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Can e-learning promote participation of female students in STEM disciplines in higher learning institutions of Tanzania?

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ABSTRACT

The recent development of ICTs has brought many changes in different sectors. In Higher Learning Institutions, there are a number of positive changes. ICTs have brought efficiency, effectiveness and efficacy in the provision of the core functions namely: teaching, outreach, research and consultancy. Previous studies showed that even though there is improvement in teaching and learning through e-learning but few studies researched e-learning as tool for promoting female students to participate in science, technology and mathematics disciplines. This study was done to evaluate if the e-learning can promote the participation of female students in science, technology and mathematics subjects in different Higher Learning Institutions of Tanzania. The mixed research methodology was used in this study. The results showed that the potential benefits of e-learning as tool for promoting students uptake for science, technology and mathematics subjects was not fully exploited in Tanzania. Thus, this calls different stakeholders to fully implement and mainstream e-learning in Higher Learning value chain to make it a reality and not myth in promoting female students participation is science, technology and engineering.

Keywords: *higher learning institution, female student, promotion, participation, ICT resource, technology, face to face learning, e-learning*

1.0 BACKGROUND INFORMATION

Information and Communication Technologies (ICTs) hold great promise for promoting participation of female students in learning and teaching (Tearle *et al.* 1998). The ICTs enhance interaction among students, information, and systems in ways that never before have been possible (Sife *et al.* 2007). In Tanzania, participation of female students in Science, Technology and Mathematics (STEM) disciplines in Higher Learning Institutions (HLIs) is very low (Leigh-Doyle 1991; Morley *et al.* 2007; Nawe 2002). In this study, technology discipline meant subjects dealing with ICT or computing and related engineering subjects. In any country, e-learning has been invoked as solution in promoting participation of female students in the mentioned disciplines.

Participation of female students in STEM is relatively very low in Tanzania. Statistics from HLIs indicate that the levels of participation in some aspects of STEM, particularly science and engineering, have not increased to the same extent as overall levels of entry to higher education[1] (Morley *et al.* 2007). Possible reasons for such situation could be among others:the negative images of science subjects, relative difficulty of science subjects, low social status of technology graduates as compared to arts and social sciences subjects graduates, gender differences, the system of subject choice in secondary schools, low number of secondary schools enrolling females in science subjects, lack of encouragement from/by family members/teachers/pioneersetc., low levels of occupational awareness and careers guidance and problems of student finance (Green & Trevor-Deutsch 2002).

[1] http://www.tanzania.go.tz/gender.html

However, under the current globalized era such subjective reasons should not be accepted and become barriers. There are many challenges that developing countries including Tanzania face. Some of these challenges include old, low and uneven education participation; poor quality education; low per-capita incomes; and a rapidly growing population (Mkude *et al.* 2003). These challenges have been joined by new and more daunting challenges including HIV/AIDS[2]and lack of political influences. Factors influencing poor quality education in developing countries including Tanzania are well understood (Mkude *et al.* 2003). These include poor financing; unregulated, uncontrolled proliferation of tertiary training institutions; a tendency to distort the real worth of experts' contributions; lack of political support; and weak institutional structure of higher learning institutions (Mkude *et al.* 2003).To reverse the trend of education system, Tanzania and other developing countries, need to adopt well-advanced technologies in delivering education services. Thus, Government should have an emphasis on ways to improve the quality of education in STEM.

E-learning is becoming a key and effective component in higher learning institutions worldwide (Eklund *et al.* 2003; Stoltenkamp *et al.* 2007). Additionally, the technology has become a major player in global provision of education, which is gender sensitive (Morley *et al.* 2007). In Tanzania, e-learning is at infancy stage; in a way thatmajority of the population is not aware of the technology (Sife *et al.* 2007). This calls for much information which will be useful for motivating female students in STEM subjects.

E-learningcan help in solving some problems and addressing the challenges facing education system in developing countries (Sanga *et al.* 2006). Well-designed e-learning initiatives can provide a low-cost, flexible, and culturally appropriate alternative to traditional face-to-face learning. This is more important in complementing the advantages brought by face to face learning and teaching. Much effort is required to promote high participation of female students in STEM. Experiences elsewhere showed that e-learning plays a great role to promote female participation in STEM disciplines (Green & Trevor-Deutsch 2002).

In light of the above, promotion of female students' participation in STEM through e-learning is of great importance for (i) ensuring young people entering the workforce in the 21st century have the knowledge and skills necessary to promote economic, scientific and technological development; and giving the appropriate and required service to different citizens of Tanzania and (ii) understanding of scientific and technological approaches and evidence, so that they will be able to make informed decisions on scientific and technological issues. Therefore,there is a correlation between gender and ICT as started by many researchers such as Derbyshire(2003), Isaacs(2002), Huyer(2005),Buskens(2006), Radloff*et al*. (2004), and Betancourt (2013).

The participation of female students in STEM disciplines in other sub-Saharan countries has remained very low (Ottevanger *et al.* 2007). This calls fora need to promote their participation in STEM subjects in order to hold up with the current challenges facing developing countries. This calls for stakeholders from different sectors to invest in promoting females participation in sciences and computing related subjects.This study has explored the importance of e-learning technologies in delivering educational services and its promotion in enhancing participation of female students in STEM. The findings of this study will be useful to policy makers, academic communities and other stakeholders dealing with the development of e-learning systems.

The immediate goal of any HLI is to provide education which is not racial, age or gender-based bias. E-learning technology has potential to prove this premise. Long-term goals of the e-learning should be to facilitate and enable students and lecturers become and remain active participants

[2] http://www.tanzania.go.tz/hiv_aids.html

during learning and teaching processesanytime and anywhere. Also, it should improve the HLIs conditions for collaborative work between studentsand lecturers or students and students or lecturers and lecturers. This virtualrelationshipis important in creating conducive environment for studying and critical thinking.

The overall objective of this study was to explore the potential of e-learning in promoting participation of female students in STEM disciplines in HLIs of Tanzania.
Specifically, the study intended:

a) To analyze feasibility, efficiency and reach of various strategies for using Information and Communication Technologies for education, particularly on the benefits and degree of participation of female students in STEM disciplines at the higher learning institutions;

b) To analyze benefits of e-learning;

c) To establish indicators on female's participation in STEM at the higher learning institutions;

d) To establish strategies to encourage the participation of female in STEM education and training at higher learning institutions and in the workplaces;

e) To assess the factors, which hinder the development or adoption of e-learning systems at Higher learning Institutions.

2.0 RESEARCH METHODOLOGY

2.1. Study Area

The studyhas explored the appropriate ICTs for facilitating promotion of female students in STEM subjects through e-learning for different universities in different geographical locations of Tanzania basing on availability of different types of Information and Communication systems. Data was collected through research methods such as interviews, observation and documentary evidence.In addition to these methods some existing e-learning systems in those universities under this study wereanalyzed.Thus in summary the research method adopted in this study was mixed research method (Oates, 2006). The aim of triangulation is to have counter effect between qualitative and quantitative research methods where by the advantages of qualitative research methods will address the weakness of quantitative research method and vice versa.

2.2. Unit of analysis (Population)

The universities which were involved under this study were: University of Dar es Salaam (UDSM), Sokoine University of Agriculture (SUA), Open University of Tanzania (OUT), and Kilimanjaro Christian Medical College (KCMC) of Tumaini University. The experience gained in these universities can be rolled out to other universities, colleges and schools in any country with similar environment of Tanzania. This comprised the undergraduate and postgraduate students as well as academic staff of the SUA, UDSM, OUT and KCMC.

2.3. Sampling frame

This consists of list of undergraduate students, postgraduate students and academic staff as contained in the respective university directory book (or Fact and Figure report) for 2006/2009 academic years.

2.4. Sampling technique:

Random sampling technique was used so that selection of respondents is not biased.

2.5. Data Collection methods

2.5.1. Collection of primary data

Primary data were collected through personal interviews and observation. Questionnaires were also used. Interviews involved various stakeholders in the education sector including trainers/teaching staff, learners/students and researchers. An observation sheet for e-learning systems which are currently running was also prepared.

Assessment of the available e-learning in the selected universities was made through interviews with key informants such as lecturers, trainers, researchers, students, planning officers and examinations officers. Barriers attributable to poor implementation of e-learning systemwere identified. The socio-economic factors that hinder adoption of e-learning system were also determined. The willingness of various stakeholders (policy makers, students, lecturers, researchers and technicians) to adopt and use e-learning systemto promote participation of female students in STEMwas also assessed through interviews.

2.5.2. Collection of secondary data

Secondary data were collected through review of relevant documents available in the universities under this study (Table 1). Review of the universities' planning office plans was done to establish whether there are any e-learning system implementation components.

Table 1 *Data collection methods*

Specific activities	Expected outcomes	Research techniques
Visit other HLIs under this study to get information.	Workable examples of e-learning systems.	Documentary search, interviews with key informants and questionnaires
Conduct survey to collect information using focus groups and structured questionnaires.	Cost and benefit analysis of using e-learning	Documentary search, interviews with key informants and questionnaires
Consulting relevant organization to get information.	List of indicators to get rid of gender digital divide	Documentary search, interviews with key informants and questionnaires
Dissemination workshop to HLIs top officials, students and staff.	HLIs sensitized to encourage participation of female	Sensitization workshop. Number of students and staff using e-learning system.
Dissemination of results	Proposed solution to the implementation of e-learning	Leaflets, booklets and study report.

The study produced the following results:

a) Status of e-learning system in the universities under the study and socio-cultural factors hindering its' implementation was identified.

b) Workable examples of free and open source software e-learning systems(FOSSES) for universities under this study

- SUA - http://www.suasis.suanet.ac.tz:2020/
- UDSM - http://lms.udsm.ac.tz/login/index.php
- OUT - http://elms.out.ac.tz/login/index.php.

c) The potential benefits of e-learning in HLIs were identified and its effect to the participation of female students in STEM was identified.

2.6. Data analysis

Data collected were coded and then entered in statistical software for data analysis.

3.0 RESULTS AND DISCUSSIONS

This section presents the research results as per specific objectives of the study.
The distribution of respondents to different universities under this study is as shown in Table 2 below. Furthermore, participants were under three groups' namely undergraduate students, postgraduate students and teaching staff who contributed to a total of 251 respondents. Out of 165 undergraduate students, 90(54.5%) were male and 75(45.5%) were females (Table 3) students were 27(58.7%) and female postgraduate students were 19(41.3%) contributing to 46 postgraduate student. Teaching staff who were females outnumber males (11(27.5%) males and 29(72.5%females). The larger number of males students participated in the study reflects the reality that more males are enrolled than female students.

Table 2 *University where the respondents are based*

	Undergraduate Students		Postgraduate Students		Teaching staff	
	Frequency	Percent (%)	Frequency	Percent (%)	Frequency	Percent (%)
KCMC	14	8.5	6	13.0	7	17.5
UDSM	92	55.8	31	67.4	24	60.0
SUA	51	30.9	9	19.6	4	10.0
OUT	8	4.8	0	0	5	12.5
Total	165	100.0	46	100.0	40	100.0

Table 3 *Sex of respondent*

	Undergraduate Students		Postgraduate Students		Teaching staff	
	Frequency	Percent (%)	Frequency	Percent (%)	Frequency	Percent (%)
Male	90	54.5	27	58.7	11	27.5
Female	75	45.5	19	41.3	29	72.5
Total	165	100.0	46	100.0	40	100.0

A total of 165 undergraduate students, 154 students indicated that they pursued A' level studies in STEM subjects. Out of these;those who were took Physics, Chemistry and Mathematics (PCM) combination were 44(28.6%) whilePhysics, Chemistry and Biology (PCB) combination were 84(54.5%); Physics, Geography and Mathematics (PGM) combination was 1(0.6%);Chemistry, Biology and Geography (CBG) were 13(8.4%);Chemistry, Biology and Nutrition (CBN) combination were 3(1.9%);Chemistry, Biology and Agriculture (CBA) combination were 7(4.5%); and those who took Economics, Geography and Mathematics (EGM) combination were 2(1.3%) students (Table 4).

Table 4 *Combination undertaken during A-Level studies*

Combination	Frequency	Percent (%)
PCM	44	28.6
PCB	84	54.5
PGM	1	0.6
CBG	13	8.4
CBN	3	1.9
CBA	7	4.5
EGM	2	1.3
Total	154	100.0

3.1. Pre-Secondary School Computer Use

The use of ICT resources for learning and teaching process has not been utilized fully in Secondary school in Tanzania (Lujara, 2008; Kalinga, 2010). There are a number of factors that are contributing to this. Statistics shows a small proportion of students used computer during their primary education(Tedre *et al.* 2010). Table 5 shows that out of 165 undergraduate students, 3(1.8%) students started to use computers at primary school level, 48(29.1%) students used computer during their O' level secondary school studies and 55(33.3%) students started using computer during their A' level studies and 52 students started to use computer when they joined for their undergraduate studies. Situation like this does not accelerate the use of ICTs in learning and teaching.

Table 5 *When the respondent started using a computer*

Time	Frequency	Percent
During A-Level studies	55	33.3
During O-Level studies	48	29.1
During Primary School	3	1.8
During Bachelor's degree studies	52	31.5
Missing	7	4.2
Total	165	100.0

Table 6 shows that computer use did not influence students in choosing STEM subjects and even Advanced level (A-level) combination in their A' level studies (33 (20% were influenced, 132(80%) were not influenced). Failure of technology to influence the choice of subjects indicates that technology is at low level of usage, old or even not recognized.

Table 6 *Influence of computer in choosing A-level combination*

Response	Frequency	Percent
Yes	17	10.3
No	138	83.6
-	10	6.1
Total	165	100.0

The choice of studying STEM and combination during A' level studies are based on student's own interest and ability. Low computer use might be attributed by absence of computers in primary schools and secondary schools. Computer ownership is also hindering computer use as a small proportion of students owned computers.

3.2. Female students and STEM subjects

For quite sometimes now it is known that only a few female students studySTEM subjects during their O' level and A' level studies and even at the university level (Lord, 2008). Most female students opt for Arts subjects. This now is becoming a common notion among the students. Situations like this do not prepare young females to serve better the nation in future in science, technology and engineering fields. There are some reasons for females not joining for STEM studies that the respondentsmentioned. Examples of such reason are as shown below;

a) STEM subjects are hard and require confidence and ability to afford

b) Female students fear STEM subjects

c) Female students lack interest in STEM subjects

d) A built in notion from the society that STEM subjects are tough

e) Female students lack basic ground/poor background

f) Female students perform poor in STEM subjects

g) Female students are not motivated to study STEM subjects

h) Females have family engagement and social responsibilities

Some of these factors tend to be subjective and there are no concrete reasons to support them as they equally affect male students. Other reasons that are obstacle in promoting STEM subjects among girls are low level of technology or old technologypresent in developing countries, poor teaching system of STEM subjects, lack of teaching and learning resources like books and laboratories, a few STEM teachers and low payments to science and engineering graduates after being employed.These factors have the associated results;

a) Some girls change their mind and do not opt for sciences and engineering fields when they join the University even though they studied STEM at A' level

b) A few females graduate in sciences and engineering fields

c) Graduates not competent

Situations like these need to be addressed if the nation wants to prepare and recruit young females in sciences and engineering fields. In order to ensure that more female students study STEM subjects, undergraduate student respondents gave several options;

a) STEM subjects have to be introduced and emphasized at elementary level

b) The society should be sensitized, educated and even encouraged in STEM subjects

c) The STEM teaching system should be improved.For example, the Government should provide more ICT teachers, ICT books, and computer laboratoriesand laboratory equipments to schools.

d) Establishment of STEM subjects association or clubs in schools

e) The Government should motivate female students who perform well in STEM subjects

f) Open more STEM schools for girls

g) The teaching of STEM subjects should be localized as per resources available to students

3.3. Access to ICT resources

Access to ICT resources and its related technologies can also be a factor that hinders the use of computer in the learning and teaching process. The following was the observation during our study;

a) Few computer laboratories with a few computers. As a result of this, many students crowded for sharing a single computer during practical sessions in computer laboratory. This does not give a student on-hand practices as only a single student takes control of the computer and others have to watch what he/she is doing.

b) It was also observed that students submit written assignment by hands rather than printed work. The reason for this was that students didnot have enough computer skills and they felt 'it is tedious to type their works' and also feared printing costs.

c) Also few computer access points were observed in universities under this study. It was observed that a small proportion of students owned computers that they share with their fellow students. Students have to travel some distances to look for Internet café. At the Internet café, students have also to wait if all computers are in use.

d) Internet browsing was also another area that greatly drew our attention. Students felt that Internet use was not adequate in computer laboratory as most of the time it was inaccessible. A few computers were connected to the extremely slow Internet. As a result students rely only on photocopying text books for reference rather than relying to the Internet surfing.

Table 7 shows the places where students access computers.

Table 7 *Where the respondent accesses a computer*

Place	Frequency	Percent
Uses his/her own computer	42	25.5
Uses a computer in University lab	58	35.2
Uses computer in an Internet café	11	6.7
Uses his/her friend's computer	16	9.7
University lab and Internet café	27	16.4
His/her own computer, computer labs, and internet café	5	3.0
Not Indicated	6	3.6
Total	165	100.0

Table 8 shows the skills that students had in Word processing, data handling and analysis using MS Excel and SPSS, and Internet surfing.

The result shows that students are better equipped with word processing and Internet surfing. Student also indicated that they did notknow how to analyze data using spreadsheet and SPSS.

Table 8 *Knowledge level Application Software*

	MS Word		MS Excel		SPSS		Internet Surfing	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Very good	81	49.1	37	22.4	19	11.5	72	43.6
Good	54	32.7	68	41.2	38	23.0	59	35.8
Fair	22	13.3	34	20.6	45	27.3	17	10.3
Poor	5	3.0	18	10.9	42	25.5	8	4.8
-	3	1.8	8	4.8	21	12.7	9	5.5
Total	165	100.0	165	100.0	165	100.0	165	100

Table 9 shows that most students access the Internet at the Internet café rather than at the students' computer laboratories. This is due to the fact that there are no adequate computers connected to the Internet in the computer laboratory and the slow Internet connection in universities' laboratories.

Table 9 *Where the respondent normally uses the Internet*

Place	Frequency	Percent
University Computer Lab	34	20.6
Internet café	77	46.7
University Computer Lab and Internet café	38	23.0
Total	149	90.3
System	16	9.7
Total	165	100.0

3.4. Factors Hindering Access to ICT resources

There are a number of factors that hinder respondents from accessing ICT resources and its related technologies like the Internet, e-learning etc. Some of these factors are within respondents' ability, some are institution's cases and others are formingthe national ICT policies. Undergraduate students pointed some factors that prevent them from accessing ICT resources. These are as mentioned below;

a) Lack of funds to purchase computers or pay Internet from the Internet café

b) Time limit to look for Internet café from university

c) Not adequately ICT coursesavailable in Tanzania education system for A- level and O-level schools

d) Illiteracy in using computer

e) Slow Internet connection in most of the universities

f) Few Internet access points for wireless Internet connection

g) Lack of adequate computers in students' computer laboratories

h) Some websites require subscription fee to access journals

i) Poor strategies to manage computer labs as a result some computers were not running most of the time

j) Unreliable power supply as computer require stable electricity

k) Poor knowledge on Internet search

3.5. Use of ICT in learning and teaching

The use of ICT in learning and teaching process in HLIs of Tanzania is now taking its course. Universities like UDSM and SUA have implemented e-learning and some instructors are using them as described above. In exclusive interview with students and teachers, the following were the observations;

a) Instructors felt that e-learning has reduced physical contacts with students. Instructors can give course notes, assignments and even announcements to students electronically. Students also do the same by submitting their assignments and questions to their instructors electronically.

b) Students felt that e-learning makes course materials to be more available especially in electronic form rather than relying on sharing on few hardcopies.

A small proportion of postgraduate students (17 (37%)) responded that they have used e-learning during their studies compared to 26(56.5%) out of 46 respondents who never used e-earning (Table 10). These respondents felt that e-learning was very helpful and useful, provides access to learning materials at any time and supplement classroom activities. The respondents also felt that use of ICT technologies like e-learning can increase female participation in STEM subjects by providing learning and research materials, motivates them and builds their confidence, very convenient in terms of being flexible in terms of time to support learning and it is always available, and creates lifelong learning.

Table 10 *Whether the postgraduate students have ever used e-leaning*

Response	Frequency	Percent
Yes	17	37.0
No	26	56.5
missing	3	6.5
Total	46	100.0

On the other hand, teaching staff respondents felt that e-learning resource can increase female participation in STEM subjects in terms of:

a) Learning materials are readily available and free of charge

b) E-learning is very flexible, allows learning anywhere and anytime

c) Create lifelong communities of learners

d) Students participate in group learning and discussions over the e-learning platform and enhance distance and open learning

The use of e-learning in learning and teaching is also encouraged by instructors at the respective institutions. The strategies involved include teaching information searching courses, provide assignment that require Internet searching, provide references to learning websites, post notes, discussion questions, assignments on e-learning, and encourage students to register and participate on online discussion forums.
Though some respondents felt that e-learning can increase female participation in STEM subjects, other respondents had opposite opinions. Postgraduate students mentioned the following reasons;

a) Studying STEM subjects depends on attitudes and sensitivity of female students

b) There are no/fewer computers in secondary schools attributing to inadequate use of computer and the Internet thus can't motivate female students

c) Studying STEM subjects is a matter of personal interest, and most girls opt for Arts subjects

d) Nothing can replace face-to-face interaction between teachers and students. E-learning can be used as a supplement only and not a replacement

Teaching staff who felt that e-learning cannot increase female participation in STEM subjects had the following opinions in addition to above opinions of postgraduate students:

a) ICT is a new technology and there are few competent instructors to teach it

b) ICT resources are not available in some areas of Tanzania

c) Girls prefer more social issues than technology, science and engineering subjects.

d) Girls perceive that STEM are difficult subjects compared to ARTS

3.6. Improving thee-learning in HLIs

As the world now is moving to information and knowledge society, there is a need to mainstream ICT in every aspect of our life. ICT need to be mainstreamed in education sector, health sector, business sector etc. As pointed above, a number of factors are obstructing the struggle to break to the information and knowledge age. Respondents have different opinions on how the Universities can improve computer use among students;

a) Provision of adequate computers

b) Increase number of computer labs

c) Increase Internet connected computers in the Computer labs

d) Instructors encourage students to use Internet

e) Improve Internet speed

f) Introduce/teach more computer courses

g) Staff training and development in ICTcourses

3.7. University strategies to increase ICT usage

Universities have realized the importance of ICTs in learning and teaching. Almost all the Universities under this study have computer laboratories though computer use is inadequate. The

respondents suggested the Universities should have strategies to increase more computers and mainstream ICT courses in learning and teaching;

a) Improve/build ICT infrastructure to accommodate all students and staff

b) This is through providing more computers and computer laboratories which need to have local area network connected with reliableIntranet

c) Increase bandwidth and connect more computers to the Internet

d) Teach computer courses to students

e) Staff training in ICT courses

f) Instructors involvement in encouraging students to use ICT

g) Fully employ e-learning to complement face to face learning and teaching processes

h) Develop ICT policy and master plan of it with one of the emphasis being ICT use in learning and teaching

3.8. Female students with ICT

Access to ICT resources also need to be assessed based on gender(Blum *et al.* 2007; Reagle 2012). Previous study shows that in situations where there are scarce resources males students tend to benefit more if gender is not consideredin allocation of ICT resources (Nawe 2002). In computer laboratories with inadequate computers and students crowded for sharing computers, male students predominantly are the operators. Failure of female students to access proportionally ICTs resources as males do originates from some gender factors(Sanga *et al.* 2011). Respondents have different views on this. Undergraduate students pointed out that male student have more time to spend on computers than female students. Table 11 shows the undergraduate students opinions on which male have more time to access computers.
Respondents showed that male students have more time because they are curious and interest to learn more knowledge in ICT usage, they are willing and commitment to study and learn, more favored and outnumber females, and they are not committed to social responsibilities as compared to female students.

Table 11 *The category of University Students with more access to ICT*

Category	Frequency	Percent
Male	64	38.8
Female	10	6.1
Both have equal time	87	52.7
Total	161	97.6
Missing	4	2.4
Total	165	100.0

The results from this study have shown the potential and promises of e-learning in promoting female participation in STEM disciplines. This concurs with the results of other researchers such Green and Trevor-Deutsch(2002); Mwetulundila (2002) and Sanga *et al.*(2011). The findings from this research contribute to the body of knowledge in the area of implementation of e-learning. Holistic research approach for implementing e-learning is suggested as having a promise of

bringing required positive results. This is an additional recommendation from the ten myths identified by Njenga and Fourie (2010). Also, the teaching methodologies for e-learning need to incorporate some feminist issues in all of the research processes so that research activities are engendered and not endangering gender. This is a key factor because the goal of our research was to find how to mainstream e-learning for female students' promotion in STEM. Furthermore, it advocates participatory action research as the method for e-learning implementation. This is additional to eight paradoxes identified by Guri-Rosenblit (2005) in implementing e-learning for HLIs.

The incorporation of ICT in learning and teaching process in Universities in developing countries like Tanzania is inevitable. Even though the Universities in developing countries are characterized by poor teaching and learning environments, shortage of teaching staff, shortage of text and reference books as well as crowding of students in classes but still ICT can help to address some of these prevailing problems. This observation is a similar to that from STRAPA report which calls for change in strategy and management, learning (pedagogy) design, course delivery, staff support and student support so that East Africa Universities can change from infancy stage (level 1) to the maturity level (level 5) of e-learning implementation framework (Rytkønen & Rasmussen 2010).

The application of e-learning and its related technologies such as web 2.0 tools have great potential in improving the learning process(Lwoga 2012). The e-learning provides more learning material to students, and thus supplements the gap of shortage of text books. The best practices in strategizing e-learning in HLIs advocated by Nagunwa and Lwoga (2013) for the universities in developing countriesneed to be shared and be piloted to assess its usefulness in promoting STEM for female students.

The area for further study could be towards debunking the myth about poor performance of female in STEM subjects using e-learning (Blum *et al.* 2007; Stoet & Geary 2012). Thus, the justification for such research could be centred at getting rid the perceived stereotype about poor participation of students in STEM subjects as advocated by Lauer *et al.*(2013).

4.0 CONCLUSION

The findings from this paper are based on the specific objectives mentioned earlier. We found that the degree of participation of female students in STEM disciplines at the higher learning institutions in Tanzania is very low comparative to male students taking STEM subjects. On the analysis of the benefits of e-learning mentioned by instructors and students are as follows: Learning materials are readily available and free of charge, E-learning is very flexible, allows learning anywhere and anytime, Create lifelong communities of learners, Students participate in group learning and discussions over the e-learning platform and enhance distance and open learning, e-learning has reduced physical contacts with students, and course notes, assignments and announcements can be communicated to both students and lecturers electronically.

The indicators on female's participation in STEM at the higher learning institutions are as follows: STEM subjects have to be introduced and emphasized at elementary level, The society should be sensitized, educated and even encouraged in STEM subjects, The STEM teaching system should be improved. For example, the Government should provide more teachers, books, and laboratories and laboratory equipments to schools, Establishment of STEM subjects association or clubs in schools, The Government should motivate female students who perform well in STEM subjects, Open more STEM schools for girls and the teaching of STEM subjects should be localized as per resources available to students.

Strategies to encourage the participation of female in STEM education and training at higher learning institutions and in the workplaces are as follows:Improve/build ICT infrastructure to accommodate all students and staff Increase bandwidth and connect more computers to the Internet, Teach computer courses to students, Staff training in ICT courses, Instructors involvement in encouraging students to use ICT, Fully employ e-learning to complement face to face learning and teaching processes, Develop ICT policy and master plan of it with one of the emphasis being ICT use in learning and teaching and The use of pre-entry programme for students applying for STEM degree courses in universities (Morley *et al.* 2007; Nawe 2002).The factors, which hinder the development or adoption of e-learning systems at HLIs identified in this study, are:Lack of funds to purchase computers or pay Internet from the Internet café, Time limit to look for Internet café from university, Not adequately ICT courses available in Tanzania education system for A- level and O-level schools, Illiteracy in using computer, Slow Internet connection in most of the universities, Few Internet access points for wireless Internet connection, Lack of adequate computers in students' computer laboratories, Some websites require subscription fee to access journals, Poor strategies to manage computer labs as a result some computers were not running most of the time, Unreliable power supply as computer require stable electricity and Poor knowledge on Internet search.

RECOMMENDATIONS

From the findings of this study, the following recommendations are made:

i. Need to integrate the teaching and learning methodologies which are feminist by nature. For example the adoption of pre-entry programmes (PEP) for female candidates who want to join university. PEP is the remedial course for admission of female candidates in Science and Engineering at SUA and UDSM.

ii. Establishment of the unit which deals with educational technologies in each university. The unit must have the following sub-sections: strategy and management, learning (pedagogy) design, course delivery, staff support and student support.

iii. Adopt a holistic approach for e-learning implementation where cultural, socio-economic, technical and gender perspectives are taken into considerations. The e-learning should be blended with face to face teaching plus the mobile learning (m-learning).

iv. Participatory action research needs to be chosen for a sustainable solution for e-learning as a tool for STEM promotion for the female students in HLIs.

v. Each HLI should establish Gender committee for mainstreaming gender in all university functions. The committee can work with other departments in formulating ways to attract more female students in STEM courses. Some of the initiatives[3] which can be done to attract girls and women in STEM, include continuous sensitization in secondary schools and lobbying of policymakers and legislators so that all policies formulated incorporated issues related to gender; promoting gender mainstreaming in policy and programmes; incentives such as scholarships, award systems; special internships for female students; career guidance and mentoring in institutions of learning, adaptation of curricula, and interaction with of teachers and parents.

[3] http://www1.uneca.org/Portals/nepad/CrossArticle/1/Documents/CODIST-IIReportExecutiveSummaryMainstreaming-gender-inSTI-System.pdf

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REFERENCES

Betancourt, V. 2013, "Changing the way you see ICT", from http://www.genderit.org/editorial/lets-go-beyond-basics-what-would-feminist-internet-governance-look, Accessed On November 10, 2013.

Blum, L., Frieze, C., Hazzan, O. *et al.* 2007, "A cultural perspective on gender diversity in computing". Retrieved from http://www-2.cs.cmu.edu/~lblum/PAPERS/CrossingCultures.pdf

Buskens, I. 2006, "GRACE Project : State of the Research", from http://www.apc.org/en/news/grace-project-state-research, Accessed On February 12, 2013.

Derbyshire, H. 2003, "Gender issues in the use of computers in education in Africa". *Imfundo, London*. Retrieved from www.enawa.org/icons/Tekstbestanden/Gender%20issues%20in%20use%20of%20comp%20in%20education%20in%20Africa%20Report.doc

Eklund, J., Kay, M., & Lynch, H. M. 2003, "e-learning: Emerging Issues and Key Trends". *A Discussion Paper*. Retrieved from www.nederlandbreedbandland.nl/uploaded/FILES/Elearning_Australia.pdf

Green, L., & Trevor-Deutsch, L. 2002, "Women and ICTs for open and distance learning: Some experiences and strategies from the Commonwealth". Retrieved from http://dspace.col.org/handle/123456789/201

Guri-Rosenblit, S. 2005, "Eight paradoxes in the implementation process of e-learning in higher education", *Higher Education Policy,* vol. 18, no. 1, pp. 5-29.

Huyer, S. 2005, "Women, ICT and the information society: global perspectives and initiatives", Paper presented at the Proceedings of the international symposium on Women and ICT: creating global transformation.

Isaacs, S. 2002, "IT's Hot for Girls!". *ICTs as an instrument in advancing girls' and women's capabilities in school education in Africa*. Retrieved from www.un.org/womenwatch/daw/egm/ict2002/reports/Paper%20by%20Isaaks2.PDF

Lauer, S., Momsen, J., Offerdahl, E. *et al.* 2013, "Stereotyped: Investigating Gender in Introductory Science Courses", *CBE-Life Sciences Education,* vol. 12, no. 1, pp. 30-38.

Leigh-Doyle, S. 1991, "Increasing Women's Participation in Technical Fields-A Pilot Project in Africa", *Int'l Lab. Rev.,* vol. 130, pp. 427.

Lwoga, E. 2012, "Making learning and Web 2.0 technologies work for higher learning institutions in Africa", *Campus-Wide Information Systems,* vol. 29, no. 2, pp. 90-107.

Mkude, D., Cooksey, B., & Levey, L. 2003, "Higher Education in Tanzania *A Case Study"*. Dar es Salaam: Partnership for Higher Education in Africa.

Morley, L., Leach, F., Lugg, R. *et al.* 2007, "Widening participation in higher education in Ghana and Tanzania: developing an equity scorecard", *University of Sussex, Brighton*.

Mwetulundila, P. N. 2002, "Why girls aren'fitfully participating in science and mathematics in Namibia". *In Reform forum*. Retrieved from www.nied.edu.na/journals/journal11/Journal%2011%20Article%204.pdf

Nagunwa, T., & Lwoga, E. 2013, "Developing an eLearning strategy to implement medical competency based curricula: experiences from Muhimbili University of Health and Allied Sciences", *International Journal of Education and Development using ICT,* vol. 8, no. 3, pp. 7-21.

Nawe, J. 2002, "Female participation in African Universities: effective strategies for enhancing their participation with reference to the University of Dar es Salaam, Tanzania", Paper presented at the 28th Annual Spring Symposium, African Universities in the 21st Century, University of Illinois/CODESRIA, Dakar, Senegal.

Njenga, J. K., & Fourie, L. C. H. 2010, "The myths about e-learning in higher education", *British Journal of Educational Technology,* vol. 41, no. 2, pp. 199-212.

Ottevanger, W., van den Akker, J., & de Feiter, L. 2007, "Developing science, mathematics, and ICT education in sub-Saharan Africa: Patterns and promising practices*"*: World Bank Publications.

Radloff, J., Primo, N., & Munyua, A. 2004, "The Role of Information and Communication Technologies in the Development of African Women". Retrieved from www.apc.org/en/system/files/article_english.pdf

Reagle, J. 2012, ""“Free as in sexist?” Free culture and the gender gap", *First Monday,* vol. 18, no. 1.

Rytkønen, M., & Rasmussen, P. S. 2010, "E-learning capacity atthe EastAfrican STRAPAuniversities". *Pre-appraisal on a e-learning project*. Retrieved from http://www.development.life.ku.dk/Capacity_building/~/media/Development/Infomateriale/E%20learning_capacity_STRAPA.ashx

Sanga, C., Lwoga, E. T., & Venter, I. M. 2006, "Open Courseware as a Tool for Teaching and Learning in Africa", Paper presented at the Fourth IEEE International Workshop on Technology for Education in Developing Countries

Sanga, C., Magesa, M., & Kayunze, K. 2011, "E Learning Technology-enabling Science Education to Female Students: e Learning-enabling Science Education to Female Students in Developing Countries: The Case Study of Tanzania Universities*"*: LAP Lambert Academic Publishing AG & Co KG.

Sife, A., Lwoga, E., & Sanga, C. 2007, "New technologies for teaching and learning: Challenges for higher learning institutions in developing countries", *International Journal of Education and Development using ICT,* vol. 3, no. 2, pp. 57-67.

Stoet, G., & Geary, D. C. 2012, "Can stereotype threat explain the gender gap in mathematics performance and achievement?", *Review of General Psychology,* vol. 16, no. 1, pp. 93-102.

Stoltenkamp, J., Kies, C., & Njenga, J. 2007, "Institutionalising the elearning division at the University of the Western Cape (UWC): Lessons learnt", *International Journal of Education and Development using ICT,* vol. 3, no. 4.

Tearle, P., Davis, N., & Birbeck, N. 1998, "Six case studies of information technology-assisted teaching and learning in higher education in England", *Journal of Information Technology for Teacher Education,* vol. 7, no. 1, pp. 51-70.

Tedre, M., Ngumbuke, F., & Kemppainen, J. 2010, "Infrastructure, Human Capacity, and High Hopes: A Decade of Development of e-Learning in a Tanzanian HEI", *Redefining the Digital Divide in Higher Education,* vol. 2, no. 7, pp. 7-20.