AJOTE
African Journal of Teacher Education
ISSN 1916-7822. A Journal of Spread Corporation

Volume 10. No. 2 2022 Pages 80-100

Preparing secondary school science teachers for learner-centered teaching in Tanzania's Teacher Training Colleges: Educators' perceived challenges and perspectives

Selina Mkimbili[1] **& Festo Kayima**[2]
[1]Department of Educational Psychology and Curriculum Studies,
Mkwawa University College of Education, Tanzania
[2]Dept of Teacher Education, Norwegian University of Science and Technology, Norway.

Abstract

This study explored learner-centered science teaching approaches that eight science-teacher educators from two teacher education colleges in Tanzania, consider when teaching their students, and the challenges encountered when attempting to implement these approaches. We used a semi-structured interview to collect data which we analysed interpretively. Our findings revealed that the aspects of learner-centered pedagogy, such as engaging student teachers in practical work and discussion, and linking classroom science to the real world, were insufficiently considered by the teacher educators in the teacher colleges studied. The challenges and or difficulties that the teacher educators in these colleges perceive to impede the implementation of learner-centered science teaching in teacher education and as well as the possible approaches that can support the implementation of learner-centered science teaching in such colleges are discussed..

Keywords: science teacher educator; teacher training; science teacher trainees; learner-centered teaching

Introduction.

The current broad understanding of the important role of science and technology in the world of work and as a major driver of the global economy cannot be overemphasized. In the face of current environmental challenges and diminishing resources, the acquisition of basic science knowledge and skills is considered pertinent to enabling citizens of every nation to participate in and use environmental resources in ways to ensure sustainability (Treagust,

Won, & Duit, 2014). Education for sustainable development (ESD) is considered central to achieving the United Nations 17 sustainable development goals outlined for the Agenda 2030 (UNESCO, 2015). The nature of this education is one that ensures that individuals develop the needed competencies to reflect on their individual actions, account for their current social, cultural, economic, and environmental impacts. Science education has a role to enable students (citizens) understand the complexity and causes of global challenges the world faces today, such as climate change, water and food scarcity, energy transition and loss of biodiversity, and as well as equip citizens with relevant science knowledge and skills to be able to contribute to solving these challenges (Fensham, 2012; O'Flaherty & Liddy, 2018; UNESCO, 2015).

Owing to this important and central role, improving the teaching, and learning process among other factors is crucial to ensuring quality science education as an essential requirement of basic education. It is science teachers who are charged with the teaching and learning of science and we cannot talk about how important science is, without considering who will be charged with the teaching and learning process and how (Ogunniyi & Rollnick, 2015). Moreover, the training of school science teachers is also an important aspect. Whereas several research efforts and development programmes aimed at improving science teaching in schools have been going on over the years world-wide, efforts targeting science education in Africa have been largely focused on transforming teachers' ways of teaching with minimum attention paid to the trainers of these teachers. For instance, in Tanzania where this study was conducted, calls for teachers to shift from a traditional teacher-centred approach to a learner-centred teaching approach have been underscored (MoEVT), 2007; Nzima, 2016). Moreover, a number of studies on science education in the African context reveal that despite the persistent calls, the actualization of a learner-centred teaching approach by science teachers in Africa is yet to be realized (Ogunniyi & Rollnick, 2015). For this paper therefore, focus is put on science teacher educators who are charged with preparing teachers of science for future generations. Our underlying assumption is that, if at all a positive transformation in the quality of science teaching and learning is to be realized at lower levels of education, there is the need for equal attention to be paid not only to school science teachers, but also to trainers of those teachers.

Underpinning the goal of this study is the increasing need for learner-centred science teaching approaches at lower school levels in Tanzania that is learner-centred and competence-based (MoEVT, 2005). A learner-centred approach to science teaching is seen

as providing increased students' engagement and hence understanding of science, its nature, processes, and role in society (MoEVT, 2007). A learner-centred teaching is a teaching approach that offers more authority to the learners in decision making, allowing them to control their own learning and taking an active role in the teaching and learning process (Sikoyo, 2010). This approach is linked to a constructivism perspective of learning and inquiry-based teaching (APA, 1997; Vavrus & Bartlett, 2013). APA (1997) suggested that learner-centred teaching can help learners to link information from the classroom with existing knowledge and encourage students to engage with critical thinking skills.

Several research studies on the science teaching in Tanzania have consistently reported that a traditional teacher-centred approach still dominates science classrooms, and quite often these research reports have made recommendations calling upon teachers to adopt more constructive teaching approaches (Meena, 2009; Nzima, 2016). Some contextual challenges mentioned to have impeded the implementation of learner-centred teaching includes limited resources, the use of a foreign language[1] as a medium of instruction, overloaded curriculum, and overcrowded classrooms (Mkimbili, 2018). While these research reports are important and provide the needed baseline information upon which new directions could be forged, it is practically difficult for classroom teachers to adapt to alternative teaching approaches without the relevant training into how these promoted teaching approaches are actualized in teaching situations. It is with this understanding that we sought to put teacher educators' views about their teaching into perspective. Our conviction is that the educators of the science teachers who teach science in schools have an important part to play with regards to training school teachers in teaching methodologies, skills and competences with which school teachers would be able to implement the desired learner-centred science teaching approach. We thus asked the following questions:

1. What aspects of learner-centred teaching do science teacher educators in the colleges under study consider when teaching teacher trainees in science subject didactics?
2. What challenges do the educators in the colleges under study perceive as influencing how they individually approach teaching of science didactic courses to their teacher-students?

[1] According to the Tanzanian educational and training policy of 1995, Kiswahili which is familiar language to majority of Tanzanians, is used as a medium of instruction only for pre-primary and primary education. For secondary education and tertiary level education, including teacher education, English which is a foreign language in Tanzania, is the medium of instruction.

Teacher educators, their training, and competences: what earlier research says

Science teacher education has a role to educate and make science teacher trainees capable of teaching and supporting students' understanding of science (Nezvalová, 2011). An efficient science teacher education program should offer prospective teachers, the relevant content knowledge and a pedagogy that could be used to teach that content knowledge. For prospective teachers to be able to teach science in a meaningful way, acquiring special kind of knowledge and skills regarding how to teach specific content to a particular group of students is essential (Nezvalová, 2011). Science teacher education today is majorly guided by a social constructivist perspective of teaching and learning, where learners are active participants in the learning process that is set in a social context (Garbett, 2011; Nezvalová, 2011). With Social constructivism, learners attain meaningful learning through mediation of their prior experience and the new knowledge in the classroom (Amineh & Asl, 2015; Vygotsky, 1978). With this approach to teaching and learning science, inquiry is emphasized. In inquiry-based science learning, learners need to be engaged effectively in designing the question for investigation, designing investigation, collecting and analyzing data, drawing conclusions and communicating the findings (Crawford, 2014). When students are engaged with inquiry-based science teaching, they attain important skills such as critical thinking and will be able to solve their own problems and those of their societies (Kipnis & Hofstein, 2008). Thus, teacher educators are expected to be competent with knowledge with regards to both theoretical and practical aspect of science learning, to be able to transfer these knowledge and skills to their teacher students (trainees).

Considering the Diploma[2] teacher education program in Tanzanian which is the focus for this study, the curriculum emphasizes a social constructivist approach to teaching, aimed at encouraging students' active engagement in the teaching and learning process (Nzima, 2016). The expectation is that prospective science teachers must acquire the relevant knowledge and skills to be able to implement the science curricula and recommended practices. For example, one of the objectives stipulated in the syllabi for the diploma course

[2] In Tanzania, there are three forms of teacher qualification: grade A teachers, diploma teacher qualification, and degree level teacher qualification. Grade A teachers are trained to teach at the primary level, a diploma qualification enables one to teach at the secondary level, while those who acquire a teacher qualification with a bachelor's degree qualify to teach in secondary as well as in teacher training colleges. The degree program lasts three years while both grade A and the diploma programs in teacher education last two years. For the present paper, the focus is on teacher educators for science teacher trainees undertaking a 2-year diploma program in teacher education.

for those aspiring to become chemistry and biology teachers is that, after the completion of the two year teacher education program, the newly graduated teacher should be able to not only apply critical thinking skills in solving personal and teaching related problems, but also should be able to transfer these to their students (MoEVT, 2009). In addition, the graduate should have attained the ability to develop and conduct action research in teaching and learning, etc. (MoEVT, 2009). This in turn demands that teacher-educators have what it takes in terms of knowledge competences and skills to be able to produce science teachers who are suitable for the job.

Research design and methods

Theoretical underpinning

As the main goal of the present study, we set out to examine how science teacher educators implement their teaching practices, what kind of aspects are considered when teaching their teacher trainees about learner-centered approaches to science teaching. We also wanted to examine the perceived teaching skills and competence gaps that the individual educators felt to be affecting their teaching. Our conception which is located in the interpretivist research paradigm is that the participant educators in our study just like any other persons are able to construct their own understandings out of their individual experiences, within their respective cultures and contexts. Through the interpretivist lens, also considering our own personal experiences, beliefs, and values, we can analyze and construct an understanding of the meanings the participants share that are related to science teaching and learning. Our decision to collect data through interviewing, was also informed by the conception that meanings are co-created rather than being pregiven (Schwandt, 2000), and that these meanings can be realized through engagement with the activities of the research participants (Clandinin & Rosiek, 2007; Lincoln, Lynham, & Guba, 2011; Wolcott, 2009).

Data sources and collection tools

The present study was carried out in Tanzania. Eight science teacher educators (two females and six males) from two different teacher education colleges from two regions of Tanzania (i.e., Iringa and Arusha) took part in the study. Of the six educators, three taught chemistry and chemistry didactics, two taught physics/physics didactics, and one educator taught information & communication technology. All the educators had over 7 years of teaching experience. We developed a semi-structured interview guide with which the educators were

individually engaged in guided discussions about their teaching processes and activities during the period between 1st August 2019 and 30th January 2020.

The interview

The interview questions were open-ended and sought to lead the educators to disclose their individual main considerations and challenges with regards to teaching student teachers by employing a learner-centered pedagogy. The content addressed in interview questions inquired about whether or not, the teacher educators do engage student teachers in; inquiry-based science teaching and learning activities, and a discussion about how canonical science and didactic knowledge from classroom are linked to student teachers' real practice (world outside classroom). The interview also included questions inviting educators to share what they considered as the challenges impeding the use of a learner-centered pedagogy. All interview sessions lasted between 45 minutes and one hour. All sessions were recorded and transcribed following ethical guidelines and with consent from participant educators.

Data analysis

The recorded and transcribed interviews were interpretively analyzed. The individual transcribed interviews were first read through several times independently by each one of the authors of the present paper to obtain a general understanding of the different aspects taken up in the discussion by each participant. For the second part of the interview, we had initially put forward discussion themes as already mentioned, around which we asked teacher educators for their views. The analysis and interpretations were thus approached in an open way to try and let free the educators' views from our own prejudices and understandings. In other words, we let the educators' statements stand as they were given, and only constructed meanings by connecting the different parts of the dialogue, and as well as by finding consistency in what the individual teachers said or expressed. This way, we were able to identify different educators' perspectives regarding what the educators know, do and do not do with regards to a learner-centered science teaching, what challenges they claimed to face, what they wished to be changed, and as well as the different existing knowledge gaps.

The above process was applied separately by the two authors (researchers), after which we compared and reconciled our individual interpretations and conclusions.

Results

The findings from an analysis of the individual educators' views (responses), are presented and discussed in the form of answers to the two research questions that guided the present study.

What aspects of learner-centred teaching do science-teacher educators consider when teaching teacher trainees in science subject didactics?

Students' engagement with inquiry-based Science Teaching (IBST)

In the first part of the interview, our focus was on inquiry-based science teaching, and the discussion revolved around four themes, the teacher educator and students' role in formulating research/ investigation question, designing investigations, collection and analysis of data, and as well as drawing conclusions. Although all the eight teacher educators expressed the view that engaging student- teachers in guided inquiry is essential in preparing prospective science teachers, they all admitted that teacher trainee engagement in the above-mentioned four aspects was insufficient or minimal in their respective teaching classes. Accordingly, the educators attributed the infrequent engagement of teacher trainees in the above aspects of inquiry-based science teaching to several logistical, knowledge and skills related challenges. Among these, the educators pointed to limited resources (a logistical challenge) and a lack of motivation, considering that the national examinations are structured in a way that emphasis is mostly on mastery and reproduction of factual knowledge.

> *Data collection and analysis are very limited because resources are not available for real scientific investigation" (Tutor 3).*
>
> *They (referring to student teachers) are engaged, but not to a larger extent…Even the examination (needs)demands a student to do very little" (Tutor 4).*

In the interview, the educators were asked whether they allowed students to design their own experiments or provided experiments with more than one degree of freedom, or whether students had opportunities to design their own investigations. The educators seemed surprised by these questions, and accordingly responded that this was not the practice. While some educators gave reasons why they execute a different practice, others argued that they would rather prioritize other areas than a focus on the three areas that we inquired about. For example, Tutor Ai-5 said:

> *For the case of physics, most of the projects and experiments have pre-determined answers. So, for the students, what they are doing is just to prove what is there and following the formulated procedures. So, to come up with their own ways of doing things, actually that room is not there.*

Among the reasons given by some educators for not being able to consider the above elements we inquired about, was the claim that students' lack of interest (Ai-5), that there is not enough time to teach in a way that considers and incorporates the above aspects (Ma-8), the argument that the current teaching is both syllabus and examinations driven (Ai-5, An-6, & Ma-8), and as well as the argument that the teaching itself is constrained by curriculum contextual limitations (St-2). These and other related problems and challenges are explored in the next subsection.

Students' teacher engagement in science talk and linking science to their daily lives

Our interviews with teacher educators also focused on whether students (i) have opportunities to explain their ideas, (ii) can apply science concepts to everyday problems.

When asked if their students are given an opportunity to provide explanations and just their ideas during the teaching and learning process, some teacher educators disclosed that they engage their students in classroom talk but that this opportunity is limited or affected by the nature of the topic or content that is taught. The educators claimed that some of the topics that are taught are too abstract and can be difficult for student teachers to apply in science conversations.

> *The problem is that. . .most of the scientific issues are too theoretical and too abstract and (the) opportunity to observe is limited due to underdevelopment of our country…. For example, fractional distillation of crude oil, rubber processing, No industries, if we could have industries it could be easy to observe* (Tutor, 5)

On other hand, for some topics like natural resources and environmental issues, teacher educators disclosed that students were highly engaged in the discussions since such topics had a direct link to students' daily lives.

In our interview, we also explored whether student teachers are engaged in linking what is taught in the classroom to the real world. In response, teacher educators expressed that they sometimes do link what is taught in the classroom to the real world. *"In science teaching there are courses that can link what is taught in the classroom to the real*

world."(Tutor 5). To engage teacher trainees in linking what is taught in the classroom to the real world, teacher educators disclosed that tasks that are assigned to the student teachers need to be authentic:

> *. . . Everyday knowledge, yes they can use…. For instance that year we tried to demonstrate ……. how to use…how to measure soil Ph. Ehhh, and we engage them . . . .), they tried,…they tried to collect samples in our college….in different places..paaap……paap….paap… they tried to measure soil PH by the use of PH meter,…ahhh, (and discovered) , the foil PH here ..is this…..the soil PH here is this…at least they can choose proper gardening strategies in the college surrounding…..but not obvious (Tutor 6)*

What teacher educators claim to be challenges inhibiting them in engaging student teachers in learner-centered pedagogy

During our interview with educators, several factors were stated as challenges and problems that the respective educators perceive as limiting their science teaching practices. We present some of these factors (aspects) in this section.

Students' interest in doing science and the science teacher educator's role

Five out of the eight participant educators stated that their teacher trainees lacked interest in doing science. The educators implied that it would be even more difficult to ask them to design investigations on their own, given the existing lack of interest. Moreover, two educators, Ai-5 and An-6, also added that their trainees also suffered from having a poor reading culture, which further pointed to the existing lack of interest among science teacher trainees

> *The challenge of engaging students in backing their claims with evidence is that the students are not engaged in finding different sources. Students need to be interested or engaged in reading various science resources, and books. But students are not interested in reading. They are only struggling to read what is needed for answering examinations."* (Tutor Ai-5).

The educators attributed the lack of interest in doing science to the quality of the teacher candidates themselves. They argued that students who are enrolled into the science teacher education training course are those with either an average or even a low performance out of

secondary school level education. The educators are of the view that these teacher candidates start off with a low interest and competence in science well before joining the college.

> *The student teachers we enroll here at college are those who did not perform well in their secondary education examinations. Interest needs to start from lower levels of education. The types of teachers in schools are incapable of instilling interest…*(Tutor An-6:)

While these educators' argument about teacher trainees' lack of interest in doing science, their poor reading culture, as well as about the quality of the enrolled candidates being low are valid, it is important not to forget that those raising these excuses are the very science teacher educators whose job it is to equip the teacher candidates with the same abilities they are claiming teacher trainees are lacking. It is interesting to note that teacher educators are expected to address the question of interest in science, as well as enhancing and promoting the reading culture in teacher trainees. It thus paradoxical that participant teacher educators bring up these two issues as if solutions to them should come from somewhere else other than from themselves. Consequently, the educators' concerns reveal a lot about the existing gaps regarding the educators' pedagogical and didactic teaching knowledge competences. Their concerns also point to the likelihood that science educators do not have a full understanding of their roles and obligations as teacher trainers and what constitutes teacher teaching.

The curriculum and an inquiry-based approach to the teaching and learning of science

When asked whether they engage their students in exploring, designing, and executing their own investigations or projects or in some kind of inquiry teaching, six out of the eight educators claimed that the curriculum did not provide room for such kind of teaching or learning activities. For example, one tutor claimed.

> *The experiments we are doing are those prescribed by the syllabus only, for a student to come up with an idea, I have not witnessed that. Students are only learning by memorization. There is no room in the curriculum for that. The curriculum itself is a challenge. It does not provide room for grooming innovators. (Even) future teachers have not been prepared to groom (future) innovators*. (Tutor An-6)

Two different positions are given by the educators in support of their claim about the curriculum not providing room for inquiry-based teaching activities. First, there are those educators like tutors An-6 & Bc-3 who believe that the curriculum does not demand for these types of activities and way of teaching. Second, there are those who acknowledge that

although they claim the curriculum not to provide room for inquiry-based teaching activities, the curriculum itself stipulates and promotes an inquiry-based form of teaching at almost all levels of education in Tanzania. This group therefore attributes their failure to include inquiry-based teaching activities in their practice to inadequacy of time and to the curriculum being overcrowded. For example, one of the tutors in this category explained that,

> *There are several challenges, for instance overloaded curriculum. The curriculum is overloaded, and I cannot find space for these inquiry-based activities. I can see that my student is having a certain problem, but I can fail to help since I need to follow the syllabus* (Tutor Ba-1)

The policy document on education by the ministry of education in Tanzania, in particular the curriculum document concerning teacher training, includes the clause to the effect that,

> *The Diploma programme shall emphasize student centered and interactive approaches in the process of teaching and learning. Tutors will not be the sole sources of knowledge but will act as facilitators providing a broad range of learning experiences. Student teachers will be encouraged to assume more responsibility for their own learning. (MoEVT, 2007, p. 22).*

The presence of this clause in the document clearly invalidates the position of the educators that the curriculum does not consider or promote inclusion of inquiry-based teaching activities. Indeed, two of the eight educators seem to realize this. For example, tutor Bb-4 noted that,

> *The curriculum allows (inquiry-based teaching) because it is a learner-centered curriculum. The problem is that the curriculum always points out that, it's under the guidance of the teacher. So, the teacher becomes the planner of most of the things for students to do but not for students themselves to decide*.

In other words, tutor Bb-4 implied that it is the responsibility of the teacher educator to design appropriate teaching activities including allowing student self-investigations, and hence it's not only a problem of the curriculum but also a question of whether the educators themselves have the relevant teaching competences.

What remains however, are the questions of adequacy of time as well as claims of an overcrowded curriculum. These excuses cannot simply be dismissed given that they come from the very implementers of the activities stipulated in the curriculum documents. These

claims and problems, indeed, lead to the question, which we next turn attention to, of how much flexibility teacher educators have when it comes to implementing activities stipulated in curriculum documents.

The nature of curriculum and forms of assessment, and the educators' role in developing and influencing them

In addition to the curriculum constrain claims described in the previous section, teacher educators also expressed their dissatisfaction with the nature of the current science curriculum, both in secondary schools and at teacher college level, as well as with the structure and forms of assessment. The majority claimed that the curriculum was not contextualized, not adapted to the needs of the society, and that it lacks relevant and practical examples tailored towards the day-to-day problems in the Tanzania context. That is,

> *Our curriculum is colonial oriented and not contextualized. It needs to be revised to link to the local context*" (tutor St-2).

The educators further expressed that despite the curriculum being built on the premise of a competence-based teaching approach, the forms of assessment being used did not support work in this direction.

> *The curriculum is called competence based but the assessment is not competence based. You find that what is taught in four years is assessed (summative) only once*. (tutor Bc-3).

The educators also decried their lack of an active role when it comes to deciding what should and should not be a part of the curriculum content. They argued that the nature of curriculum and forms of assessment had a substantial effect on the way they approached their science teaching, including limiting the flexibility with which the individual educators are able to try out and include varied student-centered learning activities.

> *The hindrance is because we are teaching for examinations, mostly the examinations questions are not focusing on allowing students the luxury of self-exploration. In the assessment, there can be a possibility of making students engaged in that. However, the mode of assessment needs to change, and the tutor should have authority to change [something]. The practical examinations do not reflect the reality, its only rote learning*. (Tutor Ma-8).

The science teacher education program structure at colleges where the individual educators are coming from is similar and is such that, teacher educators are charged with teaching both the science content and subject didactics. With this organization, the educators feel that they are working within a tight and limited timeframe, where they must deliver both content and subject didactics in a given space of time or semester. Consequently, the focus is mainly put on completing the pre-planned teaching schedules and also on ensuring that students can pass the final examinations. As Ai-5 observed, "We are running shortage of time to accomplish what has been prescribed in the syllabus. We are struggling to complete the syllabus. The syllabus talks less on students' developing question for scientific investigation."

English-medium of instruction as a hinderance to an inquiry-based science teaching approach

The use of English as the medium of instruction in Tanzania is considered a barrier to a student-centered learning approach. While acknowledging that their students' language competencies play a big role in active learning, six out of the eight participant educators expressed that their students experience difficulties providing explanations and linking what they learn with examples due to their poor background in English. Accordingly, student teachers are not able to adequately understand or criticize scientific texts, and neither can they fully participate in scientific argumentations.

> *"Students cannot explain themselves well. How to explain is linked to mastering of the language of instruction. When you ask them in Swahili you can have very vivid examples, this is not the case with English" (Tutor An-6).*

Discussion and implications

Teaching aspects considered by science teacher educators when teaching teacher trainees

Results from our study revealed that an instructor-guided teaching approach was the most pronounced teaching practice among educators. At the same time, the study also revealed that the educators exhibited a substantial understanding about the benefits an inquiry-based approach to teaching and were more open to implementing a guided inquiry approach if they had the opportunity to do so. With an inquiry-based approach, rather than being told by the educator what they need to know, students are encouraged to explore the studied content, pose questions, share and discuss their ideas (Kipnis and Hofstein, 2008). It is an approach where students learn by doing, a process that allows them to explore, experience, discuss and hence build or construct new understandings. These characteristics were not visible from the

analysis of the educators' views about their teaching practices. Nevertheless, there were examples pointing to the educators offering their students opportunities to conduct experiments, analyse and interpret data, and draw conclusions, although the educators admitted that students are often given pre-defined procedures that they must follow when performing the experiments. Moreover, some of the common features of an inquiry-based approach such as asking question for investigation and designing investigation were considered by teacher educators not to be as important a task for the student teachers because they were neither the focus in the curriculum nor of the national examinations.

From the analysis, the educators displayed a good understanding that if their student teachers are only engaged in recipe kind of practical work (activities) and traditional learning approaches, they cannot sufficiently engage in creating meaning during science learning after their teacher training. To nurture future science teachers who are critical thinkers and who can teach their students in the use of science from the classroom to solve daily live problem, it is very important to engage them in the full range of inquiry-based science teaching, asking question for investigation, designing investigation, conducting experiments, analysing data, and drawing conclusion. Indeed, an inquiry-based approach to teaching is widely promoted in science education owing its potential benefits (Garbett, 2011; Nezvalová, 2011), and in Tanzania, for which this study is most relevant, there is an emphasis on a constructivist teaching perspective, where students are given more authority in creating meaning (Nzima, 2016).

The gap between what teacher educators know about an inquiry-based teaching approach and what the educators exactly do or how they teach their teacher students was recognisably and admittedly big. At the same time, the educators have full awareness of what might be the causes (challenges and problems) for this existing gap, which is a very crucial and important basis for finding plausible solutions to improve the current practice. Let us consider these causes and possibilities to address them in the next section.

Preparing science teacher trainees: educators' teaching challenges and possibilities of addressing them

The educators in the present study described four major challenges to their science teaching; students' low interest in science, an overcrowded and de-contextualized curriculum, forms of assessment that do not align with the desired teaching approaches, as well as the difficulties with English as a medium of instruction. To underscore the importance and gravity of these

challenges as were raised by the educators, we take a closer look at the place and roles of four aspects reflected in the four mentioned challenges as a part of the complete teaching-learning system, that is, interest in science, curriculum, assessment and instruction medium. These four aspects indeed represent four of the seven main pillars of a complete teaching-learning system which include (i) the students, (ii) the curricula, (iii) the mode of communication, (iv) the assessment of learning, (v) the teacher/instructor, (vi) the physical place/setting/classroom, and (vii) external support (administrators, parents, etc.). One realizes that when the four aspects are removed from the list above, or affected in any negative way, the teaching-learning system is substantially affected. This reality therefore grants validity to the educators' observations about these challenges and thereby calls for substantial attention to be given to resolving them.

First, the medium of instruction is not only limited to teacher and students' classroom interactions, but it includes the language in which curricula and assessment material are written and conveyed. Both teacher and students should have a good understanding of the language being used for communication (Seah, 2016). Thus, the medium of communication is the tool with which all the different components that make up a complete teaching-learning system can function. The educators in the present study are strongly of the opinion that their students' do not have a good understanding of English to be able to articulate science concepts. In a previous study, the use of English as a language of instruction in which students lack a mastery was a factor limiting students' engagement with critical thinking skills (Mkimbili & Ødegaard, 2020) and was a barrier to students ability to link science in the classroom to their daily lives (Rollnick, 2000). This also links up with the educators' claim about the students' lack of interest in science. Other reasons cited for the students' low interest in science notwithstanding, there is a strong connection between students' low science interest and language difficulties. Since students have difficulties reading English text and cannot express themselves using the same language, their motivation to participate further in science activities is gradually killed off (Mkimbili, 2019).

Consequently, given the important role of the medium of instruction in the teaching learning process, this challenge identified by the educators demands urgent attention. One suggestion would be to develop a general supplementary language course as a part of the diploma curriculum to support teacher candidates to improve their English language skills. There should also be efforts in place to investigate the possibilities for translating textbook

material, especially starting with lower education levels, into local languages as it has been done in other countries.

Also, the educators' complained that their respective curriculum was overcrowded and that the assessment structure demanded that all what is in the curriculum (syllabus) be taught before the final assessment. Their examinations are also structured in a way that students must reproduce the learned concepts at the knowledge level; implying that they should master and reproduce the learned facts to be considered as having passed. To the educators, this kind of framework within which they operate limits the extent to which they can adopt a learner-centered approach in their teaching. We do not dismiss these problems which also include their lack of power to influence the needed changes. Nonetheless, we want to closely look at these educators' role in the whole teacher education program as these educators are charged with both teaching the science content, as well as subject didactics. It is in subject didactics that teacher-trainees come to learn elements of teaching such as pedagogical content knowledge, professional and classroom knowledge, and other teaching aspects relating to classroom management, and motivation, etc. (Barnet &Hadson, 2001). The educators, therefore, have the opportunity when teaching subject didactics to optimize the time available to them to be able to implement the teaching method that is recommended in the Tanzanian curricula documents (see; MoEVT, 2007) .

It seems rather that an underlying problem might be associated with instructors' lack of the needed teaching competence to actuate the needed kind of practice. Indeed, two of the educators interviewed pointed to the problem of lack of the competence to support their students in designing and executing individual experiments or in investigations that required some degree of freedom.

Educators' attribution of trainees' lack of interest in science to the poor academic background of those enrolled into the program is also a valid point in as much as this translated to the candidates starting off with a low motivation in science well before joining the program. Nonetheless, simply blaming the problem on students' pre-enrolment grades is not as conclusive as it seems because there are other intervening factors behind these poor grades. It is more the case that, once the students enroll in the program, the question of interest and motivation becomes the duty of the teacher educator to address rather than blame on others. This should be one aspect of the training that is taken up during subject didactics teaching since the educators are assumed to be aware that using activity-based teaching

approaches result in increased student interest in doing science tasks (Ofori, 2014). As educators, they should be able to prepare future teachers who will be able to teach and motivate future students and enhance their performance in science. Thus, the interviewed educators' point about their students having low science interest, though valid, actually raises important concerns about their own preparedness in their roles as science teacher educators.

Conclusions

The present paper provides a source of information and insights to stakeholders in charge of improving the quality of science teacher education in Tanzania. It provides a baseline for developing strategic and feasible solutions to support science educators in teacher colleges who are tasked with producing teacher graduates with the relevant teaching skills and competences for learner-centered science teaching. Science teacher educators themselves can also benefit from the discussions and illustrations provided in the present paper regarding their roles and the reactions to the challenges identified.

Research in science education indicates that modern teaching methods have a focus that is based on constructivist learning theory where learners participate actively in the learning process (Garbett, 2011; Nezvalová, 2011). This is to ensure that science teacher education in Tanzania (MoEVT), 2007; Nzima, 2016) as in other parts of the world (Nezvalová, 2011) is focusing on preparing future science teachers who can engage students using learner-centered approaches to teaching. They would be able to root students in inquiry-based learning, science talking and discussion and would be able to link what is taught in the classroom to the real world.

Our findings have disclosed that teacher educators in the teacher education colleges we have studied engage student teachers insufficiently in practical work nor do they consider that student teachers need to be engaged in asking question for investigation and designing of investigations. This suggests that learner-centered teaching is not sufficiently applied in the teaching and learning process in the colleges. However, this case is not an isolated one, since the lack of application of a learner-centered teaching was also reported to be a problem in other Sub-Saharan Africa countries, which on one hand, provides an opportunity to explore and adopt similar or related interventions which are being advanced in these institutions outside Tanzania in an effort to improve the practice.

Based on our findings, we argue that the promotion of effective practice of learner-centered teaching in teacher education, given the context of the challenges in sub-Saharan Africa , training of teacher educators need to consider the challenges of limited resources and language barrier. Teacher education in Sub-Saharan Africa does not give sufficient emphasis to the language problem in science learning, since prospective teachers are assumed to have sufficient competence in the language of instruction (English in Tanzania) to be able to use it in effective learning. It is thus imperative that teacher educators be trained on how they can use learner centered teaching with students who are learning using a second language. Likewise, professional development programs need to be developed for educators on how to use resources contextually to support learner-centered science learning in Africa. Also, the curriculum and assessment forms need to be less focused on summative examination orientation and be restructured to offer more opportunity for learner-centered and meaningful learning. This can be done by encouraging formative assessment forms such as project work, portfolio assessment, experimentation and report writing, and peer and self-evaluation approaches and these will, in turn, facilitate peer-to-peer interactions and peer and self-assessment that are important for meaningful learning (Bell & Cowie, 2001; Nilsson, 2013). Finally, teacher educators need to be given more authority with regards to what to teach and how to assess so that they can be open to engage their student teachers with higher level inquiry-based science learning.

Limitation of the study

This is a small study conducted in two colleges of education and with only eight research participants. The findings of this study cannot be readily generalized to the wider population of all colleges of education in Tanzania. Further research enclosing more teacher education colleges in Tanzania would be required for more generalizable results. Nevertheless, this study makes an important contribution to understanding the status of the implementation of learner-centred teaching in the country and the contextual challenges that have hampered its implementation particularly by a thorough analysis of teachers' voices.

References

Amineh, R. J., & Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of Social Sciences, Literature and Languages*, *1*(1), 9-16.

APA. (1997). *Learner-centered psychological principles: A framework for school reform and redesign*. Washington, DC: American Psychological Association.

Bell, B., & Cowie, B. (2001). The characteristics of formative assessment in science education. *Science Education, 85*(5), 536-553.

Clandinin, J. D., & Rosiek, J. (2007). Mapping a landscape of narrative inquiry: Borderland spaces and tensions. In J. D. Clandinin (Ed.), Handbook of narrative inquiry: Mapping a methodology (pp. 35-75). Thousand Oaks, California: SAGE Publications, Inc. Retrieved from https://methods.sagepub.com/book/handbook-of-narrative-inquiry. doi:10.4135/9781452226552

Crawford, B. A. (2014). From inquiry to scientific practices in the science classroom. In N. Lederman & S. Abell (Eds.), *Hand book of Research in science education* (Vol. 2, pp. 515-541). New York:: Rutledge.

Fensham, P. J. (2012). Preparing Citizens for a Complex World: The Grand Challenge of Teaching Socio-scientific Issues in Science Education. In A. Zeyer & R. Kyburz-Graber (Eds.), *Science | Environment | Health: Towards a Renewed Pedagogy for Science Education* (pp. 7-29). Dordrecht: Springer Netherlands.

Garbett, D. (2011). Developing pedagogical practices to enhance confidence and competence in science teacher education. *Journal of Science Teacher Education, 22*(8), 729-743.

Gotwals, A. W., & Birmingham, D. (2016). Eliciting, identifying, interpreting, and responding to students' ideas: Teacher candidates' growth in formative assessment practices. *Research in Science Education, 46*(3), 365-388.

Kipnis, M., & Hofstein, A. (2008). The inquiry laboratory as a source for development of metacognitive skills. *International Journal of Science and Mathematics Education, 6*(3), 601-627.

Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2011). Paradigmatic controversies, contradictions, and emerging confluences, revisited. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (Vol. 4, pp. 97-128). London: Sage.

Meena, W. (2009). Curriculum innovation in teacher education: exploring conceptions among Tanzanian teacher educators.

Mkimbili, S. T. (2019). Meaningful science learning by the use of an additional language: A Tanzanian perspective. *African Journal of Research in Mathematics, Science and Technology Education, 23*(3), 265-275.

Mkimbili, S. T., & Ødegaard, M. (2020). Inquiry-based science teaching in community secondary schools in Tanzania: role played by the language of instruction. *Cultural Studies of Science Education, 15*(4), 1121-1142. doi:10.1007/s11422-020-09973-9

Mkimbili, S. T. (2018). *Learner-Centred Science Teaching in Community Secondary Schools in Tanzania.* (PhD), University of Oslo.

MoEVT. (2005). *Curriculum for Ordinary level Secondary Educationin Tanzania*. Dar es Salaam: Tanzania Institute of Education.

MoEVT. (2007). *Curriculum for diploma in teacher education program in Tanzania.* . Retrieved from Dar es Salaam, Tanzania:

MoEVT. (2009). *Biology academic sylabus for diploma in secondary education.* . Retrieved from Dar es salaam, Tanzania:

MoEVT), M. o. e. a. v. t. o. T. (2007). *Curriculum for Diploma in Teacher education programms in Tanzania*. Dar es Salaam: Ministry of Education and Vocational Trainning.

Mtika, P., & Gates, P. (2010). Developing learner-centred education among secondary trainee teachers in Malawi: The dilemma of appropriation and application. *International Journal of Educational Development, 30*(4), 396-404.

Nezvalová, D. (2011). Researching science teacher pedagogical content knowledge. *Problems of Education in the 21st Century, 35*, 104.

Nilsson, P. (2013). What do we know and where do we go? Formative assessment in developing student teachers' professional learning of teaching science. *Teachers and Teaching, 19*(2), 188-201.

Nzima, I. (2016). *Competence-based Curriculum (CBC) in Tanzania: Tutors' Understanding and Their Instructional Practices.* Linnaeus University Press.

O'Flaherty, J., & Liddy, M. (2018). The impact of development education and education for sustainable development interventions: a synthesis of the research. *Environmental education research, 24*(7), 1031-1049. doi:10.1080/13504622.2017.1392484

Ofori, I. (2014). *Using activity-based instruction to impart College of Education trainees' attitude towards the study of science.* University of Education, Winneba.

Ogunniyi, M., & Rollnick, M. (2015). Pre-service science teacher education in Africa: Prospects and challenges. *Journal of Science Teacher Education, 26*(1), 65-79.

Rollnick, M. (2000). Current issues and perspectives on second language learning of science.

Schwandt, T. A. (2000). Three epistemological stances for qualitative inquiry: Interpretivism, hermeneutics, and social constructionism. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2 ed., Vol. 2, pp. 189-213). Thousand Oaks, CA: Sage.

Seah, L. H. (2016). Elementary teachers' perception of language issues in science classrooms. *International Journal of Science and Mathematics Education, 14*(6), 1059-1078. doi:10.1007/s10763-015-9648-z

Sikoyo, L. (2010). Contextual challenges of implementing learner-centred pedagogy: the case of the problem-solving approach in Uganda. *Cambridge journal of education, 40*(3), 247-263.

UNESCO. (2015). Transforming our world: the 2030 Agenda for Sustainable Development. Retrieved from https://sustainabledevelopment.un.org/post2015/transformingourworld/publication

Vavrus, F., & Bartlett, L. (2013). *Teaching in tension: International pedagogies, national policies, and teachers' practices in Tanzania* (Vol. 1): Springer Science & Business Media.

Vygotsky, L. S. (1978). Mind in society: The development of higher mental processes (E. Rice, Ed. & Trans.): Cambridge, MA: Harvard University Press.([1930, 1933] 1978

Wolcott, H. F. (2009). *Writing up qualitative research* (3rd ed. ed.). Los Angeles: Sage.