



THE ROLE OF TEACHER EDUCATION IN THE SUSTAINABILITY OF STEM

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Abstract:

All human developmental requirements, including socio-economic transformation demands, depend on the effectiveness of its education system. This research seeks to find out the role teacher education (TE) can play as mass intellectual output in promoting the sustainability of technology, engineering and mathematics (STEM) as a necessity for socio-economic transformation. There is a need to examine possible suggestions on how to improve TE curriculum to focus on STEM for socio-economic transformation dynamics literacy and cognition. Literature reviewed showed that TE and teacher expertise are one of the most crucial basics for cultivating STEM appreciation culture. The results of this research revealed that current TE has been criticised for not producing innovative, competent teachers with skilful thinking relevant to motivate students to be agents and active participants of STEM subjects. Data analysis indicated that TE faces challenges in making an impetus to contemporary STEM needs because TE remains traditional, focusing on teaching 'course content' instead of higher order-activities like critical thinking, creative thinking and problem solving. Literature reviewing and data analysis took a qualitative paradigm. The 'analytical model of constant comparison' was mainly used in gathering and analysing data. The major conclusion to this research was: if teacher education institutions produce effective teachers, these teachers will be in a position to use innovative pedagogies and reflective approaches to enhance critical thinking and cultivate a science culture in schools which is essential to the promotion of STEM. The research recommended a consideration of introducing sciences for all from tender learning levels compared to sciences for only gifted students, review of TE entry qualification requirements, change of TE curriculum to be inclined toward STEM orientation.

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1. Introduction

It has been noted by several educationists that human development especially socio-economic growth depends on the effectiveness of its basic education system. Developing countries, like Zimbabwe, have noted a need to invest in the teaching and learning of science, technology, engineering and mathematics STEM to improve science literacy. Science literacy is seen as a necessity to advance human standard of living, improve invention and productivity expecting in return to improve productivity necessary for economic growth (Watkins, 2000; UNESCO, 2014; Cockcroft, 1982; Dean, 1982). Even though the need for teaching STEM subjects for socio-economic transformation has been noted, there are challenges on how to successfully achieve sustainable approaches in teaching STEM subjects for socio-economic transformation. There is a complex relation between education and how to make it effective for bringing in much needed socio-economic transformation.

2. Theoretical Framework

In its diverse educational challenges, Zimbabwe has currently been criticized for not channelling sufficient resources to solve STEM subjects or STEM related educational challenges and support key socio-economic transformer agents like teachers and teacher education. Education without skilful teachers becomes an irrelevant effect in producing reflective and contributive students, aware of solving socio-economic challenges (Avalos, 2011; Bransford, et al., 2005, Guskey, 2002; Silva, et al., 2006; Adler & Reed, 2002). In addition to education not an end to itself, the above cited scholars not only concern themselves about reflective and adaptive teachers, as part of an equation to enhance socio-economic transformation, but also how they are trained. They see TE as the pinnacle foundation and backbone to all human development and progress. The main argument is, if TE can be effective in promoting and training competent STEM teachers likewise these teachers will likely produce STEM and STEM related issues literate school graduates. But easier said than done, producing both creative STEM student and competent STEM teacher require a number of considerations: introduction of science subjects and scientific research culture from tender ages, qualification requirements for TE entry, preference of what to teach the teacher to be, organisation of beneficiary teaching practice (TP) duration, curriculum issues and what sort of product is intended to be produced.

3. Objectives of the study

Teacher education at all times remains relevant to human developmental needs. However, human needs especially socio-economic needs are dynamic and not static. Given such a predicament TE should be progressive, critical in its ways of teaching

trainee teachers reflective to current global, technological, socio-economic advancement as well as political developments and quality of STEM teachers. There is an imperative to be investigated as TE is directly linked to economic development. In this context, the present research seeks to critic the relevance of TE and challenges that hinder TE to play its role as an agent of socio-economic transformation, in order to reach conclusions, provide suggestions to mitigate identified challenges and also suggest possible approaches to improve TE curriculum in general.

4. Methodology

To this end a qualitative research was conducted, attempting to determine the relevance of teacher education in STEM as a trajectory to socio-economic transformation, with a focus on two major TE aspects: the role a reflective teacher can play to effect socio-economic transformation and the role TE institutions as a system could perfectly produce a socio-economic reflective teacher who is also an agent of influence and change. Literature reviewed was selected through purposive sampling, specifically the 'maximum variation technique' (Glaser and Strauss in Lincoln and Guba, 1985; Creswell, 2007; Krefting, 1991). Data was collected from both primary and secondary documentary sources from libraries and internet. Data collection and analysis as true to the canons of qualitative research took place simultaneously using the 'constant comparative method' of Corbin and Strauss (2008).

5. Data Analysis and Discussion

5.1 Teacher Education in Zimbabwe

Teacher education in Zimbabwe is provided by private, government universities and teachers' colleges. Both primary and secondary teachers' colleges are controlled by Ministry of Higher and Tertiary Education, Science and Technology Development. The Department of Teacher Education from the University of Zimbabwe acts as a quality assessor for all government primary and secondary teachers' colleges. Even though provided by different education institutions, current teacher education challenges and student enrolment for entry into TE are less or more similar. The challenge faced by most TE institutions is that most students with excellent passes in STEM subjects at ordinary and advanced levels opt to study STEM related University programmes than enrol for TE qualifications, thus affecting the calibre of students teachers' college end up enrolling. Most prospectus student teachers who end up in teachers' colleges would have written five required ordinary level subjects especially mathematics on several sittings. However, not saying in all cases teachers' colleges receive students with lower qualifications, but in most cases teachers' colleges receive people who would had not found their way to specially areas with strict enrolment requirements like medicine and engineering. The challenge of limited students opting for STEM related higher and further education is affected by the fact that a majority of secondary and high schools in Zimbabwe do not offer some STEM subjects especially Engineering, Technology and

Design, the situation is worse in rural schools which cannot offer STEM subjects like Biology, Chemistry and Physics due to infrastructural and qualified teachers shortage.

Apart from enrolment challenges, after enrolment while on training non-technical teachers' colleges offer limited orientation on STEM and STEM areas of specialisation, most if not all teacher training institutes focus on application of classical theories of education, classroom management, instead of focusing on functional literacy, contemporary pedagogies and how to address socio-economic challenges through skilful-useful-practical oriented educational pedagogies. Yet several Afrocentric scholars have criticised the theoretical pedagogy approach as 'bookish', irrelevant for socio-economic transformation (Zvobgo, 1998; Fafunwa and Aisiku, 1982; Chikomba, 1988; Maravanyika, et al., 1990). Non-technical teachers' colleges curricula have limited STEM subjects being offered as major areas of study, the situation is acute in primary teachers' colleges. In other terms non-technical teachers' institutions keep channelling to the market liberal arts specialists at a time when Zimbabwe needs more science and engineering skills.

Beside the challenges of low STEM qualification TE enrolment and limited STEM curricula offered in some teachers' colleges, most teacher training institutions have limited consideration for the introduction of compulsory contemporary STEM complementary subjects that increase critical, creative thinking, and consciousness on socio-economic matters and development. These include philosophy, logic, philosophy of science disciplines, history and development of technology and design, introduction to economics and developmental studies, innovative pedagogies and global politics. The major reason to teach these subjects to teacher trainees is to open teacher trainees' minds on topical contemporary needs in the hope that in turn they will motivate learners to have interest and be literate in these contemporary issues and perhaps even become experts in these STEM related issues.

The other critical issue to be considered by teacher training institutes in order to be relevant to current socio-economic needs is the reality that currently in Zimbabwe, the issue of access to education is no longer a complex challenge; the current challenge is the increasing number of highly qualified unemployed school/college/university leavers. Given the case of increasing number of trained teachers not employed, the concern of teacher training institutes today, therefore, is to sustain current and future teacher demand especially considering and focusing on producing a quality teacher reflective to 21st century demands. Producing a quality teacher may also require extending the duration of training and increasing pedagogy courses relevant to contemporary issues instead of focusing on mainstream theories of teaching and learning.

5.2 Teacher education challenges

Effective teaching is consequential, effective teaching can address educational challenges like ineffective teaching of STEM subjects which are key subjects in sustaining economic basics like productive, innovative and creative workforce (Ericsson, 1993; Gray, 1999; Feuerstein, 1980; Geoff, 2009). Effective teaching contributes

a huge difference in sustaining socio-economic literacy and reflective thinking needed by school graduates who can be part of socio-economic challenges solution. Even though essential in Zimbabwe not only have TE been inadequately resourced, the quality and effectiveness of its products being sensitive to dynamic and diverse socio-economic needs has currently been questioned, especially the calibre of STEM teachers, indicated by low Sciences and mathematics national examination pass rates. Criticism of teacher quality comes as a result of high failure of STEM subjects in ordinary and advanced levels national examinations not only in Zimbabwe, also prevalent in most African countries (Adabor, 2008; Tella, 2008; Ojose, 2011). High failure of STEM subjects hinders students to continue studying STEM or STEM related disciplines at higher learning levels. On the long run hindering STEM competent labour force reducing industrial productivity-needed to boost economic sustainability.

In addition to failure in the productivity of competent teachers, teacher training institutions have also faced challenges to become trend setters in academic STEM and STEM related researches which are essential in laying a foundation to discuss or address socio-economic STEM or STEM related challenges. As a result, TE institutions instead of being preparatory foundation for producing socio-economic transformers they become places to nurture people who fill-in STEM teacher-shortage gap for the sake of securing employment opportunities attached to the teaching profession as compared to other economic sectors.

According to human rights and labour theorists education is considered critical for economic development because in general, it can give people the skills and knowledge to compete in markets and because it can help bring about a more equitable distribution of wealth and power which in turn contributes to long-term economic growth (World Bank, 1988; UNESCO, 2014, Ornstein, et al., 2011). However, disputed by Marxism and has come under criticism in Zimbabwe given high literacy, but limited economic growth and employment for individual wealth and empowerment. The human rights and labour theorists approach can be applicable when there is equity, social justice, under a normal performing economy where there are no political challenges affecting economic performance. The challenge in Zimbabwe concerning TE education to be utilised as a critical economic developmental tool are educational challenges hindering education to become a human right due to limited government funding, poverty, corruption in TE enrolment, unrealistic lecturer-trainee teacher ratios, high tuition charges, precarious conditions and resources, poor management of TE institutions, low salaries, congested time-tables not allowing consistent tutorials (Nyagura and Reece, 1990; Shumba, 1993; Calderhead, 1987; Nziramansanga, 1999; World Bank, 1988; Shaw, 1995). These challenges, in addition to ineffective teaching and teacher training, hinder improvement of TE systems, resulting in the production of non-performing teachers.

In addition to the above challenges the number of teacher graduates has increased in Zimbabwe yet the demand and employment opportunities for these graduates is not on the rise. School graduates also don't see themselves as much needed contributors to socio-economic solutions with no well-paying jobs available in the

country worsened by static governance structures not absorbing the young, ambitious and energetic. Some well-trained STEM teachers immigrate to wealthier countries with better employment opportunities and end up making intellectual contributions to the socio-economic development of foreign countries.

At the apex of diverse challenges is that teacher education has remained traditional in its training approaches which may not be highly relevant to contemporary socio-economic needs like STEM competent teachers according to reconstruction perspectives. Traditional approaches to education have focused, on the teaching of “course content” material which is to say, on imparting factual knowledge (Daner, 1989; Schon, 1987; Levine, 2006; Moon, 2010, Perraton, et al., 2002). By comparison relatively little attention has been given to the teaching of thinking skills or higher order activities such as reasoning , creative thinking and problem solving essential for socio-economic transformation or general ability to apply taught or learnt knowledge effectively in all spheres of life. The question then is how TE institutes should inculcate these much needed critical skills? Despite these challenges TE institutions have the potential to bring socio-economic changes within Zimbabwe that will shape the knowledge and skills of future generations needed for socio-economic transformation. TE institutions serve as key change agents in transforming education and society.

6. Conclusions

The main argument throughout this research was the opinion that effective teaching is a key essential force in bringing sound re-emphasis of STEM focus in the Zimbabwe education system at all schooling levels. However, effective teaching can only be achieved if the process of training STEM teachers in itself is rigorous and considerate of contemporary socio-economic needs and expectations. There is also the need to align teacher education curricula to suit or support STEM oriented education. This research also argued that teachers’ college initially mandated by government to focus on liberal arts need to reconsider their traditional curricula to meet 21st century socio-economic needs like technical and STEM focus. This research also acknowledge other challenges in addition to ineffective teaching and gave examples of quantitative challenges like unavailability of special laboratories for the study of STEM subjects in teachers’ colleges, in secondary schools especially in rural areas. Above all this research made an observation that socio-economic transformation in Zimbabwe can only be achieved through a sound education system with reflective teachers who teach for critical thinking as the cornerstone for further education and contributory factor to economic participation and development.

7. Recommendations

1. There is need for a shift of inclination by traditional liberal arts oriented teacher training institutes from liberal arts focus to a diverse focused curriculum that includes both sciences (STEM) and arts.

2. There is need for the introduction of diverse STEM disciplines from primary to tertiary education especially in Technology and Design, Engineering disciplines, Computer Technology and Space Studies and Technologies.
3. Contemporary teacher training should focus on quality productivity of teachers instead of quantity since there is an increase in the number of unemployed teachers in Zimbabwe.
4. Introduction of stringent recruitment strategies to be considered by teacher training institutes to reduce people who come to train as teachers for the sake of easy access to employment opportunity.
5. Infrastructure development supportive to STEM oriented education especially in disadvantaged high density suburbs rural and new resettlement areas should be considered for the success of STEM emphasis and using unqualified and temporary STEM teachers should also be avoided.
6. Training of effective science teachers equipped with both science subject content and 21st contemporary pedagogies should thus be prioritized as a way of inculcating the STEM ethos to both the teacher and learner in the long run. This will in turn create a societal culture deeply imbedded in critical analysis and introspective reflection leading towards meaningful and relevant economic development in line with the 21st century demands.

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