts through inter-governmental cooperation, linkages and agreements. In this connection, one Registrar (Academic) had the following sentiments during the interview:

> A memorandum of understanding on scientific and technological development was signed between Kenya and China in 2013, where China was to fund science and technology projects in local Universities at a cost of Ksh. 2.7Billion. Technical University of Kenya benefited from this cooperation through installation of state-of-the-art engineering equipment in laboratories, studios and workshops dubbed as Kenya-China Friendship Technology Training Centre (KCFTTC). (Male, Academic Registrar, November, 2019)

Another Academic Registrar had this to say:

> The cooperation between China and Kenya resulted in Nanjing Agricultural University and Egerton University working together on promoting agricultural and higher education exchanges. This cooperation has led to the establishment of crop molecular biology laboratory with the most advanced equipment worth 70 million Kenya shillings and is currently serving as a Centre for Agricultural Technology Transfer in Kenya. Further, China offered 60 doctorate and 40 master scholarships to Kenyan students with the opportunities to study doctoral and masters courses at top Chinese Universities. (Female, Academic Registrar, November, 2019)

Another Academic Registrar pointed out that:

> EXIME Bank of India and Kenya signed a bilateral trade agreement in 2016 where EXIME Bank disbursed a concessional loan worth USD 29.95 Million to revive the Rivatex East Africa Limited (REAL) which is owned by Moi University. (Male, Academic Registrar, October, 2019)

All the sentiments above indicated the existence of inter- governmental cooperations, linkages and agreements which were geared towards improving infrastructure, teaching and learning resources. These findings correspond to those by Oanda & Sall (2016) which established that World Bank, European Agency for Space Sciences for Technology, and other development partners, had pledged for seed funding to kick-start Science and Technology Programmes in Pan African University (PAU). Also, Kaing (2016) revealed that with financial assistance from US Department of State, Cambodia had established the Golden West Design Lab.

This study further sought opinions of lecturers, HoDs and Academic Registrar's on whether the inter-governmental cooperations were enhancing participation. The findings are depicted in Figure 4.27 below:

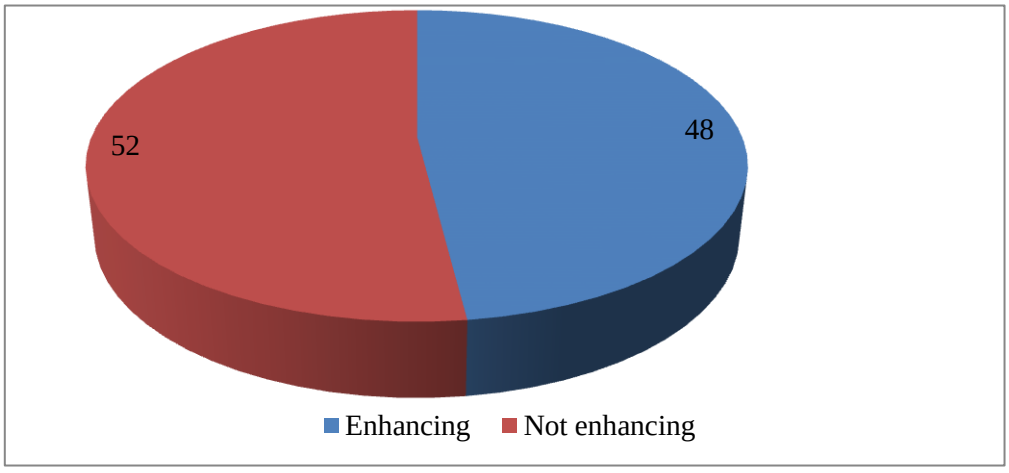


Figure 4.27: Lecturers, HoDs and Academic Registrars' views on whether inter-governmental cooperations was enhancing participation

Source: Data obtained from respondents' during field inquiry, 2019

Figure 4.27 above shows that 52% held the view that intergovernmental cooperations were not enhancing participation while 48% contended that they were. In that regard, one lecturer opined:

> I even doubt the possibility that beneficiaries of scholarships will come back to Kenya and undertake teaching jobs to boost the academic staff numbers due to poor teaching environment in Kenya. (Male, Lecturer, October, 2019)

Majority of the respondents at 52% were skeptical about the possibility that inter-governmental agreements had actually led to any improvement in infrastructure in a manner that would enhance students' participation in Science and Technology Programmes. In summary, all Universities revealed the existence of inter-governmental cooperations as one of the intervention measures being undertaken. Nonetheless, the success of such venture to increasing participation was in doubt since the participation trends remained low.

4.6.2. University-based interventions at sampled Universities

The study sought to establish the University-based interventions based on specific voices from lecturers, HoDs and Academic Registrars. 100% (33) of the respondents indicated that Universities had initiated University-secondary schools linkages, Income Generating Activities (IGAs) and relying on philanthropic gestures. As regards University-secondary schools linkages, one Registrar (Academic) said:

> In 2012 and 2013, Technical University of Kenya selected six needy secondary schools from different Counties that neighbour Nairobi

> County for outreach programmes where a presentation on demystifying science was delivered to learners and the courses and careers they could pursue once they study science subjects. (Male, Academic Registrar, November, 2019)

Another Registrar (Academic) indicated:

> Moi University-owned Rivatex East Africa Limited offers scholarships for bright needy students in high schools with the intention of nurturing their talent and who may not get the opportunity to further their education due to financial limitation they face. Additionally, it has been making donations to schools in organized events where career talks focusing on Science, Technology, Engineering and Mathematics are delivered to learners. (Male, Academic Registrar, November, 2019)

Another Registrar (Academic) pointed out:

> Egerton University Directorate of International Linkages and Career Services works on a schedule which includes visiting of secondary schools with the aim of mentoring learners and marketing of academic programmes to high school students. A recent visit by career office was in September 2019 to St. Ann's Kisoko Girls in Busia County. (Female, Academic Registrar, October, 2019)

This study sought to establish to what extent University-secondary linkages were enhancing participation. Majority of the respondents felt that it was not. In this connection, one HoD argued during the open-ended interview that:

> There is no justification for such linkages since our capacity is already overwhelmed with the number of qualified applicants we receive every year. We cannot admit more because of infrastructure, teaching and learning resources limitations. I consider marketing these programmes to secondary school students as giving them false hope because when they qualify as they normally do, we again fail to admit them. (Male, HoD, November 2019)

In summary, 100% of Universities had linkages with secondary schools in order to enhance participation. However, majority of respondents were skeptical about them.

The sentiment above alluded to the fact that many candidates failed to enroll into Science and Technology Programmes due to lack of capacity on the side of the Universities and not lack of qualifications on the side of the candidates. Therefore, career talks, mentorship or marketing science programmes among secondary school students may not necessarily enhance participation. Nevertheless, the study by Dube (2018) on STEM initiatives in Zimbabwean education system corresponds to the current findings in that Universities were attempting to link with secondary schools with a view of motivating students to do well in Science and Technology Programmes.

4.6.3. Income Generating Activities (IGAs) at the sampled Universities

The study endeavoured to establish whether the Universities engaged in IGAs with the aim of augmenting the meagre financial base to enhance students' participation in Science and Technology Programmes. Data was collected from lecturers, HoDs and Academic Registrars. The findings show that 100% (33) of the respondents concurred that Universities engaged in IGAs. In this regard, one HoD pointed out:

> We have established the Centre for Engineering Innovation and Production (CEIP) for both initial training and proficiency enhancement in various specific skills areas in Mechanical Engineering, Production and Manufacturing. A total of 20 short term professional courses are offered, charging fee ranging from Ksh. 12,000/= to Ksh.54, 000/=. We also signed a 10 Million spare parts export contract with Avic International Holding Corporation of China, making our University to be the first institution of higher learning to manufacture and export heavy machinery equipment. (Male, HoD, November, 2019)

Another HoD explained:

> Moi University owns Rivatex East Africa Limited (REAL) which is a vertically integrated textile factory that converts cotton lint through various processes to finished fabrics. The factory sells textile products to the government by supplying uniforms for the disciplined forces. It also sells to independent retailers, schools, Universities and exports others. Further, we have established the African Centre of Excellence in Photochemical, Textile and Renewable Energy (ACE II- PTRE). Through the Centre, we organize 5 days' training courses for professionals. A course fee of Ksh. 160,000/= is charged. (Male, HoD, November, 2019)

One HoD pointed out:

> Egerton University has established a Centre of Excellence in Sustainable Agriculture and Agribusiness Management (CESAAM). The Centre has adopted a model of relying on internally established capacities in terms of infrastructure, teaching and learning resources. The Centre targets to enhance students' enrolment that will generate revenue from fees collected from innovative and demand-driven programmes and short courses, engaging in consultancies, commercialization of innovations, and development of fundable proposals which attract grants and utilizing of Agricultural Centres to offer extension services that attract paying actors and customized farm support services at a modest fee. (Female, HoD, October, 2019)

Another lecturer explained:

> Egerton University has established Tatton Agriculture Park (TAP) which generates income through sale of milk, animals, breeding stock and crops. Equally, it raises income through paid visits by students from all levels, thus primary schools through secondary schools, colleges and Universities; consultancy services to farmers and fees raised through short courses training organized by the Centre of Excellence in Livestock, Innovation and Business (CoELIB) housed in the park. The short courses attract a fee of Ksh. 27,500/= per participant. (Male, Lecturer, October, 2019)

One Academic Registrar indicated:

> Moi University has established a digital assembly plant where a wide range of products like laptops, Personal Computers (PCs), tablets, desktops, phones, servers, and mobile phones, TVs, digital meters and other IT related components are assembled. The plant has undertaken government projects like: Digital Literacy Programme, 2019 Kenya Population and Housing Census, and Constituency Innovation Hub. It has also showcased new products portfolio like desktops, Notebooks and All-in-One .The selling prices of these products varies from the

> cheapest starting price of Ksh. 50,000/= to the most expensive start selling price of Ksh. 105,000/=. (Male, Academic Registrar, October, 2019)

In summary, 100% of the respondents concurred that Universities were involved in some IGAs. This was in the context that Universities in Kenya had diversified their sources of revenue (Oanda & Sifuna, 2016; Michieka, 2016; Akuno, *et al*, 2017; Odundo *et al*, 2015).

In order to understand the effectiveness of IGAs as interventions towards enhancing participation, Lecturers', HoDs' and Academic Registrars' views were sought and all 33 (100%) of their responses reflected, in one way or another, the challenges facing the initiatives. The findings are presented in Table 4.14 below:

Table 4.14: Lecturers', HoDs' and Academic Registrars' views on challenges facing IGA initiatives

Challenges facing IGAs initiatives	Frequency	Per cent
Little income generated	30	90.9
Lack of market for the products	24	72.7
Poor business model adopted	22	66.7
Lack of raw materials	14	42.4
High cost of production	11	33.3

Source: Data obtained from respondents' during field inquiry, 2019

Table 4.14 above shows that 90.9 % of the respondents indicated that IGAs generated little income. 72.7% felt that lack of market for products was a challenge. 66.7% thought that poor business model had been adopted. 42.4% contented that lack of raw materials was a challenge and 33.3% thought that high cost of production was a challenge.

In this connection, a lecturer averred that:

> The model used to establish and run IGAs largely relies on the University's already established capacities and the government. Therefore, they are bound to face the same funding challenges already facing University education. On short courses, we admit very few numbers like 20 due to limited training facilities and also charge a modest fee. Additionally, some initiatives are short time like the Africa, Caribbean and Pacific- European Union (ACP-EU) co-financed Innovation for Livestock Industry project from 2014 to 2016 and the sponsorship stopped. (Female, Lecturer, September, 2019)

Another HOD decried:

> 500,000 acres of cotton will be required to meet the company's cotton demands. So far, we have acquired 50,000 acres in Mwingi and a combined of 1,100 acres in Kerio Valley and Mogotio. Sensitizing the already discouraged farmers is equally not easy. The factory is currently producing an average of 10,000 bales annually against a capacity of 70,000 bales. Further, high cost of power is making it difficult for investors in textile industry to break even. (Male, HoD, November, 2019)

Another HoD explained:

> One of the major challenges is free market concept in the country where our products might get outmuscled by cheap imports since the government maintains that Kenya is an open market and local products must compete with imports. (Female, HoD, October, 2019)

The above sentiments indicate a number of challenges that Universities face as they venture into the IGAs. First, the numbers admitted into short courses were few and consequently the income generated was equally less. Similarly, the period of sponsorship was short and this made sustainability difficult. Secondly, operations at REAL were not optimum and were seven times below the expected capacity due to lack of raw materials. Thirdly, the model of relying on government budgets at the same time making the same government a major customer in the IGAs might not be effective intervention because of the shrinking capitation. The situation was further

compounded by the fact that in government to government business, aspects like late procurement and high operational costs of production were common. Moreover, lack of markets for the products constituted the major challenge. In summary, such challenges hindered the Universities from investing the proceeds from the IGAs into infrastructure, teaching and learning resources. Eventually, this limited students' participation in Science and Technology Programmes. These findings concur with those by Kahn (2013) in South Africa, which revealed that the Department of Education had put in place a national wide redress programme in 1995, only for the programme to stop in 1999. Furthermore, Atuahene & Owusu-Ansah (2013) established that during 2008/2009, University of Cape Coast, through concessionary selection of students from Less Endowed Secondary Schools (LESS), only admitted 80 students as a result of the intervention.

4.6.4. Research grants and donations at sampled Universities

Information was sought from lecturers, HoDs and Academic Registrars in the sampled Universities on whether research grants and donations were part of University-based interventions to enhance participation. 100 % (33) of the respondents indicated that Universities won research grants and received donations. In this connection, one HoD had the following sentiments during the interview:

> Our University was awarded Ksh. 79,759,620/= by National Research Fund (NRF) to establish an Electron Microscopy Centre. The Centre will run High Resolution Transmission Electron Microscope (HRTEM) and Scanning Electron Microscope (SEM). The Centre targets to train many undergraduates, 25 Masters and 10 PhDs and five post-doctorate over five years, besides collaborating with other Universities. Besides, the fee that will be charged for sample analysis

> of collaborating institutions and researchers will offer a good income generating stream. (Male, HoD, December, 2019)

One Registrar (Academic) had the following revelations during the interview:

> The Safaricom Limited sponsored the construction of innovation laboratory and equipment/materials worth Ksh. 225 Million in our University which is dubbed as "TechAvenue" for engineering students. Also Samsung Electronics East Africa has launched an air conditioning and refrigeration Engineering Academy at our institution. Further, through Kenya Airways, General Electric Aviation USA donated to the University a CF6-80A2 aircraft engine that powers Airbus A310 and Boing. Aerosim Technologies, a US-based Aviation Training Solutions Company donated an aviation simulators and equipment to the University while Amatrol Advanced Manufacturing Company based in Jeffersonville USA, through the Ministry of Education also donated modern technical and advanced Engineering equipment for training Mechanical and Electrical Engineering students. (Male, Academic Registrar, December, 2019)

The sentiments above alluded to the fact that Universities were not only competitively winning grants, but also relied on philanthropic gestures through donations from local, regional and international quotas.

This study also sought views of Academic Registrars, HoDs and lecturers on whether philanthropic gestures were sustainable means to enhance participation. Majority of respondents concurred that philanthropic gestures were not sustainable means to enhance participation. In this connection, one lecturer argued during the open-ended interview that:

> Benevolent gestures are not sustainable in the long run as they are bound to change from time to time based on the government of the days' political orientation in the global arena and networking circles of the days' University top management. (Female, Lecturer, December, 2019)

The above sentiment alluded to the fact that philanthropic gestures were not sustainable means of mitigating the challenge of lack of infrastructure, teaching and learning resources. The research concluded that it was not a sustainable intervention measure in the long run. Nonetheless, grants and donations were being used as an intervention measure to improve infrastructure, teaching and learning resources with the aim of enhancing students' participation. These findings correspond to the ones by Kaing (2016) which revealed that, with the assistance from US Department of State, Cambodia had established the Golden West Design Lab. Furthermore, Government of Malaysia (2014) stated that Massachusetts Institute of Technology (MIT) and University of Technology Malaysia were collaborating to develop new learning approaches.

In summary, 100% indicated inter-governmental co-operations, linkages and agreements as some of the intervention measures undertaken to enhance participation. 52% had reservations on inter-governmental cooperation enhancing participation. 100% revealed that University-based interventions employed were University-secondary schools linkages, IGAs and reliance on philanthropic gestures. However, University-secondary linkages were not enhancing participation. 100% of IGAs ventures faced challenges and the most severe ones included generation of meagre income 90%, lack of market for the products 72.7%, operating on poor business models 66.7%, lack of raw materials 42.4%, and experiencing high cost of production 33.3%. With regard to research grants and philanthropic gestures, most of them were not sustainable. Therefore, inter-governmental co-operation had not

played a significant role in enhancing students' participation. Also, University-secondary schools linkages did not enhance participation, given that students failed to enroll due to lack of capacity on the side of Universities and not lack of qualifications from the students' side. With regard to IGAs, they faced a myriad of challenges. This scenario was compounded by the fact that they were being implemented in a context where Universities were confronted with chronic underfunding. The philanthropic approach came out as a measure that was completely not sustainable in the long run.

4.7. Summary and conclusion

With regard to the trend of students' participation in Science and Technology Programmes, enrolment was below the government's target. Engineering recorded the highest enrolment, followed by Life and Physical Sciences. Medical and Health, Agriculture and Environmental Sciences were the least represented. Universities had prioritized most of their programmes in science and technology, albeit emerging trend of increasing the Applied Sciences Programmes, duplication within same institutions and course splintering. On funding, the study established that DUC formula had a net effect of decreasing capitation. GSP admission policy was punitive and restrictive while SSP mode was very flexible but targeted well-to-do in society. Also, majority of participants came from middle or upper socio-economic backgrounds.

On effect of infrastructure, teaching and learning resources, this study found out that overall there was inadequacy of physical infrastructure. The curriculum review and

design procedure was flawed as securing industrial attachment was difficult. Moreover, industrial visits were few and in some cases lacking. Teaching methods were mainly transmission and assessment was theoretical. With regard to teaching staff qualifications, very few had PhD qualifications as the rank Professor, Associate Professor and Senior Lecturer were least represented. Nonetheless, the lecturer-student ratio was compliant to CUE guidelines. With regard to government interventions, inter-governmental co-operations, linkages and agreements were some of the measures employed. Moreover, University-based interventions included University-secondary schools linkages, IGAs and reliance on philanthropic gestures. However, IGAs ventures faced a myriad of challenges.

In conclusion, the government enrolment target was missed since the distribution of students into academic programmes was not aligned to the government policy. On funding, DUC was not working as expected. The GSP admission process was shunting many qualified students while SSP applied double standards. Also, the affirmative placement policy had not helped much to increase participation.

On HELB loans, the amounts extended were inadequate to finance science and technology education. Moreover, HELB had no relationship with the type of programme pursued and household financing capacities largely determined participation. Universities were experiencing acute shortage of facilities. Hence, practical elements in curriculum were extremely undermined since students were mainly being grounded in theory. Furthermore, there was non-compliance with the CUE requirement for University academic staff and this raised the question of

quality. Consequently, most of the measures for intervention had not played a significant role in enhancing students' participation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This Chapter summarizes research findings, presents the conclusions and makes policy recommendations. It also presents suggestions for further research based on emerging issues.

5.2 Summary

The summary of the main findings of this study is based on the field data in relation to the objectives and research questions that were sought to address.

5.2.1 Trend of students' participation in Science and Technology Programmes

Objective One focused on trends of students' participation in Science and Technology Programmes at Bachelor Level in Public Universities in line with the Government of Kenya admission policies. The study established that participation in science and technology was below the government's target. The order of representation from the highest cluster was Engineering, Life and Physical Sciences, Medical and Health. The least represented was Agriculture and Environmental Sciences. As regards graduation trends, very few students graduated with a Bachelor's degree in science and technology. As per the programmes, Universities had prioritized most of them in science clusters. Nevertheless, the emerging trend of converting technical institutions into academic institutions by increasing the Applied Sciences Programmes, duplication within same institutions and course splintering were evident.

5.2.2 Relationship between funding of University students and participation in Science and Technology Programmes

Objective Two dealt with the relationship between funding of University students and participation in Science and Technology Programmes at Bachelors' Level in Public Universities in Kenya. In this regard, it was established that DUC formula had a net effect of decreasing capitation. Qualified students missed entry into Science and Technology Programmes due to punitive and restrictive GSP admission policy while SSP mode was very flexible, and targeting well-to-do in society. Overall, SSP entry mode was more expensive than GSP mode in Science and Technology Programmes. On average, the HELB loans awarded were not equivalent to the cost of both GSP and SSP entry modes per year respectively. It was further established that majority of students were financed by parents since socio-economic status largely determined participation.

5.2.3 Effects of infrastructure, teaching and learning resources on student participation in Science and Technology Programmes

Objective Three focused on the effects of infrastructure, teaching and learning resources on students' participation in Science and Technology Programmes at Bachelors' Level in Public Universities in Kenya. This study found out that there was inadequacy of physical infrastructure as well as Curriculum Review and Design procedure had not been followed in the sampled Universities. Also, securing industrial attachments by students was extremely difficult. Moreover, industrial visits were very few or totally lacking. Furthermore, the common teaching method was dictation and reading from handouts. Assessment was largely theoretical with practical and laboratory sessions only contributing less than a third of the total

assessment. With regard to teaching staff qualifications, only few of the academic staff had PhDs, and a paltry of them was in the cadre of Professor, Associate Professor and Senior Lecturer. Nonetheless, the lecturer-student ratio certified the CUE requirements.

5.2.4 Institutional-based interventions that could increase students' participation in Science and Technology Programmes

Objective Four dealt with the institutional-based interventions that could increase students' participation in Science and Technology Programmes at Bachelor's Level in Public Universities in Kenya. The government interventions were inter-governmental co-operations, linkages and agreements. The University-based interventions were University-secondary schools linkages, IGAs and reliance on philanthropic gestures. The University-secondary linkages were not enhancing participation and IGAs ventures faced many challenges. The most severe challenge included generation of meagre income, lack of market for the products, operating on poor business models, lack of raw materials and experiencing high cost of production. With regard to research grants and philanthropic gestures, it was established that they were largely not sustainable to enhance participation.

5.3 Conclusions

The study draws several conclusions from its findings. First, contrary to the Government of Kenya policy on enrolment ratios for programmes in science and technology and non-science, the target was missed. Also, the distribution of students in academic programmes was not aligned to the stated policy. Therefore, the

government was not producing enough graduates to realize her aspiration of using science and technology as a way of underpinning economic development.

Secondly, the DUC was not working as expected. Implementation of GSP admission process was so rigid that it shunted many qualified students from enrolling, contrary to the stated government's admission policy. Furthermore, SSP admission policy applied double standards by discriminating learners based on socio-economic status. The HELB loans extended were not sufficient, making it an inadequate mode to finance science and technology education for majority of poor students. Moreover, HELB had no relationship with the type of programme to pursue and the Affirmative Placement Policy had not helped to increase students' participation.

Thirdly, Universities were experiencing acute shortage of facilities and this extremely undermined practical element in the curriculum. Therefore, students were largely grounded in theory at the expense of practical industrial training. Furthermore, there was non-compliance with the CUE requirement for University teaching staff. Nonetheless, the lecturer-student ratio was sufficient to meet recognized CUE standards.

Fourthly, most measures of intervention like inter-governmental co-operations, linkages and agreements, University-secondary schools linkages, IGAs, and philanthropic gestures had not played a significant role in enhancing students' participation. Particularly, the IGAs faced many challenges. Hence, such interventions were not sustainable in the long run.

5.4 Recommendations

The study dichotomized recommendations into those related to policy and practice and those related to further research.

5.4.1 Policy recommendations

The study made the following recommendations. First, Universities should rationalize and balance enrolment into University programmes so that they are clearly aligned to the development needs of the country. The percentage of academic programmes which have greatest bearing on the development agenda need to be directly proportional to the percentage of its goals. Consequently, this should hinge on successful implementation of government's admission policies. Also, efforts should be directed towards designing an individualized University admission where students are given a voucher and they decide where it is tenable.

Secondly, funding of Public Universities needs to be backed by a coherent policy which prioritizes quality and quantity in Science and Technology Programmes. At the same time, the government should adhere to timely disbursement of the funds to Universities as well as expand the financial base of HELB to enable it mobilize resources for loans to needy students.

Thirdly, University Government Sponsored Programme (GSP) policy should be flexible so as to allow "get-in-get-out" arrangement for those who cannot afford to finish their studies continuously in a block. Also, it should not just target KCSE candidates who seek admission in the year succeeding examination year. The policy should provide clear avenues which promote entry through coordinated middle level

education and training institutions, by accumulation of credits at certificates and diplomas, pre-University programmes, alternative and continuing education. Similarly, the policy should consider students from low socio-economic status in society.

Fourthly, Universities should establish structures for supporting lecturers to move away from transmission–based lectures to problem-based learning, more participatory, collaborative lecture rooms and promote use of technology so as to prepare increasingly diverse student cohorts for a borderless economy. Also, reform students' evaluation and move gradually away from dependency on examinations which mainly focus on memorization and adopt hands-on approaches in assessments.

Fifth, Universities should prioritize collaborations with industry and professional practitioners in the development of curriculum in order to provide useful input regarding the skills required to perform in the job market and, at the same time, keeping abreast of new developments in industry and work place by benefiting through internships, workplace seminars and symposia. Hence, Universities should formulate, adopt and implement University Industry Partnership and Placement (UIPP) policy to recognize the Universities' science and technology study programmes as part of the industry chains.

Sixth, Universities should strengthen staff development programmes, scholarships and provision of lecturers' book and research allowances and payment of non-

practising allowance in order to respond to the challenge of attracting, motivating and retaining staff.

Seventh, the government should implement the exemption of higher education from taxation and tariffs, including value added tax, on equipment and imported materials. Moreover, government should relax the taxing of higher education through tax waivers, tax rebates, and tax refunds as a way of improving Universities' infrastructure required to support science and technology.

Finally, Universities should engage in Public- Private- Partnerships (PPP) in funding University education, including but not limited to the establishment of robust endowment funds through alumni and other donors for scholarships, establish and commercialize Intellectual Property Organization (IPO), promote co-operation for research, offer incentives to staff winning research grants, engage in value engineering and also diversify sources of income by adopting suitable business models and entrepreneurships.

5.4.2 Recommendations for further research

The following general areas related to the concerns of this study and were proposed for further research: First, this study focused on government policies on admission into Science and Technology Bachelor Degree Programmes and their impact on students' participation, with special reference to Manufacturing Engineering and Veterinary Medicine and Surgery. Therefore, a study focusing on other science and technology programmes should be conducted.

Secondly, an in-depth study should be conducted on why some Universities were more competitive in Science and Technology Programmes and were being preferred and even attracted SSP students as compared to others.

Lastly, there is need for a study on why some Science and Technology Programmes attracted many applicants leading to practices like “splintering” and “duplication” within the same Universities, compared to other similar programmes.

5.4.3. Study contributions to knowledge

a) The study established gaps which existed in the stated government policies on admission and the actual practice during implementation.
b) The study established the impact of the actual practice during implementation of the admission policies on students’ participation in Science and Technology Programmes.
c) The study suggested policy interventions which could be employed to increase students’ participation in Science and Technology Programmes.

REFERENCES

Africa Union Commission. (2014). *Agenda 2063: The Africa We Want.* Addis Ababa: Africa Union Commission.

African Capacity Building Foundation. (2016). *African Union Agenda 2063: African Critical Technical Skills: Key Capacity Dimensions Needed for the First 10 Years of Agenda 2063.* Harare: African Capacity Building Foundation. ISBN/ISSN 978177937063: https://opendocs.ids.ac.uk/opndocs/handle/20.500.12413/12847

Akumu, O. P., Kasandi, A. J., & Maiyo, J. (2017). Does Students' Loan Amount Affect Choice of Programme of Study? Evidence From Privately Sponsored Undergraduate HELB Loan Recepients in Kenyan Public Universities. *International Journal of Education and Research.*, 5(8) 161-176 ISSN: 2411-5651.

Akuno, A. E., Ondieki, O. D., Barasa, L. P., Otieno, P. S., Wamunyu, M. S., & Amateshe, O. M. (2017). *Higher Education Leardership and Governance in the Development of the Creative and Cultural Industries in Kenya.* Dakar: Council for the Development of Social Science Research in Africa. ISBN: 978-2-86978-717-9. Doi: 10.2307/j.ctvh8r11g

Aliva, L. E., & Amunga, J. (2017). Revisiting Bursary Awards, HELB and National Polytechnics in Kenya: The Place of Recipients' Social-economic Status. *Developing Country Studies.*, 7(9) 30-36.

Amin, M. A. (2005). *Social Research: Conception, Methodology and Analysis.* Kampala: Makerere University Press.

Anyalebechi, G. (2015). Barriers to Equity of Access to Educational Opportunity in Nigeria: A Philosophical Perspective. *Journal of Education and Practice.*, 6(4) 148-152 ISSN 2222-1735.

Atuahene, F., & Owusu-Ansah, A. (2013). A Descriptive Assessment of Higher Education Access, Participation, Equity and Disparity in Ghana. *SAGE open* 3(3*)*. Doi: 10.1177/2158244013497725.

Bagde, S., Epple, D., & Taylor, L. (2016). Does Affirmative Action Work? Caste, Gender, College Quality, and Academic Success in India. *American Economic Review.*, 106(6) 1495-1521. Doi: 10.1257/aer.20140783

Barthorpe, G. (2012). *Trends and Issues Affecting Workforce Planning in New Zealand University Libraries.* Auckland: Auckland University of Technology.

Bekir, S. (2016). *Democratization and Massification of Higher Education in Turkey and Challenges Ahead.* Berkely: Research and Occational Paper Series: Centre for Studies in Higher Education 3.16, University of California. Doi: 10.13140/RG.2.1.1866.9683

Bryman, A. (2004). *Social Research Methods.* New York: Oxford University Press.

Bush, T. (2002). Authenticity, Reliability, Validity, and Triangulation. In Coleman Marrianne, & Breggs Ann. (Eds). *Research Methods in Educational Leardership and Management.* London: Paul Champman.

Caner, A., & Okten, C. (2013). Higher Education in Turkey: Subsidizing the Rich or the Poor? *Economic of Education Review.*,V35 75-92. https://doi.org/10.1016/j.econedurev.2013.03.007

Chege, F., & Sifuna, D. (2006). *Girls' and Women's Education in Kenya: Gender Perspectives and Trends.* Nairobi: UNESCO Regional Office.

Chris et al. (2009). *Research Methods for Sports Studies.* New York: Routledge.

Cohen et al. (2007). *Research Methods in Education, 6th Ed.* London: Taylor and Francis Group.

Commussion for University Education. (2016). *University Statistics in Kenya.* Nairobi: Commission for University Education

Debrah, D. (2008). *Financing Higher Education: Challenges for Students at The University of Ghana.* Oslo: University of Oslo.

Drori, S. G., & Netivi, A. (2013). *STEM in Israel: The Educational Foundation of Start-up Nation. Report for Australian Council of Learned Academies.*Melbourne: Australian Council of Learned Academies.

Dube, P. S. (2018). An Investigation of the Science Technology Engineering and Mathematics (STEM) Initiatives in the Zimbabwean Education System. *International Journal for Cross- Disciplinary Subjects in Education (IJCDSE),* 9(1) 3329-3334. Doi: 10.20533/ijcdse.2042.6364.2018.0445

Eccles, J. S., & Wingfield, A. (2002). Motivational Beliefs, Values, and Goals. *Annual Review of Psychology*, 53.

Egerton University. (2019, September Thursday). *Egerton University Profile*. Retrieved September Thursday, 2019, from Egerton University: egerton.ac.ke/our-profile

Etshim, R. (2017). Collaboration Between Higher Education and Lobour Market in Kinshasa, DR Congo. *Journal of International Educational and Leardership.*, 7(1) 1-17 ISSN 2161-7252.

Fabiyi, A., & Uzoka, E. N. (2012). Massification and Quality Assurance in Tertiary Education: The Nigerian Experience. *Makerere Journal of Higher Education*, 4(1) 61-69 Doi: http://dx.doi.org/10.4314/majohe.v4il.7

Federation of India Chambers of Commerce and Industry.(2014). *Higher Education in India: Moving Towards Global Relevance and Competitiveness.* New Delhi: Federation of India Chambers of Commerce and Industry.

Field, A.P. (2005). *Discovering Statistics Using SPSS*. London: SAGE

Filippetti, A., & Savona, M. (2017). University-Industry Linkages and Academic Engagements: Individual Behaviors and Firms' Barriers. Introduction to Special Section. *The Journal of Technology Transfer*, Doi: 10.1007/s 10961-017-9576-x.

Gadzirayi, C. T., Bongo, P. P., Ruyimbe, B., Bhuknuhani, C., & Mucheri, T. (2016). *Diagnostic Study on Status of STEM in Zimbabwe.* Harare: Bindura University of Science Education and Higherlife Foundation.

Galukande, M., Maling, S., Kabakyenga, J., Nshaho, J., Oboke, H., Oonge, B., Mnyenje, H., Katumba-Sentongo, G., Mayanja-Kizza, H., & Sewankambo, N. (2018). Equitable Access to Health Professional Training in Uganda: A Cross Sectional Study. *Annals of Global Health*, 91-99 84(1) Doi: https://doi.org/10.29024/aogh.7.

Garwe, C. E. (2015). Trends in Student Enrolments in Agricultural Degree Programme in Zimbabwe. *Global Journal of Educational Studies*, 1(1) 62-77 ISSN 2377-3936.Doi: https://doi.org/ 10.5296/gjes.v1il.7615

Getu, D., & Tegbar, Y. (2006). *Research Methodology: Ethiopia Public Health Training Initiative.* Gonder: University of Gonder, USAID.

Gichuhi, L. (2015). Alternative Methods of Financing Higher Education in Kenya. *International Journal of Scientific Research and Innovative Technology.* 2(5) 57-67 ISSN: 2313-3759.URL:http://www.ijsrit.com/uploaded-all-files/2666028427-g7.pdf

Government of Malaysia. (2014). *STEM Education: Policies and Prospects Towards Achieving International Standard and Meeting National Development Needs: Malaysia Education Blueprint 2013-2025.* Kuala Lumpur: Ministry of Education Malaysia.

Gudo, C. (2016). Influence of Financing on Quality of University Education in Kenya. *International Journal of Managerial Studies and Research.,* 4(1) 49-58 ISSN: 2349-0330.

Gudo, C. O., Olel, M. A., & Oanda, I. O. (2011). University Expansions in Kenya and Issues of Quality Education: Challenges and Opportunities. *International Journal of Business and Social Sciences,* 203-214 2(20).

Hancock, B., Ockleford, E., & Windridge, K. (2009). *An Introduction to Qualitative Research.* Yorkshire: National Institute.

Higher Education Loans Board. (2017, March Friday). *Undergraduate loans products*. Retrieved March Friday, 2017, from Higher Education Loans Board: helb.co.ke/helb-products/helb-loans/undergraduate-loan/

House of Lords. (2012). *Select Committee on Science and Technology 2nd Report of Session 2012-2013.* London: House of Lords.

Israel, G. D. (2009). *Determining Sample Size.* Institute of Food and Agricultural Sciences, University of Florida.

Jensen, E. (2011). *The Practice of Social Research: Reserch Design*. Conventry: Wirwick University

Joppe, M. (2000, March Monday). *Reseach Process.* Retrieved March 10th , 2015, from http://www.ryerson.cal/mjoppe/rp.htm

Kabura, J. K., & Embeywa, E. H. (2014). An Evaluation of Quality of University Education in Kenya During this Massification Era. *Mediterranean Journal of Social Sciences.*, 5(5) Doi: 10. 5901/mjss.2014.

Kahn, M. (2013). *Science, Technology, Engineering and Mathematics (STEM) in South Africa.* Melbourne: Australian Council of Learned Academies. http://hdl.voced.edu.au/10707/256473

Kaing, S. (2016). *How Can STEM Education Help Stimulate Economic Growth in Cambodia.* Brussel: Vrije Universiteit Brussel (VUB).

Karimi, K. F. (2015). Academic Programmes in Universities in East Africa: A catalyst to Development. *International Journal of Higher Education.*, 4(3) 140-155 URL: http://dx. doi.org/10.543/ijhe. v4n3p140.

Kasozi, K. B. A. (2016). *The National Council for Higher Education and Growth of University Sub-Sector in Uganda, 2002-2012.* Dakar: Council for the Development of Social Science Research in Africa. ISBN: 9782869787117. Doi: 10.2307/j.ctvh8r20f

Kearney, C. (2016). *Efforts to Increase Students Interest in Pursuing Mathematics, Science and Technology Studies and Careers. National Measures Taken by 30 Countries- 2015 Report.* Brussels: European Schoolnet. ISBN: 9789491440984

Kenya Universities and Colleges Central Placement Services. (2014, December Monday). *Placement Policy.* Retrieved December Monday, 2014, from Kenya Universities and Colleges Placement Services: www.kuccps.net/sites/default/placement%20%policyAug-pdf

Kilango, N., Qin, Y., Watende, N., & Senguo, R. (2017). Interventions that Increase Enrolment of Women in Higher Education: The University of Dar es Saaam. *Journal of Education and Practice,* 8(13) ISSN 2222-1735.

Kiplang'at, J. (2018, February 5th). Kenya: 500 Students Face Suspension for Boycotting Lectures. *Daily Nation*., P.7

Kivati, G. (2017). The Role of Kenya's Formal Higher Education in Sustainable Development Within the Context of Globalization. In W. Leal Filho et al. (eds.), *Handbook of Theory and Practice of Sustainable Development in Higher Education.* London: Springer.

Kobla, K. O. A., Banda, M., & Wang, L. (2018). The Impact of Massification on Higher Education in Africa: A Case Study of Bunda College of Agriculture in Malawi and University of Cape Coast in Ghana. *European Journal of Economic and Business.*, 3(1) 24-28 ISSN 2456-3900.

Koketso, P. L. (2015). *STEM Education in Botswana: Understanding the Gender Disparity in Enrolment and Graduation in Post- Secondary Education.* Montreal, Quebec: Concordia University.

Kombo, D.K., & Tromp, D.L. (2006). *Proposal and Thesis Writing: An Introduction.* Nairobi: Paulines Publications Africa.

Kothari, C. R. (2003). *Research Methodology: Methods and Techniques.* New Delhi: New Age International Publication Limited.

Kumar, R. (2011). *Research Methodology: A step-by-step Guide for Beginners* . New Delhi: SAGE Publications.

Ligami, C. (2018, March Thursday). Kenya: Five Universities Lose Engineering Accredidation. *University World News.*, p. 2.

Mango, K. (2015). *Factors Influencing Access to Technical and Vocational Education and Training in Bungoma East Sub-County, Kenya.* Nairobi: University of Nairobi.

Marginson, S., Tytler, R., Freeman, B, & Robert, K. (2013). *STEM: Country Comparisons: International Comparisons of Science, Technology, Engineering and mathematics (STEM) Education.* Melbourne: Australian Council of Learned Academies. http://hdl.handle.net/10536/DRO/DV:30059041

Masaiti, G., & Shen, H. (2013). Cost Sharing in Zambia's Public Universities: Prospects and Challenges. *European Journal of Educational Research.*, 1(1) 1-15 Doi: 10. 12973/eu-jero. 2.1.1.

Matovu, M. (2018). Massification or Quality of Graduates? A Model for Higher Education and Development in Uganda. *African Journal of Education, Science and Technology.*, 5(1). Doi:10.13140/RG.2.2.17296.66568

Mbano, N., & Nolan, K. (2017). Increasing Access of Female Students in Science, Technology, Engineering and Mathematics (STEM) in University of Malawi (UNIMA). *Science Education International.*, 28(1) 53-77.

Mbirianjau, W. L. (2016). *Exploring Enabling Interventions for Increasing Female Students' Access and Participation in Science, Technology, Engineering and*

Mathematics (STEM) Disciplines in Kenyan Public Universities. Ph.D Thesis. Kenyatta University, Kenya.

Mbirithi, M. (2013). *Management Challenge Facing Kenya's Public Universities and Implications for the Quality of Education.* Ph.D Thesis. Kenyatta University, Kenya.

McCowan, T. (2016). Universities and the Post-2015 Development Agenda: An Analytical Framework. *Higher Education*, 505-523 72(4). https://doi.org/10.1007/s10734-016-0035-7

McCowan, T. (2018). Quality of Higher Education in Kenya: Addresing the Conundrum. *International Journal of Education Development.*, 60: 128-137. Doi: 10.1016/j.ijedudev.2017.11.002

McCowan, T., & Schendel, R. (2016). The Impact of Higher Education and Development. In S. McGrath. (Eds), *The Routledge Handbook of International Education and Development.* Abingdon: Routledge.

Michieka, R. W. (2016). *Trails in Academic and Administrative Leadership in Kenya.* Dakar: Council for the Development of Social Science Research in Africa.ISBN: 9782869786424. https://doi.org/10.2307/j.ctvh8r3xx

Misaro, J., Jonyo, O. F., & Kariuki, K. D. (2013). A Review of the Impact of Massification on the Quality of Higher Education in Kenya. *Research in Organizational Psychology and Educational Studies.*, 2(4) 139-149 ISSN: 2276-8475.

Moi University. (2016, October Wednesday). *Moi University Historical Background*. Retrieved October Wednesday, 2016, from Moi University: mu.ac.ke/index.php/en/about-Moi-university/historical-background.html

Mosotho, J. G. (2017). Assessing the Level of Laboratory Resources for Teaching and Learning of Chemistry at Advanced Level in Lesotho Secondary Schools. *South African Journal of Chemistry*, 154-162 V 70 Doi: http://dx.doi.org/10.17159/0379-4350/2017 v 70a22.

Mpehongwa, G. (2014). Career Choices of University Students in Tanzania and their Implications for Vision 2025. *International Journal of Humanities and Social Science*, 4(5) 260-266.

Muema, E., & Lavery, R.M. (2018). Redefining Quality in Higher Education: The Concept of Juakalization. *Sino-Us English Teaching*, 15(9) 415-428 ISSN 1539-8072 Doi: 10.17265/1539-8072/2018.09.001.

Mukhwana, E. J., Kande, A., & Too, J. (2017). Transforming University Education in Africa: Lessons from Kenya. *African Journal of Rural Development*, 341-352 2(3). ISBN 978-9966-009-27-2

Mukhwana, E., Oure, S., Kiptoo, S., Kande, A., Njue, R., Too, J., & Some, D.K. (2016). *State of University Education in Kenya.* Nairobi: Commission for University Education. ISBN 978-9966-009-21-0

Mulongo, G. (2013). Inequality in Accessing Higher Education in Kenya: Implications for Economic Development and Well-being. *International Journal of Humanities and Social Science.*, 3(16) 49-61.

Muluh, M. C. (2012). *Affirmative Action Policy in Higher Education: Impact and Perceptions of the use of Race as Part of Criteria for Admisson at the University of Cape Town.* Cape Town: University of Cape Town.

Mwebi, B., & Simatwa, E. M. W. (2013). Expansion of Private Universities in Kenya and its Implication on Quality and Completion Rate: An Analytical Study. *Educational Research*, 4(4) 352-366 ISSN 2141-5161.

Mwirichia, N. W., Jagero, N., & Barchok, H. (2017). Impact of Massification on Resource Adequacy in Public and Private Universities in Kenya. *International Journal of Education.*, 9(3) ISSN 1948-5476: Doi: https://doi.org/10.5296/ije.v9i3.11874

Noble, H., & Smith, J. (2015). *Issues of Validity and Reliability in Qualitative Research.* Dallas: Wadsworth.

Ntim, S. (2016). Massification in Ghanaian Higher Education: Implications for Pedagogical Quality, Equity and Assesment. *International Research in Higher Education.*, 1(1) 160-169. ISSN 2380-9183 Doi: https://doi.org/10.5430/irhe.v1n1p160

Nyang'au, J. (2014). Higher Education as an Instrument of Economic Growth in Kenya. *FIRE: Forum for International Research in Education*, 1(1) 7-25. Doi: 10.18275/fire201401011006

Oanda, I. O. (2013). Implications of Alternative Higher Education Financing Policies on Equity and Quality: the Kenyan Experience. In D. Teferra. (ed.), *Funding Higher Education in Sub-Saharan Africa.* London: Palgrave Macmillan. ISBN 978-1-349-46665-8. Doi: https://doi.org/10.1057/9781137345

Oanda, I. O., & Sall, E. (2016). From Peril to Promise: Repositioning Higher Education for Reconstruction of Africa's Future. *International Journal of African Higher Education.,* 3(1).Doi: https://doi.org/10.6017/ijahe.v3il.9637

Oanda, I.O., & Sifuna, D. (2016). Divergent Narratives on Graduate Employability in Kenya: Dysfunctional Institutions or Dysfunctional Labour Markets. In Mc Cowan, T., Walker, M., Fongwa, S., Oanda, I., Sifuna, D., Adedeji, S., Oyebade, S., Ananga, E., Adzahie-Mensah, V., Tamanja, E. (Eds.), *Universities, Employability and Inclusive Development: Repositioning Higher Education in Ghana, Kenya, Nigeria and South Africa.* London: British Council.

Obonyo, M. (2013). *The Contributions of Affirmative Strategies to Widening Access to Universities for Students from Kenya's ASAL Regions.* Ph.D. Thesis. Kenyatta University, Kenya.

Ochuodho, O. J. (2016). Status of the Higher Agriculture Education Sector in Kenya: A Sector at Crossroads. *African Journal of Rural development*, 171-178 1(2). ISSN 2415-2838. Doi: 10.22004/ag.eco.263567

Odundo, P. A., Origa, J., Nyandega, I., & Ngaruiya, B. (2015). Effects of Mass University Enrolment on Non-Academic Activities: The Case of The University of Nairobi, Kenya. *Educational Journal.*, 4(2) 51-59 doi: 10.11648/j.edu.20150402.11.

Oduor, A. (2017, April 6th). Kenyan Universities Funding Shocker. *The Standard News Paper*.,P10

OECD. (2015). *How is the global talent pool changing (2013, 2030)? Education Indicators in Focus 31*. Paris: OECD Publishing. Doi: 10.1787/5js33lf9jk41-en

Opit, E. (2014). *Impact of Uganda Government Science- Based University Sponsorship Policy on Girls' Participation in the Sciences at A- Level in Mukono and Wakiso Districts.* Ph.D. Thesis. Kenyatta University, Kenya.

Orodho, J. A. (2004). *Techniques of Writing Research Proposal and Reports in Education and Social Sciences.* Nairobi: Reata Printers.

Osei-Asibeyi, D. (2015). *School Leadership Challenges in the Implimentation of Technical and Vocational Education Curriculum in Ghana.* Jyvaskyla: University of Jyvaskyla.

Oviawe, I. J., Uwameiye, R,, & Uddin, S.P. (2017). Bridging Skill Gap to Meet Technical, Vocational Education and Training School-Workplace Collaboration in the 21st Century. *International Journal of Vocational Education and Training Research*, 7-14 3(1) doi: 10: 11648/j.iJvetr.20170301.12.

Pantah, A.M., & Asante, J. (2018). Evaluation of Students Sources of Financing Higher Education in Ghana: A Survey of Tertiary Institutions in the Upper West Region. *International Journal of Advanced Research.*, 6(12), 610-621. Doi: 10.21474/IJAR01/8180

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods, 3rd Edition.* California: SAGE Publications. Thousand Oaks.

Rajibussalim, R. (2017). *The Impact of Industry-Based Learning Programmes on Science, Technology, Engineering and Mathematics Students: A Case Study of Indonesian Higher Education.* Brisbane: Queensland University of Technology.

Rendon, L. L., & Munoz, S. (2005). Revisiting the Validation Theory: Theoretical Foundations, Applications and Extentions. *One UTSA Circle,* 1-11.

Republic of Kenya. (1974). *Development Plan, 1974-1978.* Nairobi: Government Printer.

Republic of Kenya. (1976). *Report on the National Committee on Educational Objectives and Policies.* Nairobi: Government Printer.

Republic of Kenya. (1979). *Development Plan, 1979-1983.* Nairobi: Government Printer.

Republic of Kenya. (1981). *Second University in Kenya: Report of the Presidential Working Party.* Nairobi: Government Printer.

Republic of Kenya. (1985). *Moi University Act, Chapter 210A.* Nairobi: Government Printer

Republic of Kenya. (1988). *Egerton University Act, Chapter 214.* Nairobi: Government Printer

Republic of Kenya. (1995). *Higher Education Loans Board Act, Cap 213A*. Nairobi: Government Printer

Republic of Kenya. (2005). *Kenya Education Sector Support Programme (KESSP) 2005-2010.* Nairobi: Ministry of Education, Science and Technology.

Republic of Kenya. (2005). *Sessional Paper No. 1 of 2005 on A Policy Framework for Education, Training and Research.* Nairobi: Ministry of Education, Science and Technology.

Republic of Kenya. (2006). *Transforming of Higher Education and Training in Kenya to Secure Kenya's Development in the Knowledge Economy, Report of the Public Universities Inspection Board.* Nairobi: Government printer.

Republic of Kenya. (2007). *Kenya Vision 2030.* Nairobi: Government Printer

Republic of Kenya. (2013). *The Technical University of Kenya Act No. 42 of 2012.* Nairobi:Government Printer

Republic of Kenya. (2013). *Map of Kenya*. Nairobi: Ministry of Devolution and Planning.

Republic of Kenya. (2014). *The Universities Act No. 42 of 2012.* Nairobi: Government Printer.

Repubic of Kenya. (2015). *Sessional Paper No. 2 of 2015 on Reforming Education and Training Sector in Kenya.* Nairobi: Ministry of Education and Ministry of Higher Education, Science and Technology.

Sader, B.S., & Gabela, N.P. (2017). Spatialities of Widening Participation: Narratives of First Year Students Receiving Financial Aid. *South African Journal of Higher Education.*, 31(1) 227-242.Doi: 10.20853/31-1-1-1056

Sam-Amoah, L.K., Yawson, D. O., Agyeifrimpong, K., & Abole, E. (2016). Status and Challenges of the Higher Agricultural Education Sector in Ghana. *African Journal of Rural Development*, 159-169 1(2). ISSN 2415-2837. Doi: 10.22004/ag.econ.263566

Sang, K. A., Muthaa, M. G., & Mbugua, K. Z. (2012). Challenges Facing Technical Training in Kenya. *Scientific Research Creative Education.*, 3(1) 109-113. Doi: 10.4236/ce.2012.31018

Saunders, M., Lewis, P. & Thornhill, A. (2003). *Research Methods for Business Students.* Harlow, England: Pearson Education Limited

Sawahel, W. (2018, March). Egypt: Tax Cuts to Stimulate Science Research at Universities. *University World News*.

Schendel, R., & McCowan, T. (2016). Expanding Higher Education System in Low and Middle Income Countries: The Challenges of Equity and Quality. *Higher Education.*,72(4) 407-411. Doi:10.1007/s10734-016-0028-6

Shibru, A., Osivu, M., & Aklilu, M. (2016). Higher Agriculture Education in Ethiopia: Current Status and Future Prospects. *African Journal of Rural Development*, 1(2). Doi: 10.22004/ag.econ.263565

Sifuna, D. N. (2006). A Review of Major Obstacles to Women's Participation in Higher Education in Kenya. *Research in Post-Compulsory Education*, 11(1). Doi: 10.1080/13596740500507995

Sifuna, D. N. (2010). Some Reflections on the Expansion and Quality of Higher Education in Public Universities in Kenya. *Research in Post-Compulsory Education*, 15(4). 415-425. https://doi.org/10.1080/13596748.2010.526803

Sifuna, D. N., & Oanda, I. O. (2014). *Historical and Contemporary Trends in the Development of Education in Kenya: Government Policy, Gender and Regional Dimensions.* Nairobi: Jomo Kenyatta Foundation. ISBN 9966510060, 9789966510068

Simon, M., & Goes, J. (2012). Dissertation and Scholarly Research: Recipes for Success. *Dissertation Success*. ISBN: 1479336505 Doi: 10.13140/RG.2.1.5089.0960

Siocha, N.O., Onderi, H., & Mwebi, B. (2017). Quality Implications of Learning Infrastructure on Performance in Secondary Education: A Small Scale Study of a County in Kenya. *European Journal of Education Studies.*, 3(4) 97-123 ISSN 2501-1111 doi: 10.5281/zenodo.344956.

Streete, D. A. (2016). *The Price Paid: Free Higher Education in Trinidad and Tobago Re-Examined.* New York: Columbia University.

Sumaworo, M. D.,& Ibrahim, A. (2015). Challenges of Tertiary Education in Liberia and Possible Solutions. *European Scientific Journal*, 273-285 ISSN: 1857-7881.

Technical University of Kenya. (2016, October Monday). *Technical University of Kenya Profile*. Retrieved October Monday, 2016, from Technical University of Kenya: tukenya.ac.ke/tu-k-profile

Thabane. (2010). A Tutorial on Pilot Studies: What, Why and How. *BMC Medical Research Methodology*.

Thomas, J. (2014). *Academic Staff Views of Higher Education Quality in Somaliland.* Minnesota: University of Minnesota.

Too, J., Njeru, M., & Adoyo, C. (2018). *Towards Becoming an Industrialized Middle-Income Country: Recasting the Focus.* Nairobi: Commission for University Education.

UNESCO. (2010). *National Education Support Strategy (UNESS) for the Republic of Kenya 2010-2011.* Nairobi: UNESCO.

UNESCO. (2014). *Sustainable Development Begins with Education. How Education can Contribute to the Proposed Post-2015 Goals.* Paris: UNESCO

UNESCO. (2015). *International Standard Classification of Education: Fields of Education and Training 2013 (ISCED-F 2013)- Detailed Field Descriptions*: Montreal: UNESCO. ISBN 978-92-9189-179-5. Doi http://dx.doi.0rg/10.15220/978-92-9189-179-5en

UNESCO. (2016). *TVET, Higher Education and Innovations: Policy Review Namibia.* Paris: UNESCO.

UNESCO. (2017). *Cracking the Code: Girls and Women's Education in Science, Technology Engineering and Mathematics (STEM).* Paris: UNESCO.

UNESCO. (2017). *At a crossroads: Higher Education in Latin America and the Caribbean.* Washington DC. World Bank. http://dx.doi.org/10.1596/978-1-4648-1014-5

Universities Funding Board. (2019, May Monday). *Differentiated Unit Cost Criteria*. Retrieved May Monday, 2019, from Universities Funding Board: ufb.go.ke/wp-content/uploads/2021/01/Maximum-Differentiated-Unit-cost-criteria.pdf

Usher, A., & Medow, J. (2010). *Global Higher Education Rankings 2010: Affordability and Accessibility in Comparative Perspectives.* Toronto: Canada Higher Education Strategy Associates.

Valeta, J., Sefasi, A., & Kalizang'oma, R. (2016). Status of Higher Education, Science and Technology in Malawi: A Focus on Agricultural Higher Education. *African Journal of Rural Development*, 1(2). Doi: 10.22004/ag.econ.263568

Vibhash, K. (2013). Challenges and Opportunities in Higher Education System in India. *Business Review.*, 14(2) 29-42. ISSN 0972-222X https://ssrn.com/ abstract=2507206

Wanzala, O., & Nyamai, F. (2018, April 10th). 68,800 KCSE Candidates Get University Slots in Kenya. *Daily Nation*.

World Bank (2008). *Science, Technology, and Innovation: Capacity Building for Sustainable Growth and Poverty Reduction*. Washington DC. World Bank. ISBN: 978-0-08213-7380-4. Doi: 10.1596/978-0-8213-7380-4

World Bank. (2014). *Kenya's Education Achievement and Challenges.* Washington, DC: World Bank.

World Bank. (2016). *Expanding Tertiary Education for Well-Paid Jobs: Competitiveness and Shared Prosperity in Kenya.* Washington DC: World Bank.

Yakaboski, T., & Birnbaum, M. (2013). The Challenges of Students' Affairs at Kenyan Public Universities. *Journal of Student Affairs in Africa*, 33-48 1(1). Doi: 10.14426/jsaa.v1i1-2.34

Yano, S. (2012). *Overeducated? The Impact of Higher Education Expansion in Post-Transition Mongolia.* New York: Columbia University.

Yingyi, M., & Liu, Y. (2017). Entry and Degree Attainment in STEM: The Intersection of Gender and Race/ Ethinicity. *Social Sciences*, 6(89) 1-17 Doi: 3390/socsci6030089.

APPENDICES

Appendix: I Questionnaire for Students

Dear respondent,

My name is Bernard Wasilwa Wanyama. I am a PhD student at Kenyatta University and currently undertaking a research entitled "**Government Policies on Admission into Science and Technology Bachelor Degree Programmes and the Impact on Students' Participation in Public Universities, Kenya".** Your contribution to this research work will be highly appreciated. I assure you that your views will be used solely for the purpose of this particular study and data collected shall be kept confidential and handled professionally to ensure privacy and security. Kindly, provide information to all the questions.

Yours sincerely,

Bernard Wasilwa Wanyama (Researcher)

Tel. 0721283708

Email: wanyama.bernard@ ku.ac.ke

I: BACKGROUND INFORMATION

1. School/ Faculty: Engineering [ ] Veterinary Medicine [ ]

2. Year of study: (Please tick one) 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ]

3. Mode of access to University Programme (Please tick one) Self-sponsored [ ]

KUCCPS direct admission [ ] Affirmative KUCCPS admission [ ] any other,

Specify……..

4. Gender: Tick your gender: Female [ ] Male [ ]

5. Secondary Education: Tick the type of secondary school that you attended i) **Public**: National

[ ] Extra-County [ ] County [ ] Sub- County [ ] ii) Private [ ]

II: FINANCING UNIVERSITY EDUCATION

1. Do you apply for HELB loan: Yes [ ] No [ ]

2. If no, what is the reason for not applying?

I can afford to finance my education without student loan [ ]

I cannot find guarantors [ ]

Other (please specify)…….

3. If yes, do you receive the loan: Yes [ ] No [ ]

4. If no, what are the reasons given by HELB for not awarding you the loan?……
…….....

5. If yes, how much per year: Ksh 35,000-40,999 [ ] Ksh. 41,000-50,999 [ ] Ksh. 51,000-60,000 [ ] above Ksh. 60,000 [ ]

6. How much do you spend on University education per year per item indicated in the Table below?

Item	**Approximate amount in Ksh.**
Tuition fees	
Accommodation	
Catering	
Books and stationary	
Field work	
Research	
Transport	
Others (specify)	
Total	

7. Where do you get money to finance your University education?

Government sponsorship [ ] Parent/s [ ] Guardian [ ] scholarship [ ] Self [ ] other

(Specify)……..

8. What is your parents'/guardians' highest level of education? Non- formal education [ ] Primary [ ] Secondary [ ] Tertiary College [ ] Bachelors [ ] Masters [ ] Doctorate [ ]

9. What is your parents'/guardians' major source of income? Employment in government [ ]

Employment in private sector [ ] Employment in NGO [ ] Business person [ ] Farmer [ ]

Other (Please specify)……

10. Tick one column to fill the approximate monthly income of your parent/guardian in the Table below:

Monthly approximate amount in Ksh.	**Tic**k
Ksh. 12,000- Ksh.48,099	
Ksh.48,100- Ksh. 96,099	
Ksh.96,100- Ksh. 144,099	
Ksh.144,100- Ksh.192,099	
Above Ksh. 192,100	

11. What are the main financial challenges you face as you pursue your studies?

.....

III: INFRASTRUCTURE, TEACHING AND LEARNING RESOURCES

1. In the Table below, rate the adequacy/inadequacy of the resources in your College/School/Faculty.

Resource	**Very adequate**	**Adequate**	**Inadequate**	**Very inadequate**
Laboratories				
Workshops				
Spare parts				
Maintenance of equipment				
Repairs				
Upgrading				
Reagents and consumables				
Lecture rooms				
Lecturers				
Technicians				
Lab assistants				
Practical hours/week				
Methods of teaching				
Mode of assessment				
Tutorials and seminar work				

2. Which other resource/s do you find to be lacking in your College/ School/

   Faculty?……...
   .....

Thank you for your participation

Appendix: II Interview schedule for Lecturers

My name is Bernard Wasilwa Wanyama. I am a PhD student at Kenyatta University and currently undertaking a research entitled "**Government Policies on Admission into Science and Technology Bachelor Degree Programmes and the Impact on Students' Participation in Public Universities, Kenya".** Your contribution to this research work will be highly appreciated. I assure you that your views will be used solely for the purpose of this particular study and data collected shall be kept confidential and handled professionally to ensure privacy and security. Kindly, provide information to all the questions.

1. Background information: inquire on academic qualifications and work experience
2. Staff training and incentives: probe on staff development scheme, recruitment and motivation of staff members in the Department
3. Availability of infrastructure, teaching and learning resources: probe on laboratory space, suitability, maintenance and safety, workshops space and suitability, benches, first aid kits, lighting and ventilation, lecture rooms availability and suitability. Spare parts and maintenance of equipment, repairs, upgrading, reagents and consumables.
4. Human resources: probe on, student- lecturer ratio and teaching loads, teaching pedagogy, and mode of assessing students on campus and in the field.
5. What are the challenges that limit the number of students accessing and participating in Science and Technology Programmes in your Department?
6. Explain to what extent the curriculum being offered in your Department is reviewed with the aim of aligning it to the industrial orientation.

7. What interventions do you suggest to be done to overcome the challenges faced in relation to access and participation in Science and Technology Programmes?

Thank you for your participation

Appendix: III Interview Schedule for Heads of Departments

My name is Bernard Wasilwa Wanyama. I am a PhD student at Kenyatta University and currently undertaking a research entitled "**Government policies on admission into Science and Technology Bachelor Degree Programmes and the impact on students' participation in Public Universities, Kenya".** Your contribution to this research work will be highly appreciated. I assure you that your views will be used solely for the purpose of this particular study and data collected shall be kept confidential and handled professionally to ensure privacy and security. Kindly, provide information to all the questions.

1. What are the access modes for the admission to Bachelor programmes in your Department? (Probe on KUCCPS, SSP, Affirmative Action, and Continuing Education) Which mode gives students more latitude to pick a course of one's choice?
2. Comment on the trend of students' participation in your Department.
3. Which type of secondary schools mainly supply students to your Department?
4. How often is curriculum reviewed in your Department? (Probe on aligning to industrial orientation and splintering).
5. To what extent does your Department have links with industry players with respect to curriculum review, internships, workplace seminars and symposia?
6. Comment on the following concerning your Department:
    i) Accreditation of your academic programmes (CUE and professional bodies).

ii) Qualifications and numbers of your human resources (teaching and non-teaching), staff development scheme, staff turnover like brain drain, lecturer-student ratio, teaching loads, incentives to retain staff.

iii) Suitability of your infrastructure, teaching pedagogy, tutorials, seminar discussions.

iv) Assessment of students on campus and during industrial attachments (assessment modes and attachment duration).

v) Effects of e-learning on participation in programmes offered by your Department.

7. In your view, what are the challenges to participation in Science and Technology Programmes? (Probe on admissions policy, funding, infrastructure, teaching and learning resources).
8. What is the impact of the challenges you have identified towards enhancing participation in Science and Technology Programmes.
9. Suggest possible interventions that may enhance students' participation in Science and Technology Programmes: (probe links to secondary schools, matriculation exceptions, concessionary selection of students, incentives to human resources, staff development schemes, funding policy, tax waivers, tax rebates, endowment funds, intergovernmental partnerships, University-industry linkages, commercializing intellectual property, IGAs, science and technology entrepreneurships, professional development hubs, value engineering).

Appendix: IV Open-ended Interview Schedule for Academic Registrars

My name is Bernard Wasilwa Wanyama. I am a PhD student at Kenyatta University and currently undertaking a research entitled "**Government policies on admission into Science and Technology Bachelor Degree Programmes and the impact on students' participation in Public Universities, Kenya".** Your contribution to this research work will be highly appreciated. I assure you that your views will be used solely for the purpose of this particular study and data collected shall be kept confidential and handled professionally to ensure privacy and security. Kindly, provide information to all the questions.

1. What are the access modes of students to Science and Technology Programmes in your University?
2. Comment on the trend of students' enrolment, participation and graduation in Science and Technology Programmes in your University.
3. Comment on the variety of science and technology programmes in your University.
4. What are the sources of funds which enable your University to offer Science and Technology Programmes? (Probe on capitation, HELB, fees, whether sources are sufficient, timely disbursement).
5. In your view, what are the challenges to widening participation in Science and Technology Programmes in your University? (Probe on admissions policy, funding, infrastructure, teaching and learning resources).
6. What is the impact of the challenges you have identified towards enhancing participation in Science and Technology Programmes?
7. In what ways does the University address the challenges which limit participation in Science and Technology Programmes?
8. What is the contribution of University-based interventions on improving participation in Science and Technology Bachelor Degree Programmes?

9. To what extent are contributions by the University sufficient towards enabling many students to participate in Science and Technology Programmes?
10. Suggest any other possible measures of intervention which could enhance students' participation in science and technology programmes (Probe links to secondary schools, matriculation exceptions, concessionary selection of students, incentives to human resources, staff development schemes, funding policy, tax waivers, tax rebates, endowment funds, intergovernmental partnerships, University-industry linkages, commercializing intellectual property, IGAs, science and technology entrepreneurships, professional development hubs, value engineering)

Thank you so much for allowing me to interview you

Appendix: V Document analysis

The researcher analyzed records admissions records, graduation booklets, and fees structures.

University records

University records were analyzed to get information on:

i) Number of Science and Technology Programmes.
ii) Number of students enrolled in Science and Technology Programmes.
iii) Number of academic staff in Science and Technology Programmes.
iv) Academic staff distribution by rank.
v) Number of students graduating in Science and Technology Programmes
vi) Entry qualifications

Fees structures

Fees structures were analyzed to get information on:

Cumulative costs of participating in Science and Technology Programmes per academic year.

Appendix: VI Observation Guide Form

Name of the University……

Both direct and participant observation ware carried out and they focused on describing:

i) Physical infrastructure like nature of buildings

……

……

…….....**...**

ii) Laboratory space, suitability, maintenance, safety precautions

……

……

……

……

iii) Workshops space, suitability, benches, first aid kits, lighting and ventilation

……

……

……

iv) Availability of apparatus, reagents and consumables

……

……

……

v) Teaching pedagogy/methods

……

……

vi) Evidence of tutorials, seminar discussions

……

……

……

vii) Lecturer-student ratios suitability

……

……

……

……

viii) Sufficient space in lecture rooms/theatres/halls, chairs, lighting, ventilation

……

……

……

……

……

Any other comment in relation to availability and maintenance of infrastructure, teaching and learning resources

……

……

Appendix: VII **Accredited Public Universities in Kenya, November 2017**

SN	Name of University	Year established	Year of award of charter
1	University of Nairobi	1970	2013
2	Moi University	1984	2013
3	Kenyatta University	1985	2013
4	Egerton University	1987	2013
5	Jomo Kenyatta University of Agriculture and Technology	1994	2013
6	Maseno University	2001	2013
7	Masinde Muliro University of Science and Technology	2007	2013
8	Dedan Kimathi University of Technology	2007	2012
9	Chuka University	2007	2013
10	Technical University of Kenya	2007	2013
11	Technical University of Mombasa	2007	2013
12	Pwani University	2007	2013
13	Kisii University	2007	2013
14	University of Eldoret	2010	2013
15	Maasai Mara University	2008	2013
16	Jaramogi Oginga Odinga University of Science and Technology	2009	2013
17	Laikipia University	2009	2013
18	South Eastern Kenya University	2008	2013
19	Meru University of Science and Technology	2008	2013
20	Multimedia University of Kenya	2008	2013
21	University of Kabianga	2009	2013
22	Karatina University	2010	2013
23	Kibabii University	2011	2015
24	Murang'a University of Technology	2011	2016
25	Machakos University	2011	2016
26	The Co-operative University of Kenya	2011	2016
27	University of Embu	2011	2016
28	Kirinyaga University	2011	2016
29	Rongo University	2011	2016
30	Taita Taveta University	2011	2016
31	Garissa University	2011	2017

Commission for University Education- 2017

Appendix: VIII A machine in Civil Engineering Workshop

(Notice the deflated tire and dilapidated floor)

Source: Photograph taken during field inquiry, October 201

Appendix: IX The inside of Electricity Laboratory

(Notice the precautionary/safety measure indicated on the wall)

Source: Photograph taken during field inquiry, October 2019

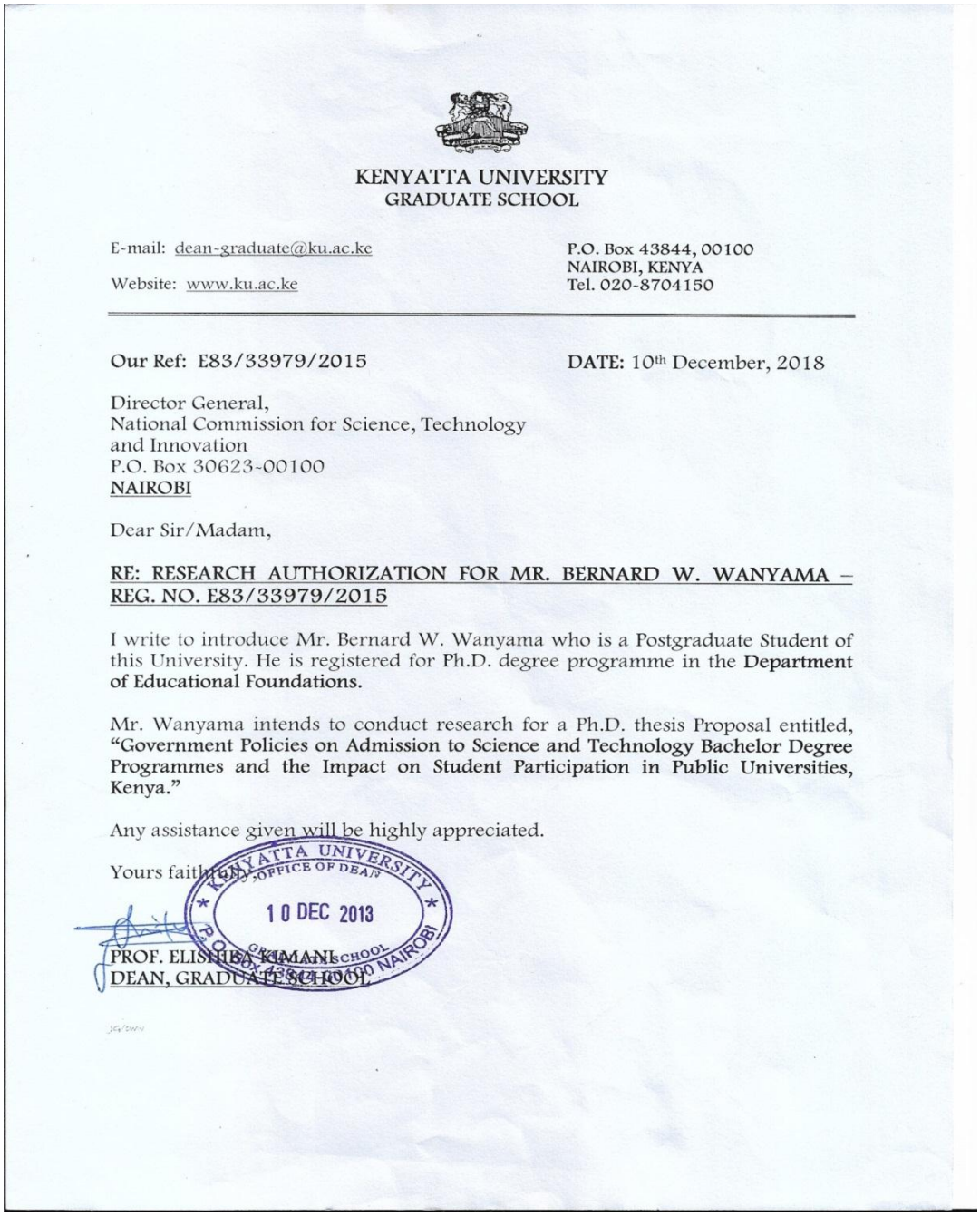
Appendix: X Entrance to Egerton University Tatton Agriculture Park (TAP)

Source: Photograph taken during field inquiry, October 2019

Appendix: XI Moi University new desktop portfolio display

Source: photograph taken during field inquiry, October 2019

Appendix: XII Letter of Research Authorization from Kenyatta University



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Our Ref: E83/33979/2015

DATE: 10th December, 2018

Director General,
National Commission for Science, Technology
and Innovation
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. BERNARD W. WANYAMA – REG. NO. E83/33979/2015

I write to introduce Mr. Bernard W. Wanyama who is a Postgraduate Student of this University. He is registered for Ph.D. degree programme in the **Department of Educational Foundations.**

Mr. Wanyama intends to conduct research for a Ph.D. thesis Proposal entitled, **"Government Policies on Admission to Science and Technology Bachelor Degree Programmes and the Impact on Student Participation in Public Universities, Kenya."**

Any assistance given will be highly appreciated.

Yours faithfully,

KENYATTA UNIVERSITY * OFFICE OF DEAN * 10 DEC 2013 GRADUATE SCHOOL P.O. Box 43844-00100 NAIROBI

PROF. ELISHIBA KIMANI
DEAN, GRADUATE SCHOOL

Appendix: XIII Letter of Permission to carry out research at Egerton University

EGERTON

P.O. Box 536 -20115
Egerton, Kenya

UNIVERSITY

Tel: +254-51-2217801/808
+254-51-2217891/2
Cell: 0708489256
0775015388
Fax: +254-51-2217942
E-mail: dvcre@egerton.ac.ke

OFFICE OF THE DEPUTY VICE - CHANCELLOR

RESEARCH AND EXTENSION

EU/DVC/RE/089 **4th October, 2019**

Bernard Wasilwa Wanyama,
Kenyatta University,
Department of Education Foundations,
P.O. Box 43844-00100,
NAIROBI.

RE: PERMISSION TO CARRY OUT RESEARCH AT EGERTON UNIVERSITY

Reference is made to your letter dated 3rd October, 2019 requesting for permission to carry out your PhD research study on "***Government Policies on Admission into Science and Technology Bachelor Degree Programmes and the Impact on Student Participation in Public Universities, Kenya***. It is noted that the data will be collected from Academic staff and students from Egerton University.

Authority is hereby granted for you to collect data in Egerton University. It is expected that this research is purely for academic purpose and will not be used otherwise. Upon completion of the study please ensure that you provide a copy of the report for our retention.

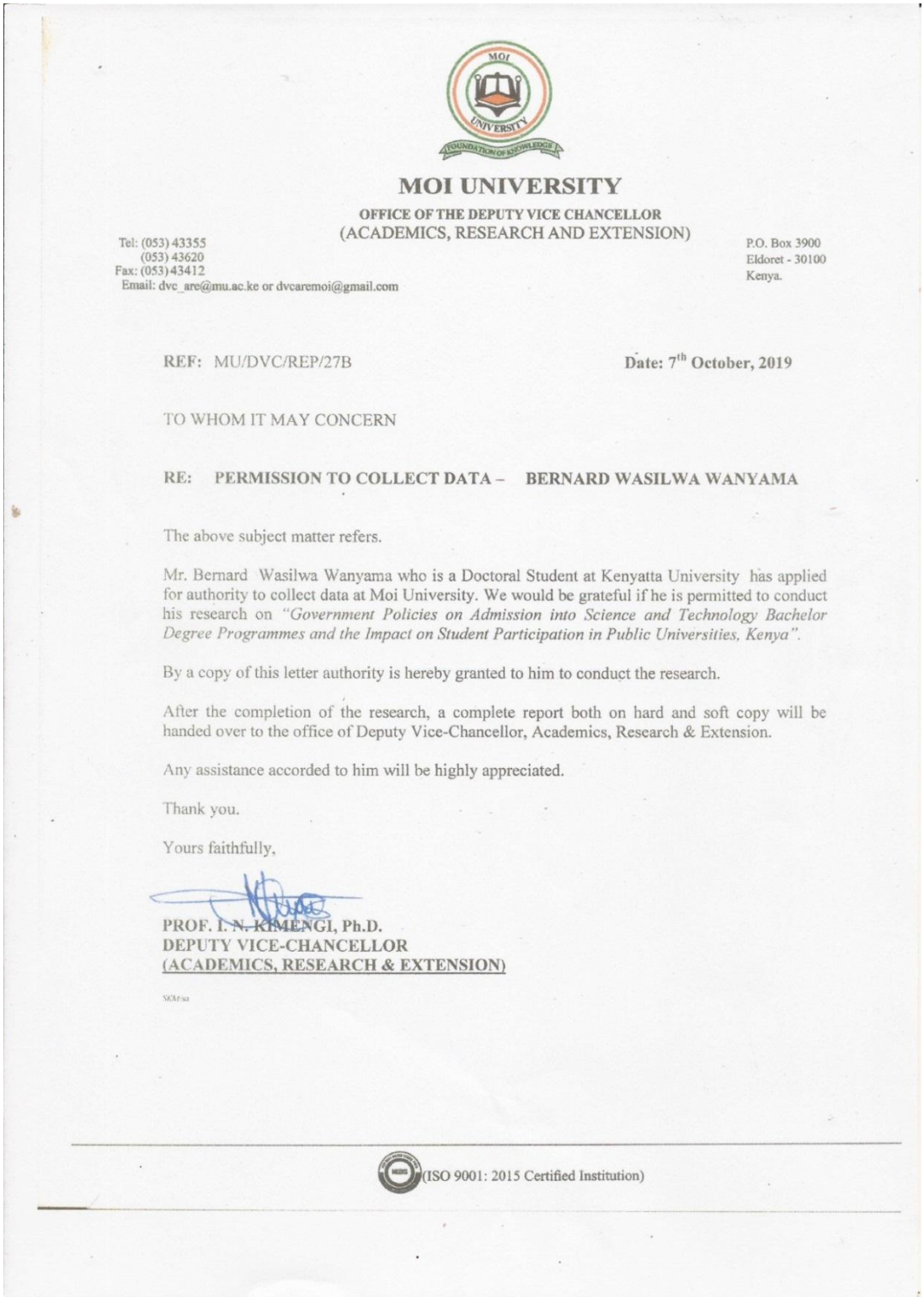
Prof. Alfred C. Kibor, Ph.D
Ag. Deputy Vice Chancellor (Research &Extension)

ACK/lm

DEPUTY VICE CHANCELLOR * RESEARCH & EXTENSION *

"Transforming Lives through Quality Education"

Appendix: XIV Letter of Permission to carry out research at Moi University



MOI UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR
(ACADEMICS, RESEARCH AND EXTENSION)

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P.O. Box 3900
Eldoret - 30100
Kenya.

REF: MU/DVC/REP/27B

Date: 7th October, 2019

TO WHOM IT MAY CONCERN

RE: PERMISSION TO COLLECT DATA – BERNARD WASILWA WANYAMA

The above subject matter refers.

Mr. Bernard Wasilwa Wanyama who is a Doctoral Student at Kenyatta University has applied for authority to collect data at Moi University. We would be grateful if he is permitted to conduct his research on *"Government Policies on Admission into Science and Technology Bachelor Degree Programmes and the Impact on Student Participation in Public Universities, Kenya"*.

By a copy of this letter authority is hereby granted to him to conduct the research.

After the completion of the research, a complete report both on hard and soft copy will be handed over to the office of Deputy Vice-Chancellor, Academics, Research & Extension.

Any assistance accorded to him will be highly appreciated.

Thank you.

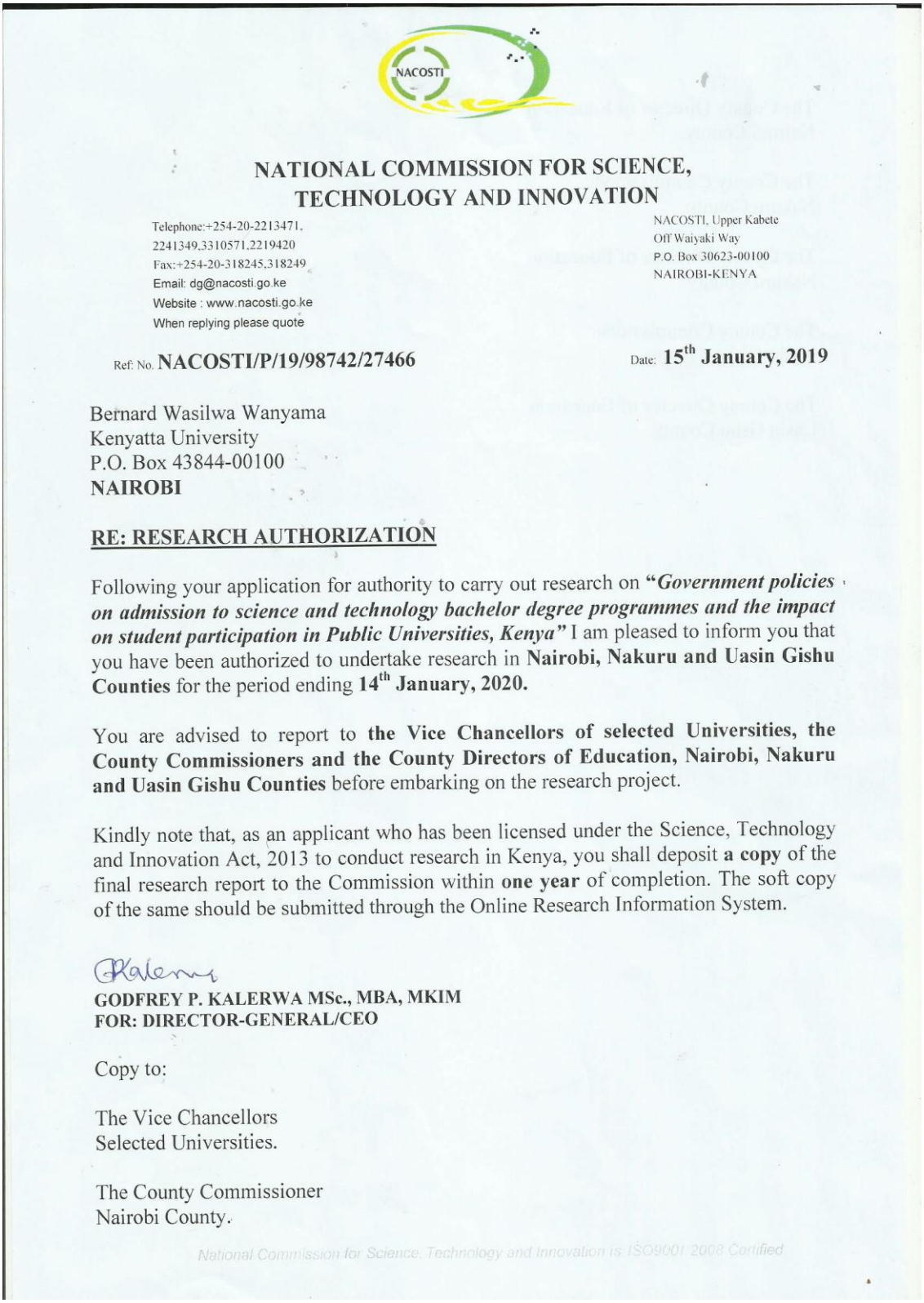
Yours faithfully,

PROF. I. N. KIMENGI, Ph.D.
DEPUTY VICE-CHANCELLOR
(ACADEMICS, RESEARCH & EXTENSION)

SCM/sa

(ISO 9001: 2015 Certified Institution)

Appendix: XV Letter of Research Authorization from NACOSTI



NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/98742/27466**

Date: **15th January, 2019**

Bernard Wasilwa Wanyama
Kenyatta University
P.O. Box 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Government policies on admission to science and technology bachelor degree programmes and the impact on student participation in Public Universities, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi, Nakuru and Uasin Gishu Counties** for the period ending **14th January, 2020.**

You are advised to report to **the Vice Chancellors of selected Universities, the County Commissioners and the County Directors of Education, Nairobi, Nakuru and Uasin Gishu Counties** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The Vice Chancellors
Selected Universities.

The County Commissioner
Nairobi County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

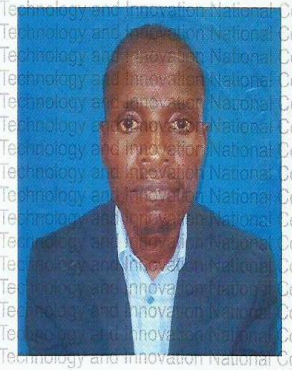
Appendix: XVI Research Permit

THIS IS TO CERTIFY THAT:
MR. BERNARD WASILWA WANYAMA
of KENYATTA UNIVERSITY, 0-100
NAIROBI,has been permitted to conduct
research in *Nairobi, Nakuru ,*
Uasin-Gishu Counties

on the topic: *GOVERNMENT POLICIES ON ADMISSION TO SCIENCE AND TECHNOLOGY BACHELOR DEGREE PROGRAMMES AND THE IMPACT ON STUDENT PARTICIPATION IN PUBLIC UNIVERSITIES, KENYA.*

for the period ending:
14th January,2020

Permit No : NACOSTI/P/19/98742/27466
Date Of Issue : 15th January,2019
Fee Recieved :Ksh 2000



Applicant's Signature

Director General
National Commission for Science, Technology & Innovation