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Original Research Article

Exploring Interventions for increasing Students' Participation in Science and Technology Bachelor Degree Programmes in Public Universities, Kenya

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Abstract: This paper argues that although the government and public Universities have committed to initiating several intervention measures targeting increasing students' participation in Science and Technology Programmes, only 29% of students were studying a course in these areas 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 evaluate some interventions that could be employed to increase student participation. The study employed descriptive survey design to target 31 public Universities, 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 who participated in the study and interview schedules were utilized to collect data. 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 and pie charts. It was established that Inter-governmental co-operations, linkages and agreements, University-secondary schools linkages, Income Generating Activities (IGAs) and relying on philanthropic gestures were interventions employed. The study concludes that most intervention measures had not played a significant role in enhancing students' participation and recommends that 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.

Keywords: Interventions, Participation, Public University, Science and Technology Programmes.

I. BACKGROUND

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). In this regard, many governments and Universities have initiated intervention measures to increase student participation in these programmes. For instance, 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).

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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).

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).

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). The purpose of this study was therefore to explore some interventions that could be employed to enhance student participation.

II. 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 and Universities introduced several interventions measures in order to increase students' participation in Science and Technology Programmes at Bachelors' level. Some of the measures included diversification of sources of revenue, introduction of IGAs, attracting funds through research grants from local, regional and international bodies and entering into inter-governmental linkages, exchanges and agreements (Michieka, 2016; Oanda and Sifuna, 2016; Akuno *et al.,* 2017).

Despite implementation of all these, 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 interventions which could be employed to popularize the Science and Technology Bachelor Degree Programmes.

III. OBJECTIVE

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

IV. REVIEW OF RELATED LITERATURE

Review of related literature covers institutional based interventions in Science and Technology Programmes, cascaded from a global viewpoint to regional level and then national level. Streete (2016) conducted an online survey of graduates of Government Assistance for Tuition Expenses (GATE) in Trinidad and Tobago. 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 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. 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. This 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 and lecturers 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). This 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 Rajibussalim carried out a case study of the University of Western Indonesia (UWI). This 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. This 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. This 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, this 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. This 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. 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.

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. This 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.

V. METHODOLOGY

Research Design

This study adopted descriptive survey design method to evaluate the institutional based interventions which could increase students' participation in Science

and Technology Programmes at Bachelor Level in Public Universities in Kenya. Descriptive survey is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals (Kombo & Tromp, 2006). Cohen *et al.*, (2007) observed that data gathered from descriptive survey serve three main purposes, namely: describing the nature of existing conditions, comparing them to certain standards of life and determining the relationship between specific events. The design was found appropriate because it assisted the researcher to evaluate the government and institutional based interventions employed.

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) which were purposively sampled. 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).The Universities were purposively sampled based on the set criteria. First, the University must have been operational during the time of the implementation of 2010 KESSP I admission policy which 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. Opinions of the lecturers, Heads of Departments and Academic Registrars was sought since they were directly involved in initiating and implementing intervention measures. The summary of target population, sample size and sampling technique are presented in Table 1.

Table 1: Summary of target population, Sample size and sampling technique

Category	Target population	Sample size	%	Sampling technique
Universities	31	3	9.7	Purposive
Manufacturing and Veterinary Lecturers	237	24	10.1	Purposive
Academic Registrars in the sampled Universities	31	3	9.7	Purposive
Heads of Departments in sampled Universities	107	12	11.2	Purposive
Total	**407**	**42**		

Data Collection Instruments

The study utilized open-ended interviews to collect data from Lecturers, Heads of Departments and Academic Registrars. Open-ended interviews yielded mainly crucial information on 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 because they were flexible, adaptive and offered credible- in-depth responses.

Data Analysis

Simple descriptive analysis was utilized where data was grouped and presented in form of narrations and quotations in order to evaluated intervention measures employed at public universities.

VI. RESULTS AND DISCUSSION

Information was sought on whether inter-governmental cooperations were part of government interventions employed to enhance participation. 100% (39) 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.

With regard on whether the inter-governmental cooperations were enhancing participation. The findings are depicted in Figure 1 below:

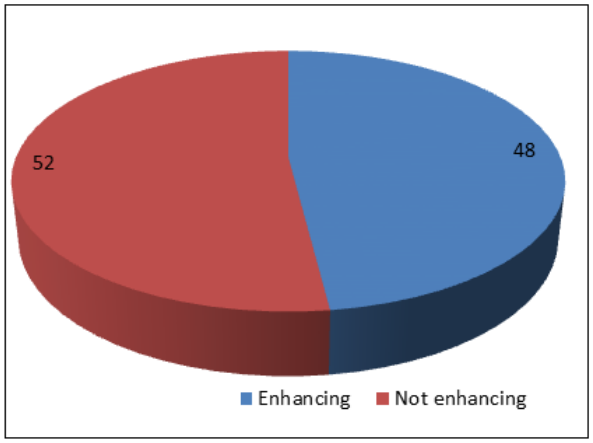

Figure 1: Lecturers, HoDs and Academic Registrars' views on whether inter-governmental cooperations was enhancing participation

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

Figure 1 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.

On University-based interventions, 100% (39) 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.

With regard to Income Generating Activities (IGAs), 100% (39) of the respondents concurred that Universities engaged in IGAs. In this regard, one HoD pointed out:
Technical University of Kenya (TUK) has 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).

On effectiveness of IGAs as interventions towards enhancing participation, 39(100%) of responses reflected, in one way or another, challenges facing the initiatives. The findings are presented in Table 2 below:

Table 2: 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 2 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.

On the question of whether research grants and donations was 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.

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.

VII. CONCLUSION

The study concludes that 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.

VIII. RECOMMENDATION

The study recommends that 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.

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