DISCOVERY

Challenges hindering effective implementation of sciences, maths and ICT in secondary schools in Tanzania

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ABSTRACT

This study investigated challenges that still hinder effective implementation of sciences, maths and ICT subjects from head of schools' perspective despite recent significant investments in secondary schools in Tanzania. The study used quantitative descriptive survey design where quantitative data from a sample of 275 head of schools drawn using random sampling technique from public and private secondary schools in 15 regions were collected using structured questionnaire. Analysis using SPSS have revealed that over 80% of the head of schools experience the following 4 most critical challenges that hinder effective implementation of sciences, maths and ICT subjects in their secondary schools; shortage of teachers, shortage of laboratory technicians, shortage of laboratories and shortage of facilities. According to the head of schools, the challenges hinder not only effective implementation of sciences, maths and ICT subjects in the schools but also negatively affect students learning and academic outcomes. Appropriate conclusions and recommendations are suggested based on the findings and experience from the schools.

Keywords: STEM, Sciences, Maths, ICT, Education & Secondary Schools

1. INTRODUCTION

Tanzania's desire to prepare students for future careers in Science, Technology, Engineering and Maths (STEM) related professions are well stipulated in the National Development Vision 2025. The referred desires are well aligned to the country's ambition of becoming a middle in-come and industrialized country by 2025 (URT, 2005c).

To realize its desire, Tanzania through the Education and Training Policy is determined to strengthen teaching and learning of sciences, maths and ICT subjects in secondary schools (URT, 2014d). Also, Tanzania is determined to ensure availability of relevant instructional materials to support teaching and learning of sciences, maths and ICT in secondary schools (URT, 2014d). Effective teaching and learning of sciences, math and ICT subjects in secondary schools is therefore important for realization of the stated desires. Studies identify different critical conditions that are necessary for effective teaching and learning of sciences, math and ICT in secondary schools (Abdi and Kharbirymbai, 2019;

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Boruah, 2018). Such critical conditions include availability of adequacy of qualified sciences, maths and ICT teachers, adequacy of infrastructure such as classrooms and laboratories, availability of qualified laboratory technicians and suitability of learning environment and facilities such as relevant textbooks, teaching materials, chemicals, equipments and other resources for effective teaching and learning of the subjects in schools (URT, 2021).

In recognizing the importance of sciences, maths and ICT, Tanzania's Ministry of Education, Science and Technology (MoEST) is determined to improve the quality of secondary education at large through implementation of the second Secondary Education Development Plan (SEDP II) (URT, 2021a). According to the ESDP II, the MoEST aims to improve provision of adequate qualified sciences, maths and ICT teachers, complete construction of infrastructures such as laboratories for sciences and ICT, provision of textbooks and provision of teaching materials such as laboratory apparatus, equipments and chemicals among other things.

As a result, the Government at different times between 2016-2019 has already recruited a significant number of additional qualified science, maths and ICT teachers to address the critical shortage of such teachers in secondary schools in the country (URT, 2021a). Also, through Tanzania's Covid-19 Response Funds, over 12,000 additional classrooms have been constructed in different secondary schools to address the critical shortage of classrooms in the country (URT, 2021b). Furthermore, the Government through MoEST has also been improving ICT infrastructure including provision of computers and installation of internet connectivity in secondary schools to further enhance utilization of ICTs in the teaching and learning of sciences, maths and ICT subjects.

All these and many others are quite commendable efforts by the Government of Tanzania towards improving the teaching and learning of sciences, maths and ICT in schools which require clear understanding of its contribution in terms of enhancing effective teaching and learning of sciences, maths and ICT in schools. This is the gap that the study reported in this paper was concerned with. Specifically, the study investigated challenges that still hinder effective teaching and learning of sciences, maths and ICT subjects from head of schools' perspective despite recent significant investments in secondary schools in Tanzania.

Objective of the study

Main objective

The main objective of this study was to "investigate the challenges that still hinder effective implementation of sciences, maths and ICT subjects despite recent significant investment in secondary schools" from head of schools' perspective.

Specific objectives

The following specific objectives were formulated in order to address the stated main objective of the study;

To determine adequacy and shortage of qualified science, maths and ICT teachers in schools

To determine adequacy and shortage of qualified science and ICT laboratory technicians in schools

To determine adequacy and shortage of science and ICT laboratories and facilities in schools

Review of literature

Adequate availability of qualified teachers

Adequate availability of qualified teachers for sciences, maths and ICT is one of the critical conditions for effective teaching and learning of the subjects in secondary schools (Eusebius, 2016; Hassan et al., 2015). According to Gatulo et al., (2015), Abdi and Kharbirumbai, (2019) and Boruah, (2018), adequacy of qualified teachers contributes to effective teaching and learning and improvement of students academic performance in sciences, maths and ICT subjects in secondary schools. However, studies indicate that critical shortage of qualified teachers for sciences, maths and ICT is among the great challenges which hinder effective teaching and learning of the subjects in most secondary schools across Sub-Sahara African countries (Abdi et al., 2019; Emendu & Okoye, 2015; Boruah, 2018).

According to Hassan et al., (2015) and Eusebius, (2016), the major cause of the shortage of teachers is mainly attrition due to departing teaching to join non-teaching professions, retirement, deaths and un-even distribution of qualified teachers especially in disadvantaged areas. The other cause is that many teachers in secondary schools are employed in more than one secondary school and others are moonlighting (Urwick & Kisa, 2014). Also, according to Projest, (2013), the shortage of qualified teachers for sciences, maths and ICT in secondary schools causes students to develop fear and hatred in the subjects which affect their overall academic achievement. In a worse situation, evidence indicates that some schools utilize unqualified teachers who lack competency and skills in the subjects and pedagogies to teach sciences, maths and ICT subjects (Gutalo & Tekello, 2015). Overall, shortage of qualified teachers undermines effective teaching and learning of sciences, maths and ICT in secondary schools (Hassan et al., 2015).

Adequate availability of qualified laboratory technicians

Adequate availability of qualified laboratory technicians for sciences and ICT laboratories in schools is another critical condition for effective teaching and learning of the subjects in most secondary schools in the Sub-Sahara African countries (Mutarubukwa, 2014; Emendu & Okoye, 2015; Buruah, 2018; Mwangu & Sibanda, 2017).

According to Mutarubukwa, (2014), adequate availability of qualified laboratory technicians for sciences and ICT subjects in schools contribute to effective teaching and learning and improvement of students' learning and academic outcomes in sciences and ICT subjects in secondary schools. This is because students in secondary schools learn easily and effectively when given opportunity to practice with concrete materials in the laboratories than only abstracts in classrooms (Gutulo et al., 2015).

Availability of laboratories

Availability of laboratories for sciences and ICT subjects in secondary schools is another critical condition for effective teaching and learning of sciences and ICT subjects in schools (Mwangu & Sibanda, 2017; Buruah, 2018; Mutarubukwa, 2014). However, studies indicate that most secondary schools experience critical shortage of laboratories for sciences and ICT subjects which negatively affect students' learning and academic outcome (Emendu & Okoye, 2015).

This causes lack of practical lessons due to shortage of sciences and ICT laboratories which affect effective teaching and learning of the subjects in schools (Emendu & Okoye, 2015; Mutarubukwa, 2014). According to Gutulo et al., (2015), shortage of laboratories hinders effective teaching and learning of the subjects leading to poor academic achievement of students.

Availability of teaching and learning facilities

Availability of relevant teaching and learning facilities for effective teaching and learning of sciences, maths and ICT in secondary schools is also very important. Such facilities include equipments, apparatus, chemicals, teaching materials and other resources (URT, 2021a; Eusebius, 2016; Hassan et al., 2017).

They also include facilities like computers, internet connectivity and other technologies which are key in enhancing effective teaching and learning of sciences, maths and ICT in schools (Mutarubukwa, 2014). According to Gutulo et al., (2015), shortage of facilities such as equipments, apparatus, chemicals and other resources hinder effective teaching and learning of the subjects leading to poor students learning and overall academic outcomes.

2. METHODOLOGY

Design

The study used a quantitative descriptive survey design to gather data about the current situation of teaching and learning of sciences, maths and ICT and challenges hindering effective teaching and learning of the subjects in schools. Descriptive research design was used in this study because it allows collection of opinions of head of schools regarding challenges that hinder effective teaching and learning of sciences, maths and ICT in schools (Cresswell, 2012; Glass & Hopkins, 1984).

Sample and sampling techniques

A sample of 275 head of schools drawn from 275 public and private secondary schools in 15 regions in Tanzania participated in the study. The schools were drawn using random sampling technique based on the following specific criteria set by the SJUIT's joint admission and marketing team; (i) presence of science subjects such as physics, chemistry, biology and maths in school, (ii) presence of either form 4 only or form 6 only or both and (iii) accessibility to the schools by roads and (iv) distance from the city or municipal centre.

As indicated, the schools were drawn from 15 regions spread in 6 zones, namely; lake zone, northern zone, eastern zone, central zone, southern highlands zone and west zone. The regions were selected using random sampling technique based on the criteria that they are among the catchment area for most programs at SJUIT in previous admissions.

Data gathering instrument and analysis

Structured questionnaire

The study used structured questionnaire to collect quantitative data from selected 275 head of schools in 15 regions. Among other data, the questionnaire collected data regarding current situation of teaching and learning of science, maths and ICT in the schools and specific challenges hindering effective teaching and learning of such subjects in schools.

The questionnaire comprised of 5 scales, namely; (i) availability of science, maths and ICT teachers, (ii) teachers' qualifications, (iii) availability of laboratory technicians, and (iv) laboratory technicians qualifications and (v) availability of facilities. Both, teachers' qualifications and laboratory technicians' qualifications scales comprised of multiple-choice items for the respondents to select from. On the other hand, the remaining scales required the respondents to choose between 'yes' and 'no' responses. The questionnaire was administered physically to the respective head of school in all selected schools. This contributed to not only timely, but also 100% retrieval of the questionnaires from respondents.

Data analysis technique

Quantitative data from questionnaires were analyzed using SPSS where descriptive statistics were reported as findings to address specific research questions. Specifically, findings are presented in Tables and Figures.

3. FINDINGS

Availability and shortage of teachers

Table 1 presents the state of availability and shortage of sciences, maths and ICT teachers in the schools as perceived by head of schools. Findings indicate that out of 275 head of schools, 154 (56%) head of schools reported to have biology teachers in their respective schools.

Regarding chemistry, physics and maths teachers, findings indicate that out of the 275 head of schools, 66 (24%) head of schools reported to have maths teachers, 69 (25%) head of schools reported to have physics teacher, 135 (49%) head of schools reported to have chemistry teachers in their respective schools. However, 45 (16.4%) head of schools reported to have ICT teachers.

Table 1 Availability of sciences, maths and ICT teachers in schools

Subjects	Teachers availability in schools N=275			
	Frequency of schools with teachers	%	Frequency of schools without teachers	%
Physics	69	25%	206	75%
Chemistry	135	49%	140	51%
Biology	154	56%	121	44%
Maths	66	24%	209	76%
ICT	45	16.4%	230	83.6%

Moreover, findings in Table 1 indicate that, head of schools in 230 (83.6%) schools reported to experience critical shortage of ICT teachers, 209 (76%) schools reported to experience critical shortage of maths teachers and 206 (75%) schools reported to experience critical shortage of physics teachers. Regarding chemistry and biology, the shortage of teachers as perceived by head of schools is relatively average (i.e., 51% chemistry and 44% biology).

Availability and shortage of qualified sciences, maths and ICT teachers

In terms of academic qualifications of sciences, maths and ICT teachers in the schools as perceived by head of schools, it has been established that out of 275 head of schools, 200 (72.7%) head of schools reported that physics teachers, chemistry teachers, biology teachers and maths in their respective schools have bachelor degree qualifications. On the other hand, 75 (27.3%) head of schools reported that their physics, chemistry, biology and maths teachers in their respective schools have other qualifications including diploma, masters and other qualifications.

Availability and shortage of sciences, maths and ICT technicians

Figure 1 presents the state of availability and shortage of sciences, maths and ICT laboratory technicians in the schools as perceived by head of schools. Findings indicate that out of 275 head of schools, 39 (14%) head of school reported to have ICT laboratory technicians in their respective schools.

On the other hand, 63 (23%) head of schools reported to have biology and chemistry laboratory technicians in their respective schools and 55 (20%) head of schools reported to have physics laboratory technicians in their respective schools.

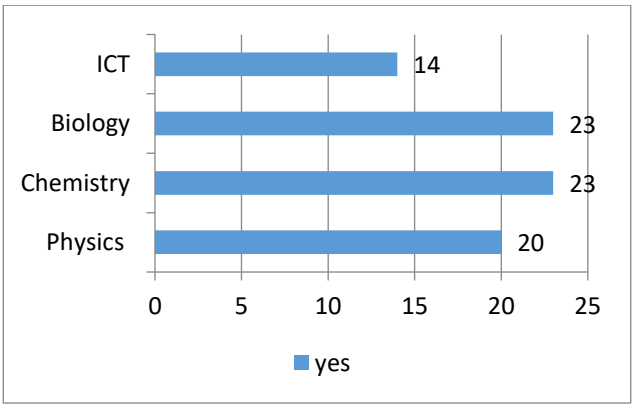

Figure 1 Availability and shortage of sciences, maths and ICT technicians in schools

Based on the findings presented in Figure 1, out of 275 head of schools, 236 (86%) head of schools reported to experience critical shortage of laboratory technicians for ICT laboratories in their respective schools. Also, 212 (77.1%) head of schools reported to experience critical shortage of laboratory technicians for both biology and chemistry laboratory in their respective schools and 220 (80%) head of schools reported to experience critical shortage of laboratory technicians for physics laboratory in their respective schools.

Availability and shortage of qualified sciences, maths and ICT technicians

In terms of academic qualifications of laboratory technicians for sciences and ICT laboratories in the schools as perceived by head of schools, it has been established that out of 39 head of schools who indicated to have ICT technicians, only 36 (92.3%) head of schools reported to have laboratory technicians for ICT laboratories who possess diploma qualifications.

It was also established that out of 63 head of schools who indicated to have chemistry and biology laboratory technicians, only 48 (76.2%) head of schools reported to have chemistry and biology technicians who possess diploma qualifications. Furthermore, out of 55 head of schools who indicated to have laboratory technicians for physics, 50 head of schools reported to have technicians who possess diploma qualifications. The rest of the laboratory technicians in the different subjects were reported to possess other qualifications including bachelors and masters qualifications.

Availability and shortage of sciences and ICT laboratories

Figure 2 presents the state of sciences and ICT laboratories availability in the schools as perceived by head of schools. Findings indicate that out of the 275 head of schools, only 53 (19.3%) head of school reported to have computer laboratory in their respective schools.

Also, 122 (44.6%) head of schools reported to have physics laboratory, 99 (36.1%) have biology laboratory and 73 (26.5%) have chemistry laboratory in their respective schools. Besides science and ICT laboratories, 43 (15.7%) head of schools reported to have libraries in their respective schools.

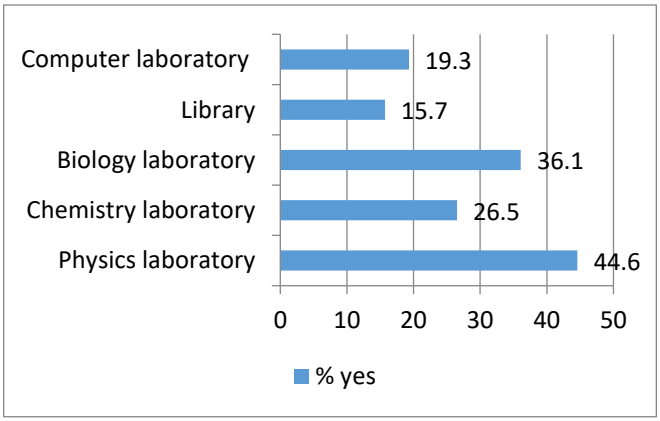

Figure 2 Availability of sciences and ICT laboratories in schools

Based on the findings presented in Figure 2, out of 275 head of schools, 222 (80%) head of schools reported to experience critical shortage of ICT laboratories in their respective schools. Also, 153 (55.6%) head of schools reported to experience critical shortage of physics, 176 (64%) biology laboratories and 202 (73.5%) chemistry laboratories in their respective schools. Furthermore, 232 (84.4%) head of schools reported to experience critical shortage of libraries in their respective schools.

Availability of sciences and ICT facilities

Figure 3 presents the state of science resources and ICT facilities availability in the schools as perceived by head of schools. Findings indicate that out of the 275 head of schools, only 53 (19.3%) head of schools reported to have instruments, 46 (16.9%) basic equipments and 49 (18.1%) chemicals in the science laboratories in the schools.

Additionally, majority of head of schools i.e., 149 (54.2%) reported to have teaching aids in the schools. In terms of ICT facilities, 33 (12%) and 23 (8.4%) head of schools reported to have computers and internet facilities in their respective schools.

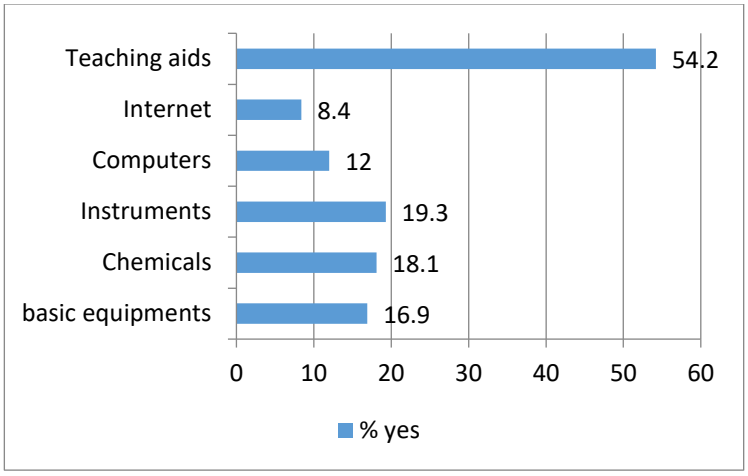

Figure 3 Availability of sciences and ICT facilities in schools

Based on the findings presented in Figure 3, out of 275 head of schools, 222 (80%) head of schools reported to experience critical shortage of instruments, 229 (83.3%) basic equipments and 226 (82.2%) chemicals in the science laboratories in the schools. In terms of ICT facilities, 242 (88%) and 252 (91.6%) head of schools reported to have critical shortage of computers and internet facilities in their respective schools.

4. CONCLUSIONS AND DISCUSSION

The study reported in this paper investigated challenges that still hinder effective teaching and learning of sciences, maths and ICT subjects from head of schools' perspective despite recent investments in secondary schools in Tanzania. Specifically, the study investigated adequacy and shortage of qualified teachers, laboratory technicians and facilities for sciences and ICT laboratories in the schools. From head of schools' perspective, the study has established that despite recent significant investments in secondary schools, over 80% of the head of schools still experience the following 4 most critical challenges which hinder effective teaching and learning of sciences, maths and ICT subjects in their secondary schools; shortage of teachers, shortage of laboratory technicians, shortage of laboratories and shortage of facilities in schools.

In terms of availability of teachers, the study has established that, as perceived by over 80% of the head of schools, schools experience critical shortage of teachers for ICT, maths and physics. Findings have shown that out of 275 head of schools, 230 (83.6%) experience critical shortage of ICT teachers, 209 (76%) maths teachers and 206 (75%) physics teacher. However, the situation is less critical in chemistry and biology subjects (i.e., 51% chemistry and 44% biology). Additionally, findings have shown that 72.7% of the sciences, maths and ICT teachers possess bachelor degree qualification. According to Hassan et al., (2015) and Eusebius, (2016), the cause of shortage of qualified teachers in schools is mainly attrition to join other professions, retirement, deaths and un-even distribution. In the context of Tanzania, teacher retrenchment due to fake certificates is an additional course to the shortage of sciences, maths and ICT teachers in the schools. Critical shortage of qualified teachers hinders effective teaching and learning of the subjects in schools (Abdi et al., 2019; Boruah, 2018). They also affect negatively students' learning and overall academic outcomes (Emendu & Okoye, 2015).

The study has also established that, as perceived by over 80% of the head of schools, availability of laboratory technicians for ICT, biology, chemistry and physics subjects is another critical challenge which hinders effective teaching and learning of the subjects in the schools. Specifically, findings have revealed that out of 275 head of schools, 236 (86%) head of schools experience critical shortage of laboratory technicians for ICT laboratories, 212 (77.1%) laboratory technicians for both biology and chemistry laboratory and 220 (80%) laboratory technicians for physics laboratory in their respective schools. Besides, findings have revealed that 76.2% of them possess diploma qualification. Students in secondary schools learn effectively when provided opportunity to practice with concrete materials in the laboratories than only abstracts in classrooms (Gutalo et al., 2015). Therefore, practical supervised by qualified laboratory technician contribute to effective teaching and learning and improvement of students' learning and academic outcomes in sciences and ICT (Mutarubukwa, 2014; Gutulo, 2015).

Regarding laboratories, the study has established that, as perceived by over 80% of the head of schools, schools experience critical shortage of laboratories for sciences and ICT subjects. Findings have indicated that out of 275 head of schools, 222 (80%) experience critical shortage of ICT laboratories, 202 (73.5%) chemistry laboratories, 176 (64%) biology laboratory and 153 (55.6%) physics laboratories in their respective schools. Shortage of laboratories affects negatively the process of teaching and learning of sciences and ICT in schools (Emendu & Okoye, 2015). According to Emendu and Okoye, (2015), shortage of laboratories makes students learn the subjects theoretically learning to ineffective students' learning and poor academic outcomes.

Additionally, over 80% of the head of schools perceive that schools experience critical shortage of facilities such as basic equipments, chemicals, instruments, internet and computer in the sciences and ICT laboratories in schools. This is because findings have shown that out of 275 head of schools, 229 (83.3%) of them experience critical shortage of basic equipments, 226 (82.2%) chemicals and 222 (80%) instruments in the science laboratories in the schools. They also experience critical shortage of internet (252 equivalent to 91.6%) and computer (242 equivalent to 88%) facilities in their respective schools. According to Gatulo et al., (2015) and Mutarubukwa, (2014), shortage of facilities hinders effective teaching and learning of sciences, maths and ICT in the schools leading to poor academic outcome of students.

Based on the findings, it is recommended that in addition to construction of 12,000 additional classrooms in secondary schools, the initiative should go hand-in-hand with the recruitment of teachers for sciences, maths and ICT in schools. Also, the recruitment should also include laboratory technicians and provision of necessary basic equipments for effective teaching and learning of sciences and ICT subjects in the schools. Moreover, there is also need for a deliberate support towards promotion and preparation of youths for future careers in STEM related professions to meet demands of the 4th Industrial Revolution which demands for soft skills development. This can be realized by promoting the effective teaching and learning of sciences, maths and ICT in the schools. Specifically, the support may include, among others, implementation of an innovative initiative that seeks to promote effective teaching and learning of sciences, maths and ICT to address the identified challenges. It can also include provision of necessary basic facilities for sciences and ICT laboratories and school-based in-service training for sciences, maths and ICT teachers.

Informed consent

Not applicable.

Ethical approval

Not applicable.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Abdi AA, Kharbirumbai BB. Teacher shortage in Kenya: Trends and policy implications. Online Int Interdiscip Res J 2019; 2249-9598(09):128 – 137.
2. Benard R, Dulle F. Assessment of access and use of school library information resources by secondary schools students in Morogoro municipality, Tanzania. Libr Philos Pract (e-journal) 2014; 1107.
3. Boruah PJ. Problems Faced By The Students And Teachers In Learning And Teaching Mathematics In Schools: A Study On Class X Students And Teachers Of Nazira Sub-Division Of Sibsagar District Of Assam. IOSR J Humanit Soc Sci 2018; 23 (7):11 – 15.
4. Emendu NB, Okoye CM. Identifying problems associated with studying of chemistry in Anambra State, Nigeria. Int J Sci Res Publ 2015; 5(6):1 – 7.
5. Eusebius F. Problems facing students in learning chemistry subject in selected community secondary schools in Kiteto distict in Tanzania. A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Education of the University of Dodoma 2016.
6. Gutalo SG, Tekello KO. Problems in the teaching and learning of physics at the secondary and preparatory schools, the cases Wolaita and Dwuro Zones. Glob J Hum Soc Sci Linguistics & Education 2015; 15(7).
7. Hassan AA, Ali HI, Salum AA, Kassim AM, Elmoge YN. Factors affecting students' performance in chemistry: Case study in Zanzibar secondary schools. Int J Sci Educ Pedagog 2015; 9:4086 – 4093.
8. Mutarubukwa AF. Computer studies curriculum implementation in Tanzania's secondary schools 2014.
9. Mwangu EC, Sibanda L. Teaching biology practical lessons in secondary schools: A case study of five Mzilikazi district secondary schools in Bulawayo Metropolitan Province, Zimbabwe. Acad JInterdiscip Stud 2017; 6(3): 47 – 55.
10. Projest G. The effects of shortage of teachers on curriculum implementation in community secondary schools in Tanzania, the case of Bukoba municipality. A dissertation submitted in partial fulfillment of the requirements for the award of the degree of Master of Education in Administration, Planning and Policy Studies of the Open University of Tanzania 2013.
11. URT. Tanzania Development vision 2025 2005c
12. URT. Education and Training Policy 2014 2014d.
13. URT. Education Sector Development Plan (ESDP II) (2016/17 - 2020/21). Endorsed by ESDC in June 2017 and updated in July 2018 and December, 2021 2021a.
14. URT. Taarifa kwa umma kuhusu utekelezaji wa mpango wa maendeleo kwa ustawi wa taifa na mapambano dhidi ya UVIKO-19 katika Tawala za mikoa na serikali za mitaa. Taarifa kwa umma kuhusu utekelezaji wa mpango wa maendeleo kwa ustawi wa taifa na mapambano dhidi ya UVIKO-19 katika Tawala za mikoa na serikali za mitaa 2021b.
15. Urwick J, Kisa S. Science teacher shortage and the moonlighting culture: The pathology of the teacher labour market in Uganda. Int Educ Dev 2014; 36:72–80.