

Pre-service science teachers' views on approaches used in their preparation

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ABSTRACT

Pre-service science teacher preparation must constantly evolve to enable prospective science teachers to adapt production of desired learner outcomes, to any teaching and learning environment. Such pre-service science teachers will facilitate appropriate responses by schools to rapidly changing technological, working and life skills. This case study rooted in interpretivist paradigm, sought to find out how approaches utilised in science teacher training assisted pre-service teachers in teaching science in diverse environments. Purposive sampling was used to select twelve pre-service science teachers and five science educators as participants, considered information rich sources. Document analysis, semi-structured interviews and focus group discussions were used to collect data. Data were thematically analysed. Results stress the need for science educators to use approaches which develop competences of pre-service science teachers to contextualise teaching and learning for achievement of intended learning objectives.

Keywords: pre-service science teacher preparation, teaching and learning environment, science educators, contextualise teaching and learning

INTRODUCTION

Pre-service science teacher preparation must constantly evolve to face challenges in society, like technological development and changing work and life skills. In the global context, approaches used in pre-service science teacher preparation in any country, should be guided by the vision of national science teaching and learning, to develop accordingly, desired exist competences for pre-service science teachers (Valli et al., 2014). A competence according to The Wing institute (2018) and Wubbels et al. (2011)) is a complex combination of knowledge, skills, understanding, values, and attitudes which lead to effective human action in a particular domain. A skill differs with a competence in that it is the ability to perform complex acts with ease, precision and adaptability, in doing a task or solving problems. Teaching competences focus on the role of the teacher in the classroom, with direct link to the process of teaching in relation to professional knowledge and skills intended to produce desired learner outcomes (Bertschy et al., 2013). However, teacher competences are concerned with implementation of teacher professionalism at multiple levels which include individual, school, community and professional networks (Madrid & Oco, 2025). Thus, teacher competences are broader comprising different skills, as well as knowledge and attitudes (Valli et al.,

2014). Since teacher competences subsume teaching competences, it follows that for a teacher to be effective in a broader sense, she / he should possess teacher competences.

A study on integration of ICT, pedagogy and content by Kafyulilo (2010) reveals that pre-service teachers use approaches when teaching, in the same way they were taught during their pre-service teacher classes. Basing on this evidence, science teacher educators should use approaches which ensure that pre-service science teachers develop competences consistent with achievement of goals of science education. The question to ask is "Are teacher education colleges equipping pre-service science teachers with appropriate competences to achieve desired educational goals?" For this to happen, American Association of Colleges for Teacher Education & the Partnership 21st Century Skills (AACTE & P21) (2010) propose that approaches used in pre-service science teacher classes should involve alignment of instructional technology with content, pedagogy and standards embedded into 21st century knowledge and skills. In addition, pre-service science teachers' ability to creatively use ICT to meet needs of learners should be developed. Many researchers (AFT, 2012; Biesta, 2012; Montrieux et al., 2015), observe that by the time some children reach secondary school they will be having very good skills in ICT. What exists as a gap is whether pre-service science teacher preparation equips prospective teachers with competences to facilitate learning

science through ICT. Competences of pre-service science teachers to facilitate learning through ICT can be developed by creating conditions that support development of skills to pursue continuous learning in adapting instruction to the context of teaching and learning at any given time (AACTE & P21, 2010). Such approaches equip prospective teachers with skills to assist learners to attain an understanding of science, regardless of the nature of teaching and learning environment.

In the African context, National Board for Professional Teaching Standards (NBPTS) (2016) notes that some students' misunderstandings of science concepts like gravity are due to their African cultural experiences which contradict modern science. If contradictions are not reconciled, so that the referral framework of modern science is accommodated by learners, science concepts may be misunderstood. It is the responsibility of pre-service science teacher preparation programmes to use approaches which equip prospective teachers with skills to understand the dynamics between learner needs due to their prior experiences, and science content learning demands.

Some researchers (Kennedy-Clark et al., 2017; UNICEF, 2014), have noted that large pre-service science teacher classes cause challenges, in using microteaching, peer-teaching, and experiments to develop appropriate skills in prospective science teachers. Therefore, large pre-service science teacher classes inhibit prospective science teachers from being exposed to enough opportunities to develop requisite competences to facilitate science learning (Admiraal et al., 2017). Such competences are critical for enabling prospective science teachers to adapt subject and pedagogical knowledge, together called pedagogical content knowledge (PCK) to science teaching and learning (Adu-Gyamfi, 2020). As propounded by Shulman (1986) cited in Bhota and Reddy (2011) the tenets of PCK are knowledge of subject matter presentation and the understanding of specific student learning style preferences of diverse learners (Bhota & Reddy, 2011).

Pre-service teachers can be good beginners upon qualifying (Admiraal et al., 2017), if pre-service teacher preparation programmes prepare them (pre-service teachers) to keep on learning on their own, on the basis of classroom experience. Adding to this view Hong and Van Riper (2016) support preparation of pre-service teachers which promotes innovation and learning outcome improvement. Opportunities for pre-service teachers to critically examine their own ideas about teaching, against a variety of sources, can be made by observation of experienced teachers, debate with expert teachers and peers, research, dialogue with teacher educators and mentors, and establishing effective partnerships between pre-service teacher preparation institutions (colleges /universities) and schools (Hong & Van Riper, 2016; The Wing Institute, 2018).

Using interactive approaches has been found to reduce perceived difficulties in learning of science and mathematics at undergraduate levels (Benedict et al., 2016). Therefore, teaching approaches used in pre-service science teachers' classes should reflect what is advocated for when learners at schools are taught, since teachers tend to teach the way they were taught (Tubonemi, 2013). Like any learner, pre-service science teachers learn in the context of their previous learning

experiences. The implication to science teacher educators is that new practices of prospective science teachers should be built on the previous experiences prior to adding new responsibilities and complexity. Focus should be put on developing new sets of teacher competences and skills at classroom level, to generate and sustain student interest in science (Dejene et al., 2018; Maringe, 2012), pre-service science teachers with such competences have potential to meet different learning needs of learners in diverse teaching and learning environments. Diverse teaching and learning environments comprise unlimited combinations in different mixes of various factors like class size, learning and teaching aids, new technologies, national goals, global science and technology views, learners from different cultural and socio-economic backgrounds, different abilities of learners, resource management skills, workload, behaviour management, students' confidence, language skills, students' motivation, attention spans and education for sustainable development goals (SDGs) (UNESCO, 2017). Pre-service science teacher preparation programmes in Zimbabwe should assist pre-service science teachers to develop competences, which promote science learning in diverse teaching and learning environments.

Premised on the foregoing arguments, this study sought to understand, from an epistemological stance, how approaches utilised in science teacher training in two teachers' colleges in Zimbabwe, assist pre-service science teachers to teach in diverse teaching and learning diverse environments. The study sought to address a knowledge gap by creating knowledge that will contribute to improved pre-service science teacher preparation for teaching in diverse teaching and learning environments.

RESEARCH METHODOLOGY

Research Paradigm and Research design

This study was guided by the interpretivist paradigm which acknowledges multiple interpretations or realities for a single phenomenon, hence relativity of knowledge to the knower, and understanding of the knowledge from the perspective of the person directly involved (Fard, 2012; Saunders et al., 2009). Therefore, consistent with the interpretivist paradigm and purpose of the study, the case study design was used. A case study design is defined by Cohen et al. (2011), concurring with Fàbregues and Fetters (2019) as use of various methods and multiple data sources to explore, describe or explain a single case (ie, an event, individual, group, organisation or programme), bounded in time and place. Multiple data sources use increased credibility of findings through triangulation (Lauckner et al., 2012). The case study design also allowed direct evidence to be collected, hence gaining in-depth data collection (Lauckner et al., 2012). These reasons justified use of case study design in this study.

Participants

Purposive sampling was used to intentionally select 13 pre-service science teachers and 5 science educators as participants, based on the researcher's knowledge that these participants were information rich sources (Etikan & Bala,

2017; Taherdoost, 2016). Of the 13 pre-service science teachers, 5 were selected from Teachers' College P (TCP) and Teachers' College Q (TCQ) respectively for focus group discussions. These pre-service science teachers had completed attachment teaching practice (ATP) and now resident for last phase of the programme, at TCP and TCQ respectively. ATP is a process when a pre-service teacher does teaching practice under the guidance of a qualified teacher called a mentor. For interviews 3 pre-service science teachers still on ATP were selected from TCP.

Of the 5 science educators, 2 were selected from TCQ and 3 from TCP. Selection of science educators was based on 3-year work experience in secondary science teacher education. From the researcher's viewpoint, at least three years of work experience is needed by a science educator to become knowledgeable about science teacher education programmes. Three mentors one in an urban setting, another in a rural day setting and the last in a boarding setting participated in the study. These were selected by virtue of them being respective mentors of three participating pre-service science teachers at TCP, deployed at schools for ATP. Choice of schools was made in this way to represent diverse science teaching and learning environments.

Data Collection and Analysis

Document analysis, semi-structured interviews and focus group discussions (FGDs) were used to collect data. Data collection and analysis were done concurrently (Sutton & Austin, 2015), consistent with the qualitative approach chosen for this study. Concurrent data collection and analysis is gathering and analysing data at the same time or simultaneously (Baxter & Jack, 2008; Sargeant, 2012). Arising themes were presented in an interrelated manner consistent with the case study design (Creswell, 2014). Extensive quotes and rich details were used to support themes.

Pre-interview and pre-focus group discussion (FGD) planning meetings were held at appropriate stages of data gathering with prospective participants, to agree on modalities of how and when each interview or FGD would be done. On average each interview or FGD took 45 minutes. However, it should be pointed that either video or audio recording of responses was dumped after many participants expressed reservations on their responses being recorded as video or audio. They argued that there has been a surge in abuse of videos or audios through the internet such that they did not feel comfortable in being recorded. In this context responses were manually recorded (Sargeant, 2012). The researcher ensured that for all interviews the space around made each interviewee and FGD participant relaxed. Language use like terminology was carefully done, so that the total environment for interviews was conducive to provide genuine data.

The researcher was always mindful of the fact that the participants were likely to modify their comments due to his position as a science educator (Sutton & Austin, 2015). In order to mitigate this, the researcher always reminded the participants that he was entering their world as a social researcher, and not as a science educator. This was important to guard against bias of participants and bias of the researcher. Data saturation was achieved by collecting data until no new data was generated by both interviews and FGDs.

Thematic data analysis was made across all data to identify themes that summarised all views collected. Open coding which allowed themes to emerge was used in transcription of interview and FGD data. To support themes, extensive quotes with rich details were used. It is crucial to point that arising themes were presented in an interrelated manner for triangulation, consistent with the case study design (Creswell, 2014). Pre-service science teacher ATP documents were accessed and analysed during lesson observation of each pre-service science teacher participating in the study. The Curriculum Framework 2015-2022 and Teacher Professional Standards (TPS) which were analysed, were acquired with permission from the Ministry of Primary and Secondary Education (MoPSE) of Zimbabwe. College Science syllabuses for the researcher's college TCP were available to the researcher as a science educator at the college.

Trustworthiness of Data

Credibility, confirmability and dependability were ensured through member checking, triangulation, and making explicit researcher bias. Triangulation of data from interviews, policy and curricula documents increased accuracy of research findings, hence ensuring credibility and dependability (Cleland, 2017). Transferability was ensured through detailed case descriptions of aspects like participants, data collection methods and research results (Lauckner et al., 2012).

FINDINGS

Findings are presented and analysed under four themes which are: (1) Competence Development (2) Global Trends Compliant Skills (3) Alignment to Teaching in Diverse Environments and (4) Pre-service Science Teacher Motivation.

Competences Development

Linking theory with practice is important in pre-service science teacher preparation, therefore opportunities to link theory with practice should be provided by science educators (Dejene et al., 2018). In line with this assertion, most participants stressed that approaches like presentations, experiments microteaching, and peer-teaching utilised in science teacher training assisted pre-service science teachers to teach in diverse teaching and learning environments by developing competences applicable during ATP. As presented before, ATP is a process when a pre-service teacher does teaching practice under the guidance of a qualified teacher. On presentations, one TCP FGD participant summarised views of other TCP FGD participants and a TCP pre-service science teacher John, currently on ATP saying:

As I compared my views with the presentation, reactions by classmates and the comments by my science educator, I became broadened in understanding of the concepts being discussed. However, for presentations to work best as a teaching and learning approach in a classroom set up, the teacher should create an environment which is friendly to the whole class, so that no learner feels threatened or targeted by the discussion of presentations.

Illustrating contextualised lesson delivery in diverse teaching and learning environments one TCP FGD participant said:

At a boarding school I taught, boarders were mostly from the upper-class families so they had resources like laptops and smartphones. Day scholars from lower class families lacked these resources. These differences created tensions between learners. To accommodate all pupils, I used different methods like asking questions for both high and low performers so that they participated. I also designed group activities such that day scholars and boarders interacted freely. In the process every learner was involved in meaningful learning. It really worked.

Contextualising teaching and learning strategies is important, so that learners from various socio-economic backgrounds collaboratively develop abilities, attitudes and values that allow them to work with others as a team. As a result no learner is left behind in the learning process, consistent with inclusive pedagogy (Florian & Black-Hawkins, 2011; Ikwumelu et al, 2015).

Digital learning methodologies are interactive making them compliant with 21st century teaching and learning (AACTE and P21, 2010). All the five pre-service science teachers (Tecla, Don, Mary, Conwell and Kate) participating in the Teacher College Q (TCQ) FGD said digital methodologies like powerpoint and interactive boards were appropriate technologies to embrace, and these were widely used during their lessons at college. However, Conwell emphatically acknowledged the idea of varying and adapting teaching and learning approaches to suit context or diversity of teaching and learning environments saying:

In Zimbabwe some schools cannot afford to acquire modern technologies like interactive boards. Also, some schools do not have electricity; hence such technologies cannot be used.

Conwell's response illustrates each teaching and learning environment's uniqueness, hence buttressing that science teaching and learning environments are diverse.

Commenting on the quality of preparation for ATP, a TCQ FGD participant Mary said:

Practical activities done like microteaching and peer-teaching illustrate how various approaches like constructivist approaches are used for teaching science in diverse teaching and learning environments. Reflections on activities such as scheming, planning and lesson delivery develop skills in pre-service science teachers on how to do ATP, in diverse contexts.

Related to Mary's view on practical activities like microteaching and peer-teaching which involve pre-service science teachers in preparation activities like scheming, planning and lesson delivery, fellow TCQ FGD participant Kate, expressing a view shared with Tecla stated that:

The benefits of these activities could be fully realised if pre-service science teachers' classes were small.

Snapshot participation in a slot of either microteaching or peer-teaching does not achieve the intended goal of developing enough skills to go for ATP

Responses by TCQ FGD participants Conwell, Kate, and Tecla concur with (Adu-Gyamfi, 2020), on the important role played by approaches used to prepare pre-service science teachers to teach in diverse teaching and learning environments before deployment for ATP. However, the participants also highlighted a deficit in preparation by indicating the need to equip pre-service science teachers with enough skills for ATP.

TCQ science educator E indicated that there is no system which is hundred per cent perfect a view supported by Ikwumelu et al. (2015). While acknowledging limitations on microteaching, peer-teaching, and experiments, as expressed by pre-service science teachers, science educator E lauded these activities saying:

Activities like peer-teaching and microteaching provide novice pre-service science teachers with a concrete starting point. This view was supported by many pre-service science teacher finalists who came from ATP, during a lesson on ATP reflections. Many said that it is far much better to have microteaching and peer-teaching activities although the individual slots were short and few.

Responses by Conwell, Kate, Tecla and science educator E, converge on the important role microteaching, peer-teaching, experiments and other practical activities play in equipping pre-service science teachers with skills for ATP. It therefore implies as Oğuz (2017) notes, teacher candidates who view themselves as competent are likely to be more successful in teaching. Linking theory with practice these practical activities (microteaching, peer-teaching, experiments) give opportunities to novice pre-service science teachers to feel what it is to facilitate learning, hence increasing their efficacy as facilitators of learning (Özdaş, 2018).

Global Trends Compliant Skills

Findings of this study show that, during teaching and learning accommodating changes in educational policies, various religious beliefs, adapting the learning process to context, and use of constructivist approaches are some of the global trends complaint skills which pre-service science teachers should be equipped with before going for ATP. An example of policy change which TCQ FGD participants acknowledged being embraced by TCQ is Education 5.0, which is Zimbabwe's Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (MHTEISTD) education framework, comprising 5 components namely teaching, research, community service, innovation and industrialisation. The framework guides curricula design and implementation in higher and tertiary education institutions in Zimbabwe. It is an improvement of its precursor, Education 3.0 which comprised teaching, research, and community service (Mashavakure et al., 2024). In relation to how current approaches used in pre-service science classes were consistent with Education 5.0, Don summarised views of other TCQ pre-service science teachers saying:

Experiments which focus on developing critical thinking and meeting STEM goals are used. For instance, when we were studying wave phenomenon, a stick was used to tap water surface in a fishpond to generate waves. Using questions on a work card each pre-service science teacher was focussed on important concepts to be learnt. We also did the same experiment using a ripple tank. After the experiment, discussions and reflections were made.

Probing, why doing the experiment with improvised apparatus, Don responded:

The purpose of using a fishpond was to illustrate how locally available materials can be used to further STEM goals.

TCQ Science educator F concurred that:

Contextualised apparatus shows learners how phenomena exist in nature. For instance, a wave generated in a pond or similar water body is closer to the natural wave phenomenon than the ripple tank one. Also using available local materials allows learners to understand that science phenomena occur in the environment outside the laboratory.

Using the local school environment by science teachers may motivate pupils to be inquisitive and explore scientific issues, consistent with Education 5.0 and STEM goals. Using the school environment as the extension of the four walled laboratory makes teaching and learning of science concrete (Waite, 2011).

In schools, multicultural classes were said to be a reality in the 21st century by FGD participants at both TCQ and TCP, which resulted in diverse social, emotional, psychological and religious needs of pupils. Pre-service science teachers said they were assisted before going for ATP to develop skills which would assist them in managing multicultural classes. For instance, acknowledging the existence of multicultural classes in schools, a TCQ FGD participant Mary noted:

During lessons at college in Sociology, Philosophy and Psychology case studies on how to manage social and emotional concerns of pupils in multicultural classes were discussed. In some cases, we watched videos, and this approach was praised by pre-service science teachers as an effective strategy to develop classroom management skills.

Congruent with Mary's view, a TCP FGD participant expressed the need to attend to social, emotional, and religious concerns of learners in multicultural classes saying:

...touching certain animals is taboo for certain learners although such animals assist in learning Biology. The teacher has to find ways of accommodating these learners to avoid infringing on their religious beliefs, and emotions. Such skills are emphasised during preparation at college.

These responses by TCP and TCQ FGD participants show that before going for ATP, pre-service science teachers were

assisted to develop global trends compliant skills, like ability to accommodate diverse learner needs (Lewis et al., 2013). Apart from challenges in accommodating diverse learner needs, shortfalls in the preparation process exist as revealed by one TCP FGD participant commenting on the preparedness of pre-service science teachers to go for ATP saying:

Yes, the preparation was good, but some short falls exist. For instance, we went for ATP without knowing how to use certain models and apparatus, especially in electricity. In fact, the teaching programme should be revisited so that first things should come first. For instance, flip charts and models should be done before going for ATP.

This response indicates that activities which prepare pre-service science teachers for ATP should be done in the first year, before commencing ATP in the second year. This will ensure that pre-service science teachers commence ATP ready to advance science reform initiatives (Lewis & Bagree, 2013).

The need to ensure that pre-service science teachers are aware of the meaning and implications of key terms in science teaching and learning (Makamure & Jita, 2019), was revealed in the current study by TCP participants during a FGD. The researcher asked TCP FGD participants to give the meaning of constructivist approaches but could not do so. They acknowledged knowing constructivist approaches meaning after the current researcher had given the definition. FGD participants contradicted their initial response in a chorus answer confidently stating, "*... we know this and we have used these strategies on ATP, it is only the term we did not know*". Therefore, science educators should explain what constructivist approaches are and their link with issues like 21st century skills, STEM, SDGs, and Education for Sustainable Development.

Alignment to Teaching in Diverse Environments

The approaches used in preparing pre-service science teachers at college should be in line with the diverse teaching and learning environments they will work in during ATP and after graduating (Dejene et al., 2018). Some TCP FGD participants described some approaches used in pre-service science teacher classes as aligned with preparation for teaching science in diverse teaching and learning environments. The comments were:

Use of group work in pre-service science teacher classes helped me to develop skills to organise groups and manage them during a lesson. If groups are not well managed, they may disrupt learning.

Discovery Method used in our classes enabled us to use the same methods during ATP.

Groups develop skills for pre-service science teachers to work with different groups and different people in society. Different science educators teaching the same class enable us to appreciate and accommodate individual differences shown by science educators.

Using group work in conjunction with other approaches like project method and experiments encourages collaborative

or cooperative learning among learners (Glaze, 2018). This develops their ability, attitudes and values that allow them to work with others or as a team. In collaborative learning actions of individuals are influenced by the group and behaviour of an individual affects the group (Ikumelu et al., 2015).

Although a lot of competences were developed in pre-service science teachers before going for ATP as expressed by participants, gaps exist as Anna noted:

ICT in education is no longer optional these days because it is used in everyday life. When pupils reach secondary school their ICT skills will be good. Therefore, pre-service science teachers should be equipped with ICT skills for teaching.

Also illustrating gaps in approaches science educators used in pre-service science teacher classes, Jane a TCP participant on ATP said:

There are so many advocacies for STEM, but there is no focus on inclusion in use of ICT during pre-service science teacher classes. For instance, some of us need more help because we started using computers here at college.

Adding to comments by Anna and Jane at TCP, Tecla a TCQ FGD indicated the need for science educators to use approaches which prepare pre-service science teachers to teach in diverse teaching and learning environments stating:

Science educators should ensure that we are equipped with skills to teach science even in poorly resourced schools without laboratories, because it is reality in Zimbabwe that some schools do not have even a beaker.

Supporting use of locally available materials and improvising, which was viewed as little in pre-service science teacher classes, Mary a TCQ FGD opined:

Improvisation should be strongly used in pre-service science teacher classes to encourage use of materials available in the school environment in science lessons when we go for ATP. This may mitigate shortage of materials and apparatus to do experiments and practicals in general.

Ability to integrated ICT in teaching and learning, improvisation and use of alternative instructional media are some skills which pre-service science teachers said they needed to effectively assist learners during ATP. It is important as Adu-Gyamfi (2020) notes, to expose pre-service science teachers to various teaching and learning strategies so that they will be prepared teach in any learning environment.

Conwell a TCQ FGD participant stressed the need to equip pre-service science teachers with diverse skills to facilitate learning saying:

The science teacher can assist pupils to develop skills to use ICT for their learning, which implies pre-service science teacher training should equip prospective teachers with such skills. The teacher should also have skills to facilitate learning using other instructional

media like charts and the chalkboard because some schools do not have computers.

Conwell's response is a caution to pre-service science teacher preparing institutions that levels of embracing ICT for learning by schools are on a continuum, from unavailability of ICT to readily available. Development of science teaching skills should include the whole continuum, so that pre-service science teachers can facilitate learning in diverse teaching and learning environments (Mooi & Mohsin, 2014).

Pre-service Science Teacher Motivation

Approaches which science educators use should motivate pre-service science teachers to develop intended knowledge and skills (Mooi & Mohsin, 2014). A teaching and learning approach which was found inspiring by pre-service science teachers is modelling by science educators. Jane summarised pre-service science teachers' perceptions of science educator modelling of teaching and learning approaches saying:

I get inspired by getting immediate feedback as I compare my view on how to teach a particular science concept and what the science educators demonstrated in our lessons.

Exposure to various diverse teaching and learning contexts provide opportunities pre-service science teachers use to understand and develop skills and confidence to teach in diverse teaching and learning environments (Özdaş, 2018). This view was expressed by TCP participants on ATP. To illustrate, Anna expressing a view shared with John said:

Knowing that I have been exposed to various teaching contexts similar to what I will experience when doing ATP, through peer-teaching, microteaching and home area teaching, I am very excited and confident that I can teach science well.

These responses are clear testimonies that practical teaching activities like peer-teaching, microteaching, and modelling by science educators, preceding ATP are important advance organisers for ATP, since they connect theory with practice. In line with these findings, Jung and Tonso (2006) posit that confidence of pre-service science teachers is built when they teach after observing experienced science educators teaching (modelling) lessons several times. After reflecting on how science educators delivered lessons and internalised how science lessons flow, pre-service sciences gain confidence in delivering lessons. This stresses the need to expose pre-service teachers to a lot of practical experiences.

Another aspect which was viewed important in motivating pre-service science teachers during ATP was mentor support. However, the pre-service science teachers noted that different understandings of mentoring by science teachers in schools (mentors) and science educators inhibited good mentoring in some cases. Differences in understanding mentoring were attributed to various pathways science teachers (mentors) and science educators are prepared as revealed by mentor W who shared this view with S that:

Both mentors and science educators are prepared by many local and international teacher education

institutions using various models or pathways, like science diplomas, Bachelor of Education (BED) in science full time, BED in Science through Open and Distance E-learning, and PhD. Therefore, mentors and science educators understand mentoring differently, hence the college should provide ATP guidelines which specify the college expectations from mentors. Assisting pre-service science teachers in line with college expectations may motivate them to be more committed.

Consistent with theories of support and motivation in psychology (Vygotsky, 1978), motivation of pre-service science teachers is critical in their preparation, so that the envisaged science teachers are produced for the intended education system.

The foregoing presentation of findings has been done themes which are competence development, global trends compliant skills, alignment to diverse teaching environments, and pre-service science teacher motivation. However, discussion in the next section is done in an integrated manner to promote triangulation, hence ensuring credibility, confirmability and dependability of findings.

DISCUSSION

Pre-service science teachers noted that some schools in Zimbabwe do not afford modern technologies due to financial constraints, and lack of electricity, hence making digital methodologies redundant. In fact (Maringe, 2012; Mushayikwa, 2012) in Zimbabwe it is prevalent that some secondary schools have good laboratories with state-of-the-art equipment on one end of the continuum, and on the other some secondary schools do not have a single laboratory. Therefore, alternative instructional media like the chalkboard, charts, and one litre plastic bottles for measurement, should not be relegated to the dust bin. Improvised apparatus should be used when the need arises, because in some school settings these are the best available apparatus to enable pupils to understand concepts. In such a context, this study suggests that science educators should equip prospective science teachers with improvisation skills to enable them to teach even in poorly resourced schools. Congruent with this view, Adu-Gyamfi (2020) states that use of locally available materials and improvisation can make science teaching and learning effective in the absence of conventional teaching and learning materials. While acknowledging the importance of ICT as instructional media, Benedict et al. (2016) observe that paired work, discussion based on 'chalk & talk' methods and peer assessment have been associated with significant gains in learning. Overall findings of this study illustrate how each teaching and learning environment is unique, hence buttressing that science teaching and learning environments are diverse. Therefore, approaches used to prepare pre-service science teachers should be adapted to the context, making them functions of time, space, available material, financial and human resources.

Science educators acknowledged limitations placed on activities like microteaching, peer-teaching, and experiments

in learning by large pre-service science teacher classes. This finding is supported by UNICEF (2014) and Kennedy-Clark et al. (2017). However, science educators lauded microteaching, peer-teaching, and experiments for providing novice pre-service science teachers with a concrete starting point. Pre-service science teachers said self-reflection through discussion and sharing of ideas, encouraged by presentations as a strategy for teaching and learning, broadened and deepened their understanding of concepts. This is supported by MoPSE (2015) which employs majority of pre-service science teachers from TCP and TCQ. However pre-service science teachers warned that presentations work best when the teacher creates an environment which is friendly, so that no learner feels threatened or targeted by the discussion of presentations.

Document analysis showed that in addition to presentations, the project method, experiments, and e-learning were aligned with the New Curriculum of Zimbabwe. This finding is congruent with some researchers (AACTE and P21, 2010; National Council for Accreditation of Teacher Education (NCATE), 2010) who note that aligning training closely with the needs of schools that pre-service teachers will serve, makes teacher preparation programmes most effective. Conversely, AFT (2012) argues that if teaching and learning in pre-service science teacher classes is not aligned to context, the preparation process becomes confusing, fragmented and bureaucratic. This would produce unintended competences in prospective science teachers. Therefore the current teacher education system in Zimbabwe should shift from academic preparation to alignment to school-based experiences (NCATE, 2010).

Preparedness to teach is enhanced by exposing pre-service science teachers to enough opportunities for equipping them with requisite skills (Admiraal et al., 2017). This resonates with pre-service science teachers' view in this study, that more time is needed to engage in constructivist activities like experiments, during microteaching and peer-teaching before going for ATP. This would allow them to gain skills in scheming, and delivering lessons, on a small scale before dealing with full ATP teaching load. Mathevela and Uwizeyimana (2014), and King (2013) assert that failure by science teachers to adapt teaching strategies to diverse teaching and learning environments emanate from insufficient training. This is a reminder to science educators to prepare adaptive pre-service science teachers aligned to expectations in schools (Flores, 2015).

Pre-service science teachers revealed that science educators' modelling of delivery of lessons was motivating since it exposed them to various contexts similar to what they would experience ATP, and after becoming qualified. This finding resonates with Mooi and Mohsin (2014) and Dejene et al (2018) who argue that approaches science educators use should motivate pre-service science teachers to develop intended knowledge and skills. In agreement, Özdaş (2018) notes that exposure to various diverse teaching and learning contexts provide opportunities pre-service science teachers use to understand and develop skills and confidence to teach in diverse teaching and learning environments. All in all, consistent with theories of support and motivation in psychology (Vygotsky, 1978), motivation of pre-service science teachers is critical in their preparation, so that the

envisaged science teachers are produced for the intended education system.

Education 5.0 is Zimbabwe's Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (MHTEISTD) education framework, which guides curricula design and implementation in higher and tertiary education institutions, in Zimbabwe. In line with Education 5.0 one pre-service science teachers said using a ripple tank together with a fish pond to study water waves and water in a 5-litre glass bottle to converge light outside the laboratory illustrated how to use locally available materials. According to Waite (2011) this allows pre-service science teachers to understand that science phenomena occur in the environment outside the laboratory, as well as diversifying application of practical teaching approaches in secondary science education. Exposure of pre-service science teachers to such experiences may encourage them to incorporate the school environment into teaching and learning. Consequently, this may motivate pupils to be inquisitive and start exploring scientific issues, consistent with Education 5.0, 21st century critical thinking skills and STEM goals. Analysis of the Zimbabwe Curriculum Framework for Primary and Secondary Education 2015-2022 (MoPSE, 2015), showed that at ordinary level (O-Level) is where the academic path (that is pursuing sciences / STEM subjects, arts or commercials) a learner will take is determined. Therefore, in this vein, teachers' colleges in Zimbabwe should equip pre-service science teachers with skills to facilitate learning to produce competent O-Level science graduates who will pursue science subjects or STEM related carriers.

In multicultural classes social and emotional concerns of learners need proper attention. As Florian and Black-Hawkins (2011) note, pre-service science teachers expressed need for accommodating religious, social and emotional concerns of pupils in multicultural classes, so that no learner is excluded. For instance, as this study proved, ways should be found to accommodate pupils whose religious beliefs consider it taboo to touch certain animals in Biology lessons. This is in line with inclusivity emphasised by the Universal Declaration of Human Rights Article 26 (UN, 2015), and SDG number 4 (UNESCO, 2017), which emphasises non-discriminatory approaches in education. According to Blazzar and Kraft (2017), taking the school as an ecological system enables pre-service science teachers to treat classroom life as a coherent entity comprising cultural, physical, social, historical, and personal systems that exist both within and outside the class. With such skills, the science teacher recognises activities not appropriate for class activity (like taboo of touching a dead animal), based on dialogues taking place within and between all the systems (González et al., 2016; Vrieling et al., 2018).

Congruent with many researchers (AFT, 2012; Biesta, 2012; Montrieux et al., 2015), pre-service science teachers acknowledged that by the time some children reach secondary school they will be having very good skills in ICT, based on interaction with cell phones of their relatives which are minicomputers, as early as pre-school age. Therefore, the large number of secondary school learners who are ICT compliant and have an unlimited access to current knowledge through the internet, makes the teacher's task increasingly complex. In order to equip them with the requisite ICT skills, pre-service

science teachers suggested that their preparation should include compulsory intensive course on application of ICT for teaching and learning. This agrees with Admiraal et al. (2017), who posit that technology should be fully integrated into education, since it supports development of skills such as, higher order skills, adaptability, and collaboration. These skills are particularly important now and in future, because of continuous change in knowledge and skills one needs to be functional in society. Premised on this learning has become a lifelong process.

CONCLUSION

Approaches used by science educators should prepare pre-service science teachers to facilitate learning in both well and poorly resourced teaching and learning environments. In this vein, alternative instructional media like the chalkboard, charts, and one litre plastic bottles for measurement, should not be relegated to the dust bin. Improvised apparatus should be used when the need arises, because in some school settings these are the best available apparatus to enable pupils to understand concepts. This is particularly important in the Zimbabwean and similar contexts where some secondary schools have good laboratories with state-of-the-art equipment on one end of the continuum, and on the other some secondary schools do not have a single laboratory. In such a context, science educators should equip prospective science teachers with improvisation skills to enable them to teach even in poorly resourced schools. Use of locally available materials, and improvisation can make science teaching and learning effective in the absence of conventional teaching and learning materials. While ICT is important as instructional media, but other methods like paired work, discussion based on chalk and talk and presentations are also important.

Science educators should use approaches which develop competences of pre-service science teachers to facilitate learning in multicultural classes where social, religious and emotional concerns of learners need proper attention. This accommodates all learners so learning becomes inclusive in line with inclusivity emphasised by the Universal Declaration of Human Rights Article 26. Each teaching and learning environment is unique, hence buttressing that science teaching and learning environments are diverse. Therefore, approaches used to prepare pre-service science teachers should be adapted to the context, making them functions of time, space, available material, financial and human resources.

RECOMMENDATIONS

Science educators should:

- Develop skills of pre-service science teachers to use the school environment as an extension of the laboratory;
- Prepare pre-service science teachers to improvise and use conventional apparatus, to facilitate learning in both well and poorly resourced teaching and learning environments; and
- Use approaches which enable pre-service science teachers facilitate learning in multicultural classes,

where social, religious and emotional concerns of learners need proper attention consistent with goals of inclusive education.

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