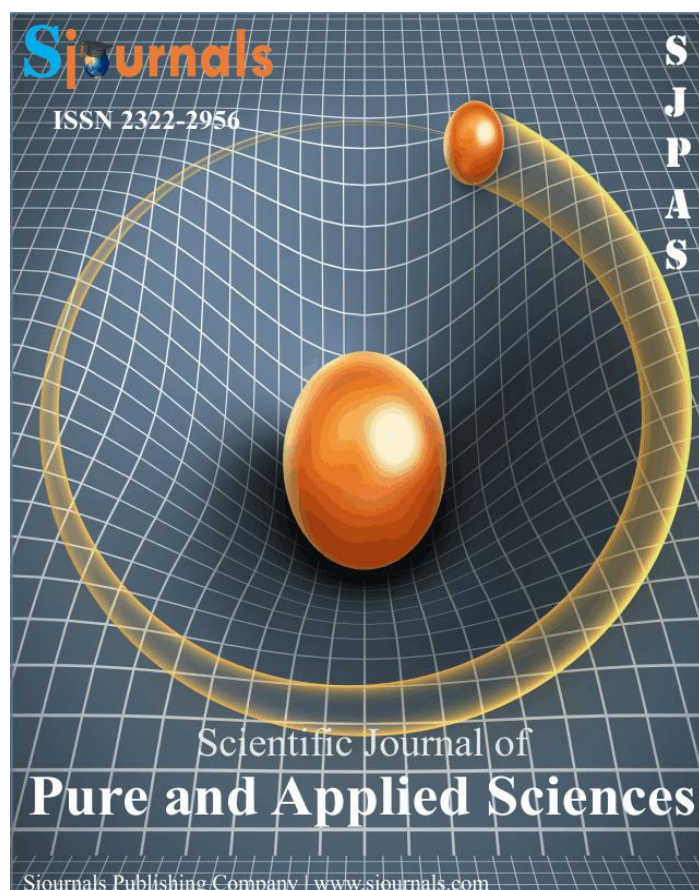


Provided for non-commercial research and education use.

Not for reproduction, distribution or commercial use.



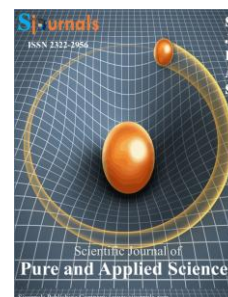
This article was published in an Sjournals journal. The attached copy is furnished to the author for non-commercial research and education use, including for instruction at the authors institution, sharing with colleagues and providing to institution administration.

Other uses, including reproduction and distribution, or selling or licensing copied, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Sjournals's archiving and manuscript policies encouraged to visit:

<http://www.sjournals.com>

© 2018 Sjournals Publishing Company



Contents lists available at Sjournals

Scientific Journal of Pure and Applied Sciences

Journal homepage: www.Sjournals.com

Review article

The relevance of teacher education in sustaining research in mathematics, science and technology education (MSTE) in Zimbabwe

Patrick Sibanda* and **Lincolyn Moyo**

Faculty of Applied Social Sciences, Zimbabwe Open University, Zimbabwe.

*Corresponding author: patrickssibandac@gmail.com

ARTICLE INFO

Article history,

Received 09 December 2017

Accepted 10 January 2018

Available online 17 January 2018

iThenticate screening 11 December 2017

English editing 09 January 2018

Quality control 16 January 2018

Keywords,

Teacher education

Research

Mathematics

Science and technology education

Zimbabwe

ABSTRACT

Currently, the Zimbabwean education system is placing re-emphasis on MSTE but with no resounding success due to a number of challenges. Of most concern to this research are teacher education and skilful teaching challenges hindering MSTE sustainability. The research focused on the role that could be played by teacher education in resuscitating and sustaining MSTE. In reality, the efficiency of an MSTE system depends on teacher quality and skilful teaching. Inseparable from quality teaching is the role played by teacher education in producing a reflective MSTE agent. This study took the form of a qualitative research design. Constant comparative analysis method of published documentary sources from libraries and the internet selected through purposive maximum variation sampling were used to gather data. Data collection and analysis took place simultaneously. Data were presented thematically. The study revealed that sustainability of MSTE is hindered by teacher training institutions which have failed to produce versatile MSTE competent teacher. This was coupled with lack of adequate human and material resources, poor teaching methods, and lack of continuous research in pedagogies and application of theory into practice. Recommendations to improve teacher education to become relevant in its production of quality teachers were made.

© 2018 Sjournals. All rights reserved.

1. Introduction

Human development depends on the effectiveness of its education system (Tella, 2008; House, 2006; World Bank, 2000). Developed and developing countries have noted a need to invest in the teaching and learning of Science, Mathematics and Technology to improve human standard of living and development (Watkins, 2000; UNESCO, 2014; Cockcroft, 1982; Dean, 1982). Despite the need for MSTE inclusion, African countries, including Zimbabwe seen as developing have been criticized for not channelling sufficient resources to support educational activities and related institutes especially government controlled teacher education colleges. Yet many teacher education researchers (Avalos, 2011; Bransford et al., 2005; Guskey, 2002; Silva et al., 2006; Adler and Reed, 2002) see teacher grooming as pivotal, a foundation to meet, achieve, promote teaching-learning for today and future utility. Research has indicated that if teacher education can be effective in promoting, sustaining science and mathematics learning its products should be equal to the task (Geoff, 2009; Moon, 2010; Perraton et al., 2002). Teacher quality is the most highly possible way in sustaining research in mathematics, science and technology education. The general base of this thought is based on the view that, all children one way or another pass through a sort of education system with a teaching authority. All teachers do get training of some sort. Teacher education in this study is seen as a disseminator of education ideology, orientation and a backbone to all diverse human development and progress. All people, social classes, all professionals are a product of a teacher.

In Zimbabwe not only have teacher education been inadequately resourced. The quality of its products has currently been questioned, especially the calibre of science and mathematics teachers. Current Zimbabwe national examinations high failure in sciences and mathematics has been generally blamed on teacher performance (Tachie and Chireshe, 2013; UNESCO and UNICEF, 2005). High mathematics failure is also prevalent in other, if not most African countries (Adabor, 2008; Tella, 2008; Ojose, 2011). In addition to failure in the productivity of competent teachers, teacher training colleges have also struggled to be academic trend setters of science, mathematics and technology research. Yet research is higher education's core-business and the essence of skilful teaching-learning for both examination passing and critical thinking. Instead of being cultivators of MSTE academic knowledge teacher education institutions have become places to nurture people who only fill-in the science and mathematics teacher-shortage gap, digesters of ancient science and mathematics theories. Teacher education colleges could be thought as producers of science, mathematics and technology appreciators not specialists who are capable to teach and contribute scientific knowledge culture in the classroom.

While African countries differ from one another in many educational features, they are broadly similar in institutional and national conditions that hinder development and sustaining research in MSTE. Several factors have been identified, such as socio-economic status; pupil-teacher ratios; class-sizes; access to education; persistent inequalities; precarious conditions and resources; salaries (Nyagura and Reece, 1990; Manokore, 2004; Shumba, 1993; Calderhead, 1987; Nziramasanga, 1999; World Bank, 1999; Shaw, 1995). At the top of vast challenges such as those mentioned above are shortages of well trained, competent, reflective, experienced researchers, teachers of science, mathematics and technology. These challenges are more prominent in rural areas (Adentwi, 2002; Levine, 2006; Adler and Reed, 2002; Jacobs et al., 2002). The justification of the view that shortage of well trained teachers is more prominent and a key challenge is based on the opinion which sees an effective, reflective teacher as a mediatory measure to other hindrances mentioned above. But there is no measure to mitigate effective teaching.

Despite the vast hindrances, it has been proven by research and summative Zimbabwe Schools Examination Council reports, that some "disadvantaged" schools because of exceptional teaching have performed fairly well in ordinary and advanced level mathematics and science (Mhishi et al., 2012; Rust and Dalin, 1990). Given the vast teacher related factors that stifles MSTE development and improvement; it is the major burden of this study to seek solutions on how to produce effective MSTE teachers. Who do not only teach MSTE but are themselves investors of knowledge, researchers and critical analysts of MSTE development. It is also part of this research's view that, production of effective teachers and general education, sustainability can only be achieved when priority of channelling relevant intellectual and material resources to teacher education is done.

2. Theoretical framework

This study is based on the perspective that sees teacher education as having potential to bring wanted changes within a given education system, shaping and promoting wanted knowledge and skills of current/future

generations (Moon, 2010; Perraton et al., 2002). To this end teacher education institutions are expected to serve as key education change initiators and agents in transforming education and society by producing effective teachers in MSTE. Effective teaching is very consequential-an effective teacher can touch children's lives forever (Ericsson, 1993; Gray, 1999; Geoff, 2009). Meaning, skilful teaching can address some of Africa's educational challenges like high failure rates in mathematics and sciences which are key subjects in sustaining development and a prerequisite for a productive, innovative and creative workforce (Ericsson, 1993; Gray, 1999; Feuerstein, 1980; Geoff, 2009). Some researchers (Tachie and Chireshe, 2013; Shin et al., 2007; Adabor, 2008) argue that, teacher training and competency alone without resources, government positive and active contributions, and the attitudes of learners can not make a huge difference in sustaining research in MSTE. They believe that, student success in the learning and sustainability of MSTE depends on multiple factors such as resources, the government, socio-economic factors and the nature of students themselves. There is some truth in their view. However, the researcher is of the opinion that, out of all factors that affect student achievements, teachers contribute by far the biggest impact and difference to student achievements. However, an effective teacher is a product of an effective teacher education system which will also be discussed in this research.

The researcher's opinion is guided by Socratic philosophy of education perspective that sees a teacher as a role model or "an authority" in teaching and learning. Socratic view of the teacher is in agreement to (Hight, 1954; Gage, 1978; Gallagher, 1970)'s opinions. Even though they argue teaching as an "Art or Science?" They think effective teachers are "...not born but groomed". In analysis their thoughts seem to suggest that, those who are naturally gifted their gift can be complimented by training. In other words learning, passing and future research interests in MSTE depends on the teacher's teaching approaches, attitudes and advertisement of MSTE in the classroom, not on the cognitive ability of the child alone. Not to say intrinsic intelligence of a child is insignificant. According to Socratic epistemology teachers are supposed to be MSTE knowledge authorities and classroom experts who know how to interpret correctly the aims and objectives of the contemporary ideologies and needs of the education system, in order to translate these into reality in the classroom. Therefore, in sustaining research in MSTE, training of science and mathematics teachers and their retention in the schools is a crucial matter. Socratic view of the teacher also leads to the conclusion that students are not supposed to fail mathematics and science if teachers carry out their obligations with extreme dexterity and devotion.

Socratic epistemological implications are in line with education for sustainable development. Which calls for allowance of every human being to acquire the knowledge, skills, attitudes and values necessary to shape continuous learning through inquiry (research). According to Socratic epistemology teachers are needed for the clarification of ideas to all students especially the challenged students. In this way Socratic epistemology could be seen as proposing for a child-centered teaching approach. According to Socratic epistemology the relevance of training teachers is to make them decision makers, effectors of change, be able to teach both current and future realities through dialogical discourse to understand and help the other key person(s) actively involved in teaching-learning process. Socratic epistemology encourages continuous search for knowledge. Effective teacher education is seen as a continuous search of improving teaching skills, a continuum-personal experience as a school student; initial training; staff development; appraisal and further staff development.

3. Statement of the problem

There is a high failure rate in science and mathematics in public examinations in Zimbabwe, if not the world over (Silva et al., 2006; Mbugua et al., 2012; Mji and Makgato, 2006; Feza-Piyose, 2012). Yet societies have appointed people (teachers) responsible for teaching children to excel in their studies and give learners direction to contemporary societal needs. One of these contemporary needs is sustaining research in MSTE after MSTE have been realized as the foundation, a gateway and necessity to diverse human developmental progress (Tella, 2008; Pandor, 2006; Ojose, 2011). The current challenge faced by many African countries is how to promote and cultivate scientific culture based on knowledge discovery instead of knowledge consumption in schools for life-long benefits. This culture can not be cultivated without effective teachers who are themselves researchers, MSTE experts. Teachers do not exist in a vacuum, there are a product of teacher education. Therefore, what possible role could teacher education institutes play in producing MSTE skilful teachers to meet and fulfill contemporary challenges and needs such as improving the pass rate of mathematics and science as foundations for MSTE research and its sustainability.

4. Research questions

- ✓ What is role could be played by teacher education in sustaining and promoting MSTE in Zimbabwe?
- ✓ What is the relevance of teacher education in sustaining research in MSTE in Zimbabwe?
- ✓ In what ways is sound teacher education correlated to effective teaching?

5. Materials and methods

This study took the form of a qualitative research design. Reviewed literature and research findings came from content analysis of primary and secondary published documentary sources on the relevance of teacher education in sustaining research in MSTE from libraries and the internet. Sources of literature were selected through purposive sampling using the maximum variation sampling technique in the form of hard and soft copies through the library catalogues, consulting subject abstracts, indexes and bibliographies. The researcher decided to use only published literature sources for the purpose of this study because in the researcher's opinion, such sources represent theoretical opinion, which has been given the seal of scholarly approval after going through the putatively rigorous processes of academic refereeing.

True to the canons of the qualitative paradigm (Taylor, 2011; Paul, 2004; Gray, 2010), in this study, the researcher was the sole instrument for collecting and analyzing data. Also, data collection and analysis took place simultaneously. The analytical model used in this research is based on the "Constant Comparative Method" formulated by Glaser and Strauss cited in Lincoln and Guba (1985). This process involved the researcher note taking through open-coding from consulted sources of literature (Creswell, 2007; Heppner et al., 2008; Lincoln and Guba, 1999). The aim of open-coding and note-taking was to identify and summarise major ideas or themes relevant to the research question(s). For the research findings to be believable account of the phenomenon being investigated by the consumers of the research, the researcher applied, data triangulation, credibility, confirmability and dependability procedures to ensure that data and interpretations are grounded in researched data rather in researchers' own constructions.

6. Discussion

The study established the relevance of teacher education as supposed to be a continuum system of producing competent teachers through research based learning. However, teacher education in Zimbabwe faces a number of challenges resulting in failure to fully meet its mandate and expectations. These challenges and other relevant teacher education issues are discussed in detail below.

6.1. Current teacher education in Zimbabwe

Current Zimbabwe teacher education system is influenced by the "Liberal arts and Professional schools' tradition approaches as a basis for learning and development. However, some critics (UNESCO, 2006; Cowan, 1995; Oyekan, 2006) have suggested it being more inclined to the Liberal approach than the other. Liberal arts tradition originates from the philosophy of idealism. Idealism originating from the thoughts of philosophers like Socrates; Plato; Aristotle; Augustine; Rene Descartes; George Berkeley; David Hume and Josiah Royce (Krant, 1992; Kurtus, 2006; Taylor, 1998; Weiss, 2001). While the Professional school traditions as the opposite of Liberal arts tradition originates from philosophers such as Aristotle; John Dewey; Rousseau; John Locke, (Bunninand Yu, 2004; Shields, 2003; Noddings, 2007). Liberal arts theory places emphasis on theory before practice, logical thinking. Teaching is seen as a complex human mental activity demanding personal characteristics and insight. Liberalists perceive teacher education as a process of exposing trainee teachers to teaching and learning theories of great works and great minds of the past sometimes known as history of education or theories of education. Liberalists favour the exposure of trainees to the academic profession side of teaching and learning first before experience or practical side of teaching as essential to preparation for teaching practice. Their idea is to develop in trainees an inquiring or reflective mind through academic teaching and learning. While the professionalists assume that education development is connected more directly to real life problems.

Current Zimbabwe teacher training is highly influenced by both theories of education, however, in reality more time is spent on learning theories than pedagogies and classroom application. It is my opinion that, teacher education should prepare a student teacher for practical teaching rather than content learning illumination. The

major strategy in teacher education is suppose to prepare prospective practitioners as problem solvers who apply knowledge, theory and research to solve problems in teaching and learning. The two-year and three-year post-advanced level and post-ordinary level science and mathematics teacher training programmes in Zimbabwe are influenced by both 'Liberal arts and Professional schools' traditions. Teacher trainees spend the first year on college campus learning theories of education, the second year is spent on teaching practice implementing theories of education in the classroom accumulated from first year course. After teaching practice students return to college for more theories of education.

Even though with its on share of criticism, the in-out-in programme or 'Liberal arts and Professional schools' approaches in this research are seen as relevant and complementary in promoting an effective competent teacher. The in-out-in teacher education programe complements the theories of seeing teaching as both an "Art and a Science". Teaching seen as an "Art" is further moved by Eisner in Curzon (1995). While teaching argued as a "Science" is further supported by Skinner in Curzon (1995). Eisner thinks teaching practice is relevant to improve natural teaching abilities possessed by various teacher trainees. Gifted student teachers will use teaching practice duration to perfect their 'art'. While the ungifted will be given an opportunity to learn the art of teaching. For both student teachers teaching practice provides form of expression, evaluation, freedom to think and perfect the 'art' or 'science' of teaching.

Teaching as an "art" should see teachers' colleges training teachers to exercise qualitative judgements in the interest of achieving qualitative ends (Levine, 2006; Moon, 2010; Adler, 1991; Sarason, 1993; Archer, 2007; Smith, 2002; Adentwi, 2002; Wragg, 1993). Some of those qualitative ends is the key question on, why should teaching of MSTE be priotitised? How best could MSTE be taught to children who are not intrinsicly motivated or gifted in MSTE? In other words effective teaching does not only come from effective teacher education, trainees themselves should understand before wanting to be teachers-what it means to be a teacher, the responsibilities and contraits. In other words, to be an effective teacher there is need for personal and socio-cultural factors awareness by the intending teacher. Skinner unlike Eisner argues that successful teacher education must focus on producing a teacher who sees teaching as a conscious application of scientific procedures (Archer, 2007; Curzon, 1995). In agreement to Skinner (Schon, 1987; Summers, 1982; Avalos, 1995; Schon, 1991) they suggest that, knowledge of teaching represents the blending of content and pedagogy into an understanding of how particular topics, problems, issues are organised, represented and adapted to the diverse interests and abilities of learners and presented for instruction.

Theorists who see teaching as a science base their opinion on the central position that, practice of any profession is the ability by its members to justify what they do and how they do it, such justification requires knowledge of the epistemological basis of the field of specialisation. There is a relation between epistemology of science and school of teaching as a science approach that should not be ignored by teacher trainees or teacher education curriculum. According to Summers (1982) trainees can only understand the scientific approach to teaching through the study of philosophy of science which is currently not offered by most, if not all, teachers' colleges/universities in Zimbabwe.

6.2. Relevance of training teachers

The need for training teachers is inevitable (Evertson et al., 1985; Ernest, 1991; Darling-Hammond, 2005). It is now widely accepted that an effective course of professional training is highly desirable for all teachers not only science and mathematics teachers (Adentwi, 2002; Lawton, 1987; Smith and Meux, 1970). Reviews of research (Bishop, 1985; Wragg, 1993; McAninch, 1991) even with the shortcomings of current teacher education and productivity of fully prepared competent teachers, suggest that formally trained teachers are more likely to be effective than those who do not have formal training (Evertson et al., 1985; Ashton and Crocker, 1986; Ashton and Crocker, 1987; Greenberg, 1983; Haberman, 1984; Olsen, 1985). According to research on science and mathematics education, there are consistent positive relationships between students' achievement in science, mathematics and their teachers' background in both education courses and science courses (Hammond, 1999; Druva and Anderson, 1983). The importance or effects of teacher training are particularly noticeable when achievement is measured on higher-order tasks such as students' abilities to think, apply and interpret scientific and mathematic concepts. Students performance in science and mathematics is also strongly related to their teachers' preparation in teaching methods as well as in MSTE content (Coble and Swanson, 1985). Accordingly, the quality of teachers' education and quality of teacher performance are inseparable (Ellis, 2002; Greenberg, 1983; Glassberg, 1980). Non performance of students could be attributed to low quality of teacher performance.

In Zimbabwe, it is currently a mandatory requirement by all Ministries of education that a person who intends to be a full-time teacher possess a teaching qualification, including university graduates without teaching components in their qualifications. The government policy is underpinned by the belief that teachers who are trained, perform better; are better prepared to teach effectively; and are able to use sound teaching strategies that respond to a student's needs and learning styles-this encouraging higher order learning (Hansen, 1988; Skipper and Quantz, 1987). The need to train graduate teachers in this perspective may have political connotations but however relevant in fulfilling the need for children to be taught by an expert. The most important role of all teacher colleges/universities is to produce teachers who are experts in teaching, committed to open inquiry, critical, reflective, able to see teaching beyond a source of income.

Even though, as far as the need to place a trained teacher in the classroom is concerned, there seem to be order and co-ordinated organisation in the Zimbabwe teacher education system. However Bishop (1985) sees in a different way. Bishop have noted certain challenges within most African teacher education institutes that hinder productivity in effective science and mathematics teaching based on sound research and innovative contributions to fields of specialty. Bishop thinks many teacher education colleges and universities are conventional in approach, meaning they hammer more on content theory instead of reflecting and researching on pedagogies and practical teaching skills. In agreement with Bishop, (Houston, 1993; Fenstermacher, 1992; Hammond and Cobb, 1996) add by saying, teacher education programmes should place more emphasis on training teachers applied research in teaching and learning in order for teachers to be able to investigate the effects of their teaching approaches on students' learning. Applied research will also help teachers learn how to look at the world from multiple perspectives; know contemporary educational challenges and use researched knowledge in developing pedagogies that can reach diverse learners especially those challenged in grasping science and mathematical concepts.

Reflective and effective teaching capacities are not innate to human beings, nor are they acquired quickly. According to Feuerstein et al. (1980) they are, rather, the outcome of "sustained and rigorous study" according to idealists like socrates teaching is improved through "dialogue and knowledge exchanging" with experienced educators. According to pragmatists teaching is gained through practical experience in teaching, observing teaching and learning processes. In this way, contemporary role of teacher education colleges is to set up training situations where trainees can develop personalised understanding of teaching.

Current Zimbabwe teacher training has been criticized for hanging in the traditional approaches of indoctrinating trainee students for uniformed perception of teaching. Yet teacher training institutes must be an aggressive force for change in education, science, mathematics, technology and research and not a reflection of the status quo. Contemporary teaching demands can only be achieved through introducing strict research standards as part of many academic requirements. The current basic researches carried out by trainee teachers are criticised (Matiru et al., 1995; Archer, 2007; Feza-Piyose, 2012) of being procedural than contributive to contemporary teaching, learning and promotion of research, science and mathematics. Yet, according to (World Bank, 1988) functions of higher learning institutions are training "effective, competent high-level manpower and production of quality research if development policies are to be correctly implemented" MSTE teachers should act as important agents of change in the sciences orientated education development process in Zimbabwe.

7. Conclusion

This study reviewed the relevance of teacher education in sustaining MSTE in Zimbabwe. Research analysis indicated teacher education's relevance as a form of grooming people with or without intrinsic skill of teaching does capacitate teachers to become innovative drivers of MSTE. Teacher education is expected to prepare people to become quality teachers, who will not only teach MSTE but promote its development and sustainability through continuous research and learning. The study, therefore, concluded that, even though teacher education's relevance is clear, in Zimbabwe the current teacher education dispensation has failed to produce competent MSTE teachers. This has mainly been due to lack of adequate resourcing of teacher education. The study further concluded that, as a result of these challenges teachers who had graduated from the system had not been attuned to the effective interpretation and implementation of MSTE standards resulting in high failure rates in public examinations and in children developing negative attitudes towards MSTE. In other words, teacher education institutions in Zimbabwe were producing undedicated teachers who viewed teaching only as a source of income manifesting in ineffective, non-innovative teaching methodologies that ignored current individual learning and future vocational needs of the learners.

Since this research's major argument was that MSTE could only be achieved and sustained through effective teacher education and skilful teaching, rigorous teacher education which is biased towards pragmatic scientific methodologies and strategies was recommended. Consistent in-servicing of MSTE teachers and provision of adequate material resources for MSTE should be prioritised in all teacher education programmes in Zimbabwe. The study also recommended the realignment of teacher education to focus more on research in scientific pedagogics. Employment of competent lecturers grounded in MSTE coupled with strict recruitment procedures to ensure enrollment of teacher trainees in possession of qualifications that are aligned to MSTE should be adopted and adhered to. There is thus a need for a teacher education curriculum that focuses more on practical application of theories and innovative pedagogies based on current researched MSTE needs. In a way, the teacher education curriculum in Zimbabwe should aim at producing a teacher who sees teaching as both an 'art'-dedicated, self-driven, curious to research, reflective and able to see the vital interrelation between content and pedagogy in the classroom. A teacher who also knows that teaching is a 'science' only learnt through continuous learning and consistent research is desirable if effective MSTE is to be achieved.

References

- Adabor, J.K., 2008. An investigation into elementary school mathematics teachers and the high school mathematics teachers' attitude towards use of calculator in mathematics. *Instruction and Learning*.
- Adentwi, K.I., 2002. Principles. Practices and issues in teacher education. Kumasi: Skies Printing Works.
- Adler, J., Reed, Y., 2002. Challenges in teacher development. An investigation of take-up in South Africa. Pretoria: Van Schaik Publishers.
- Archer, M., 1995. Realist social theory. Cambridge: Cambridge University Press.
- Archer, M., Bhaskar, R., Collier, A., Lawson, T., Norrie, A., 1998. Critical realism and essential readings. London: Routledge.
- Archer, M.S., 2007. Making our way through the world. Human flexibility and social mobility. Cambridge: Cambridge University Press.
- Ashton, P., Crocker, L., 1986. Does teacher certification make a difference? *Florida J. Teach. Educ.*, 3, 73-83.
- Ashton, P., Crocker, L., 1987. Systematic study of planned variations. The essential focus of teacher education reform. *J. Teach. Educ.*, May-June, 2-8.
- Ashwin, P., 2008. Accounting for structure and agency in close up research on teaching, learning and assessment in higher education. *Int. J. Educ. Res.*, 47(3), 151-158.
- Avalos, B., 1995. Issues in science teacher education. International institute for educational planning. Paris: Unesco.
- Barley, K.D., 1994. Methods of social research. New York: Free Press, 4th ed.
- Bartlett, S., Burton, D., 2003. Education studies. Essential issues. London: SAGE Publications.
- Bishop, G., 1985. Curriculum development. London: Macmillan Publishers.
- Bishop, G., 1986. Innovation in education. London: Macmillan Publishers.
- Bruner, J., 1996. The culture of education. Cambridge, M.A; Harvard University Press.
- Bush, T., 1989. Managing education theory and practice. Milton Keynes: Open University.
- Calderhead, J., 1987. Exploring teachers' thinking. Cassell Education: London.
- Cockcroft, W.H., 1982. Mathematics counts. London: HMSO.
- Cockcroft, W.J., 1982. Mathematics counts. Report of the committee of inquiry into the teaching of mathematics in schools in England and Wales. London: HMSO.
- Corbin, J., Strauss, A., 2007. Basics of qualitative research. Techniques and procedures for developing grounded theory (3rd ed.). Thousand Oaks, CA: SAGE.
- Creswell, J.W., 2007. Qualitative inquiry and research design. Choosing among five approaches (2nd ed.). Thousand Oaks, CA: SAGE.
- Curzon, L.B., 1995. Teacher in further education. An outline of principles and practice. London: Cassell Educational Ltd.
- Darling-Hammond, L., 2001. Teaching quality and student achievement. A review of state policy evidence. *Education Policy Analysis Archives*, 8(1), 1-44.
- Darling-Hammond, L., 2005. Teaching as a profession. Lessons in teacher preparation and professional development. *Phi Delta Kappan*, 87(3), 237-240.

- Dean, P.G., 1982. *Teaching and learning mathematics*. London: Routledge.
- Denzin, N.K., Lincoln, Y.S., 2005. *The sage handbook of qualitative research* (3rd Ed.). Thousand Oaks, CA:SAGE.
- Dillon, J., Maguire, M., 1998. *Becoming a teacher. Issues in secondary teaching*. Open University Press: Buckingham.
- Druva, C.A., Anderson, R.D., 1983. Science teacher characteristics by teacher behaviour and by student outcome. Ameta-analysis of research. *J. Res. Sci. Teach.*, 20(5), 467-79.
- Ellis, V., 2002. *Learning and teaching in secondary schools*. Exeter: Learning Matter Ltd.
- Engels, E., 1993. *The quality of science education*. Free University of Amsterdam: Amsterdam.
- Ernest, D., 1991. *The philosophy of mathematics education*. London: The Falmer Press.
- Evertson, C., Hawley, W., Zlotnick, M., 1985. Making a difference in educational quality through teacher education. *J. Teach. Educ.*, 36(3), 2-12.
- Feuerstein, R., Hoffman, M., Miller, R., 1980. *Instrumental enrichment*. Baltimore: University Press.
- Feza-Piyose, N., 2012. Language. A cultural capital for conceptualizing mathematics knowledge. *Int. Electron. J. Math. Educ.*, 7(2), 62-79.
- Gage, N.L., 1978. *The scientific basis of the art of teaching*. Teachers College Press: New York.
- Gallagher, J.J., 1970. Three studies of the classroom. In Gallagher, J.J., Rosenshine, B., Nuthall (eds.), G.A., *Glassroom observation*. American Educational Research Association Monograph Series on Curriculum, No. 6. Rand McNally, Chicago: Illinois.
- Geoff, P., 2009. *Teaching today. A practical guide*. 4th ed. Nelson Thomas: Cheltenham.
- Girl, T.A., 1998. Exploring pupils desirable activities in mathematics lessons. *The Mathematics Educator*. 3(2),26-37.
- Glassberg, S., 1980. A view of the beginning, teacher from a developmental perspective. Paper presented at the American Educational Research Association Annual Meeting, Boston, MA.
- Gray, J., 1999. *Improving schools: Performance and potential*. Buckingham: Open University Press.
- Greenberg, J.D., 1983. The case for teacher education. Open and shut. *J. Teach. Educ.*, 34(4), 2-5.
- Grossman, P.L., Schoenfield, A., Lee, C.D., 2005. Teaching subject matter. In Darling-Hammond, L., Bransford (eds.), J., *Preparing teachers for a changing world*. San Francisco: Jossey-Bass, 201-231.
- Guba, E.G., Lincoln, Y.S., 1998. Competing paradgms in qualitative research. In Denzin, N.K., Lincoln (eds.), Y.S., *The landscape of qualitative research theories and issues*. Thousands Oaks, CA:SAGE.
- Haberman, M., 1984. An evaluation of the rationale for required teacher education. Beginning teachers with or without teacher preparation. Prepared for the national commission on excellence in teacher education, University of Wisconsin-Milwaukee, September.
- Hammond, L., Cobb, V., 1996. *Knowledge base for teacher educators*. San Francisco: Jossey-Bass.
- Hansen, D., 1995. *The call to teach*. New York: Teachers College Press.
- Hartwig, M., 2007. *Dictionary of critical realism*. London: Routledge.
- Heppner, P.P., Wampold, B.E., Kivligham, D.M., 2008. *Research design in counselling* (3rd ed.). Belmont: Thomson Brooks/cole.
- House, J.D., 2006. Mathematics beliefs and achievement of elementary school students in Japan and United States. Results from the third international mathematics and science study. *J. Genet. Psychol.*, 167(1), 31-45.
- Jacobs, M., Gawe, N., Vakalisa, N., 2002. *Teaching-learning dynamics*. Sandton: Heinemann Higher and Further Education.
- Kincheloe, J., 2008. *Critical pedagogy primer*. New York: Peter Lang.
- Lawton, D., 1987. The changing role of the teacher. Consequences for teacher education and training. In prospect quarterly review of education. Paris: UNESCO 61. xvii(1).
- Levine, A., 2006. *Eduating school teachers. The education schools project*: New Jersey.
- Lincoln, Y.S., Guba, E.G., 1985. *Naturalistic inquiry*. Beverly Hills, CA:Sage.
- Locke, F.L., Silverman, S.J., Spirduso, W.W., 2010. *Reading and understanding research* (3rd Ed.). London: SAGE Publishers.
- Marton, F., Hounsell, D., Entwistle, N., 1997. *The experience of learning. Implications for teaching and studying in higher education*. Edinburgh: University of Edinburgh Press.
- Matiru, B., Mwangi, A., Schlette, R., 1995. *Teach your best. A handbook for universitylecturers*. German Foundation for International Development (DSE): University of Kassel Witzenhausen.

- Mbugua, Z.K., Kibet, K., Muthaa, G.M., Nkonke, G.R., 2012. Factors contributing to students' poor performance in mathematics at Kenya certificate of secondary education in Kenya, a case of Baringo County, Kenya. *Am. Int. J. Contemp. Res.*, 2(6), 87-91.
- McAninch, A.R., 1991. Casebooks for teacher education. The latest fad or lasting contribution? *Educ. J.*, Taylor and Francis.
- Mhishi, M., Bhukuvhani, C.E., Sana, A.F., 2012. Science teacher training programme in rural schools. An ODL lesson from Zimbabwe *International Review Research in Open and Distance learning*. 13(1), 108-121.
- Mji, A., Makgato, M., 2006. Factors associated with high school learners' poor performance. A spotlight on mathematics and physical science. *S. Afr. J. Educ.*, 26(2), 23-266.
- Moon, B., 2001. Time for radical change in teacher education guidelines. Using Open and Distance learning. Paris: UNESCO.
- Noddings, N., 2007. *Philosophy of education*. Colorado, CA: Western Press.
- Nyangura, L.M., Reece, J.L., 1990. Teacher quality in Zimbabwe secondary schools. *Zimbabwe J. Educ. Res.*, 2(3), 212-238.
- Nziramasanga, C.T., 1999. Report of the presidential commission of inquiry into education and training. Harare: Government Printers.
- Ojose, B., 2011. Mathematics literacy. Are we able to put the mathematics we learn into everyday use? *J. Math. Educ.*, 4(1), 89-100.
- Olsen, D.G., 1985. The quality of prospective teachers. Education vs non-education graduates. *J. Teach. Educ.*, 36(5), 56-59.
- Ornstein, A.C., Levine, D.U., Gutek, G.L., Voke, D.E., 2011. *Foundations of education*. Belmont: Wadsworth Cengage Learning.
- Perraton, H., Creed, C., Robinson, B., 2002. Teacher education guidelines. Using Open and Distance Learning. Paris: UNESCO.
- Roth, R.A., 1999. *The role of the university in preparation of teachers*. Philadelphia: Falmer Press.
- Rust, V., Dalin, P., 1990. *Teachers and teaching in the developing world*. New York: Garland.
- Sarason, S.B., 1993. *You are thinking of teaching? Opportunities, problems, realities*. San Francisco: Jossey-Bass.
- Schon, D.A., 1987. *Educating the reflective practitioner. Towards a new design for teaching and learning in professions*. San Francisco: Jossey-Bass.
- Schon, D.A., 1991. *The reflective turn. Case studies in and on educational practice*. New York: Teachers' College Press.
- Shin, J., Lee, H., Kim, Y., 2011. Student and school factors affecting mathematics achievement international comparisons between Korea, Japan and U.S.A. *J. Teach. Educ.*, Jan(62), 3-7.
- Shumba, O., 1993. Nature of science (Nos) in science education. Possibilities and constraints in a developing country, Zimbabwe. *Zimbabwe J. Educ. Res.*, 5(2), 155-185.
- Silva, D.L., Tadeo, M.C., Delos, R.V., Dadigan, R.M., 2006. Factors associated with non-performing Filipino students in mathematics. A vision of students cognitive and behaviour management. In proceedings of the 2nd IMT-GT-Regional conference on Mathematics Sains Malaysia, Penang, June. 13-15.
- Skipper, C.E., Quantz, R., 1987. Changes in educational attitudes of education and arts and science students during four years of college. *J. Teach. Educ.*, May-June, 39-44.
- Smith, B.O., Meux, M., 1970. *A study of the logic of teaching*. University of Illinois Press: Urbane.
- Smith, J., 2002. *The learning game. A teachers' inspirational story*. London: Abacus.
- Steen, L.A., 2001. *Mathematics and democracy. The case for quantitative literacy*. New Jersey: The Woodrow Wilson National Fellowship Foundation.
- Stephen, P., 1995. *Principled mentoring and competency-driven teacher education in an urbane comprehensive school*. London: Paul Chapman Publishing Ltd.
- Summers, M.K., 1982. Philosophy of science in the science teacher education curriculum. *Eur. J. Sci. Educ.*, 4(1), 19-27.
- Tachie, S.A., Chireshe, R., 2013. High failure rate in mathematics examinations in rural senior secondary schools in Mthatha district, Eastern Cape. *Learners' Attributions. Stud. Tribes.*, 1(1), 67-73.
- Tecla, A., 2007. Students' academic achievements and learning questions in mathematics among secondary schools in Nigeria. 3(2).

- Tella, A., 2008. Teacher variables as predictors of academic achievement of primary school pupils mathematics. Int. Electron. J. Element. Educ., 1(1), 17-33.
- UNESCO, 1985, 2000, 2010, 2014. UNESCO and education throughout the world. Damien: Paris.
- Watkins, K., 2000. The oxfam education report. Parkstone: Oxfam.
- Weiner, B., 1992. Human motivation. Metaphors, theories and research. Newbury Park, CA:SAGE Publications.
- World Bank, 1990, 1999, 2000, 2005. Priorities on strategies for education. A World Bank Policy Paper. World Bank.
- Wragg, E.C., 1993. Primary teaching skills. London: Routledge.

How to cite this article: Sibanda, P., Moyo, L., 2018. The relevance of teacher education in sustaining research in mathematics, science and technology education (MSTE) in Zimbabwe. Scientific Journal of Pure and Applied Sciences, 7(1), 713-722.

Submit your next manuscript to Sjournals Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in DOAJ, and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.sjournals.com



The Academic and Scholarly Research Publication Center Ltd. (ASRPC), a corporation organized and existing under the laws of the England country with No., 10401338. Established in 2016, Academic and Scholarly Research Publication Center Ltd. is a full-service publishing house. We are a leading international publisher as well as distributor of our numerous publications. Sjournals Publishing Company is published under cover of ASRPC Publishing Company Ltd., UK.

<http://asrpc.co.uk>

