Mathematics and science Teachers' Understanding and Practices of Learner-Centred Education in Nine Secondary Schools from Three Districts in Rwanda

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Abstract
The aim of the study reported in this paper was to reveal how Rwandan school teachers of Mathematics and science at the secondary school level understand and implement learner-centered pedagogy. The study was qualitative in nature. It employed qualitative methods of data collection including in-depth interviews and observations. In total, 40 Mathematics and science teachers from nine schools located in three districts in Rwanda were interviewed, and 57 lessons were observed and video-recorded. Schools were selected based on their socio-economic status and location. Data were analysed using an analytical framework developed by researchers. The study's findings reveal that learner-centred teaching is limited to simple oral questioning, group discussion, and experimentation or doing exercises. Similarly, the findings prove that teachers' knowledge and skills as regard learner-centred pedagogical paradigm is limited. Based on these findings, the researchers are concerned about how the competence-based curriculum that has been recently adopted by the government of Rwanda is being implemented. The article concludes by suggesting ways of enhancing Mathematics and science teachers' understanding and practices of learner-centred education.

Keywords: *learner-centred approach, Mathematics and science education, practice, and understanding*

Introduction

Education theorists such as Jean Piaget, John Dewey and Lev Vygotsky in the 19th century, argued that students should be responsible for determining what they want to do in class since they are considered as key people in the teaching and learning process. Therefore, different countries including those of sub-Saharan ones have called for the adoption and implementation of the learner-centred pedagogy and have encouraged the use of new innovative teaching and learning methods especially during the teaching of Mathematics and science. In this context, different interventions such as the one of enhancement of Mathematics and Science in Secondary Education (SMASSE) Project were introduced to improve the teaching and learning of Mathematics and science and to reinforce the new approach of teaching and learning by strengthening the capacity of the educational stakeholders particularly teachers. However, the monitoring report of UNESCO showed that there was undesirable teaching practices and persistence of teacher-centred in sub-Saharan Africa countries (UNESCO, 2004). Rwanda has adopted and implemented learner-centred education since 2006, with the introduction of a knowledge-based curriculum (Ministry of Education, 2006), and has continued to implement it with a competence - based curriculum (Rwanda Education Board, 2015).

The adoption and implementation of such curricula were in line with developing a knowledge-based society, with a special attention to science and technology (Republic of Rwanda, 2000; Ministry of Education, Science, Technology, Scientific Research, 2003; Rwanda Education Board, 2015). It is believed that the successful use of the teaching and learning methods particularly those of learner-centred approach, play a crucial role in shaping individuals who are needed as agents of national development. This aligns with Hallak 's position (1990) cited in Pârgaru et al., (2009) that education fosters economic, social, and cultural activities in a society. Quality education is therefore the most powerful tool to be used to change the world as quoted by Nelson Mandela. In particular, Mathematics and science education are reputed to give opportunities to

individuals to get knowledge, skills, positive opinions and values needed in today's situations that demand creativity, problem solving and decision making skills (Nagao et al., 2007). They, therefore, build the nation through the production of the scientifically and technologically literate people who are the economical prime movers (Nagao et al., 2007).

Considering the aforementioned role of Mathematics and science, the academic staff of University of Rwanda - College of Education who are in charge of pre-service training of secondary school teachers were interested in investigating Rwandan secondary school teachers' theoretical knowledge and practical skills in learner-centred approach. The staff were also interested in examining how secondary school teachers put learner-centred pedagogy into practices. This can allow the College to streamline curricula and put more emphasis on the way pre-service Mathematics and science teachers are trained in order to produce competent teachers. This study will also help the staff who are in charge of in-service professional development for secondary school teachers to be aware of Mathematics and science teachers' needs, and accordingly support them.

Nevertheless, only few studies have been carried out to examine the implementation of learner-centred pedagogy in Mathematics and science in Rwanda. A study by SMASSE examined how and why Mathematics and science were taught and learned in secondary schools in Rwanda (The SMASSE Rwanda, 2009). Another study by Nsengimana et. al., (2014) investigated how the knowledge-based curriculum was implemented in three schools in Rwanda. Similarly, Mugabo's (2015) study investigated science teachers' understanding of inquiry-based science teaching (IBST) in Rwandan lower secondary schools. There are no enough studies that examine how Mathematics and science teachers understand and apply learner-centred methods in Rwanda. To fill this research lacuna, this study aims to address three main research questions:

a) How do Mathematics and science teachers understand learner-centred education?

b) What are the methods of learner-centred education known by Mathematics and science teachers?

c) What are the methods of learner-centred education that are applied in Mathematics and science lessons?

This paper discusses the relationship between teachers' pedagogical understanding pertaining to learner-centred education and their practices. It also uncovers the shared understanding and practices about learner-centred methods in Mathematics and science lessons, and contributes to the teaching and learning of Mathematics and science at the secondary education andCollege of Education levels.

Literature Review

Understanding learner-centred approach

A diversified understanding of learner-centred approach depends on scholars, academia, subject and context. The concept is at first according to Jean Piaget, Lev Vygotsky and John Dewey understood pedagogically as a constructivist approach that has emerged from the constructivist learning theory. The pioneers of the theory distinguished cognitive from social constructivism where cognitive construction stipulates that the new information is added to the prior knowledge and social constructivism adds how students' interaction with the environment around them leads to developing deeper understanding through collaborations and questioning by

comparing their thinking processes to that of their peers and in being engaged in questioning for revising their understanding on a concept or a theory (Piaget, 1926, 1950, 1973; Dewey,1938; Vygotsky,1978). The authors have largely emphasized that teacher-centred education has to be replaced by hands-on activities and group work, in which a child determines on their own what they want to do in class.

Learner-centred is a concept and a practice in which students and teachers learn from one another (McCombs & Whistler, 1997); a learning oriented rather than content oriented (O'Neill & McMahon, 2005); a means that places learners at the heart of the learning process and meeting their needs(Edwards, 2001). The concept is understood as active learning (Bonwell&Eison, 1991) which occurs when students solve problems, answer questions, formulate questions on their own, discuss, explain, debate, role play or brainstorm in a class; cooperative or team based learning(Johnson, Johnson&Smith, 1991; Michaelson,Knight, & Fink,2004) and collaborative learning (Bruffee, 1984 for collaborative learning), which takes place when students work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability.

Other scholars use the term inductive teaching and learning, which includes inquiry based learning, case based instruction, problem based instruction, project based learning, and discovery learning. For Rwanda, learner-centred learning as described in knowledge-based science curriculum is characterized by a number of features including discovery approach, active participation of students, and engagement in experimentation and other science processes (Nsengimana et al., 2014). Also Mugabo (2015) found that Rwandan science teachers were not having common understanding of inquiry as many of them were associating inquiry teaching with a few of its specific characteristics while others had a very different understanding. Moreover, other forms of learner-centred methods such as brainstorming, problem tree, and memory cards, among others, have been introduced in Rwandan education system through training provided to teacher training institutions (Aflatoun, 2014).

Application of the learner-centred approach in Mathematics and science education

Teachers in Sub-Saharan African countries continue to teach in undesirable way of chalk and talk regardless of the introduction of, and different interventions on the learner-centred approach in their education system (UNESCO, 2004). Even though Brown (2003) has found that teachers hold constructivist beliefs about mathematical problem solving, more importance is given to student's answers rather than problem solving solutions (Brosnan & Erickson, 1996) cited in Mwelese (2014). The educationists who have been involved in SMASSE project have observed that in Kenya, in 1998 students were not performing enough experiments and the lessons were not learner-centred (The SMASSE Rwanda, 2009). Such practices persisted for a long time as Kenyan teachers were found to prefer to use teacher friendly activities which concentrate on early syllabus coverage at the expense of the slow learners, the use of one particular textbook, moving ahead with faster learners at the expense of slow learners, giving too much assignments and not marking all of them or providing their answers and being biased in allocation of questions in class to only a few bright students (Mwelese, 2014). What have been observed in Kenya in 1998 was also observed in Rwanda in 2008 as reported in The SMASSE

Rwanda Newsletter 2009. Further, the study of Nsengimana et al (2014) showed that science teachers were still dominating in the lessons than learners.

Even, the hands – on activities planned and facilitated by Zambian local teachers were usually teacher-centred as cited in Ikeda and Matsubara (2017). The so-called learner-centred teaching in science found in Zambia is that the questions are teacher- led responses which are given immediately after the teacher's question to the students as agreement with the teacher's opinion and or the intention rather than the learning content of the lesson or the students' scientific knowledge and thinking (Ikeda & Matsubara, 2017).

The identified classroom practices are not limited to Southern African countries since the research conducted in Ghana to find out whether the teaching is perceived by teachers and students to be learner-centred or teacher-centred revealed that a mixed bag of both approaches are used with dominance of the teacher-centred one in their teaching. Additionally, students described Mathematics teaching to be dominated by teachers. On this, they reported that they listen while the teacher explains, follow instructions, memorise rules and procedures but also work in groups (Ampadu, 2012). Again, the investigation of science teaching practices in Rivers State secondary schools in Nigeria revealed a highly dominated transmission- oriented pedagogical practices comparing to the constructivist ones (Ovute at al., 2015).

Challenges in implementing learner-centred approach in Mathematics and science education

Regardless of the popularity of the learner-centred approach, different studies have revealed a number of challenges that prevent teachers from implementing such innovative teaching approach. Those include a lack of, or inadequate, teaching resources such as science apparatus, chemicals, physical infrastructure, laboratories, science textbooks among others as found in Malawi, Nigeria, Ethiopia, Zambia, Kyrgyzstan, and Namibia respectively (Chiphiko&Shawa, 2014; Omoifo, 2012; Tegegne et al.,2010; Matsubara, 2009; De la Sablonnière, R., et al.,2009; O'Sullivan, 2003); a large class size in Malawi, Zimbabwe, Ethiopia and Kyrgyzstan (Chiphiko&Shawa, 2014; Gladys et al., 2012; Tegegne et al., 2010; De la Sablonnière, R., et al.,2009); limited teaching capacity in asking questions that require students to think and or reason found in Zambia (Ikeda & Matsubara, 2017) and a lack of competence in teaching and in the implementation of advanced teaching methods that would include activities that foster critical thinking and problem solving as noticed in Nigeria and Malawi (Ezekannagha 2008; Okebukola 2005; Esiobu 2000; Chiphiko & Shawa, 2014); and learning cultures in Namibia (O'Sullivan, 2003); the belief system of the students and staff, and students' lack of familiarity with the term learner-centred instruction (Simon,1999) as the approach is criticized to its focus on the individual learner without taking into consideration the needs of the whole class as Simon (1999) pointed that " if each child is unique, and each requires a specific pedagogical method appropriate to him orher and not to other, the construction of all embracing pedagogy or general principles of teaching become impossible"; Other challenges affecting learner-centred teaching include a lack of awareness of the existence of the new teaching strategies (Ossai, 2004); inadequate professional development accentuated by complete lack of training of science teachers in areas such as improvisation, management of large classes and teaching of difficult concepts identified in Nigeria (Owolabi, 2012); poor or lack of understanding of the approach, as the case of students from the University of Plymouth had not heard the term learner-centred (Lea et al. , 2003); the need for covering the

contents in the syllabus, the lack of interest from students' side because of various reasons and the scarcity of professional teachers (Tegegne et al.,2010); language used as medium of instruction, culture whereby in Oman females are hard to be grouped with males, lack of student exposure due to being shy, unfamiliarity with exported teaching materials, negative attitude towards student-centred approach where a teacher is still believed to be the sole authority in classroom, social loafers in groups, and readymade materials (Emenyeonu,2012); and negative perceptions on how to implement learner centered education, no enough conferences, symposia, and workshops that would bring educators together from different schools and universities (De la Sablonnière, R., et al.,2009); and the belief that students and teachers who are familiar with teacher–centred approach may reject the learner-centred one and vice –versa (Prosser and Trigwell,2002).

Research design and methodology

The qualitative research design intended to gain an in-depth understanding of how learner-centred approach is understood by Mathematics and science teachers and practiced in schools was employed.

Schools selection

With an intention to gather information that reflects the reality about Mathematics and science education in secondary schools, three different types of schools were selected from three districts in Rwanda. Purposive sampling was used to select participants and schools. Different criteria guided the selection of schools. These included the type of school (only public and government subsidized schools), the education level and the presence of Mathematics and science combinations within schools, the school history (i.e. school with many years of existence and school with adequate years of existence or the school which was established few years ago), accessibility as represented by the distance from the main road to school or the availability of public transportation, and the socio-economic environment of the school in terms of teaching and learning resources.

Collection of data

Data were collected in five consecutive days at each of the school. The lessons were video-recorded and transcribed by three researchers who were involved in this study. The observation tool was also used by the observers for recording the activities of both Mathematics and science teachers and students. The checklist tool was also used to identify the necessary materials needed for learner-centred education. In total, 57 lessons were video-recorded and then after transcribed.

Semi - structured interviews were conducted with 40 Mathematics and/or science teachers. Interview questions focused on the understanding of learner-centred approach and the implementation of this approach during the teaching of Mathematics and science. Sample data-gathering questions included:

- How many approaches of teaching and learning do you know? Describe each of them?
- Which approach of teaching do you put more emphasis on and why?
- What are the different methods of learner-centred approach do you know?
- Have you ever heard any of the following (problem solving, open- ended, close- ended, inquiry based or experimental, problem tree, memory card, concept map, backward teaching, teacher directed, discovery, project based, resource based, brainstorming; and KWL chart) teaching methods?

- Which approach of teaching do you apply in class? Why do you say so?
- What are the methods of learner-centred approach do you use in your teaching?
- Outline at least three methods that you use most and which facilitate your teaching during Mathematics or science lessons.
- Describe how each type of the above learner-centred methods is applied in your class?

The questions asked to school administrators were aimed at finding out whether they provide support to teachers to apply learner-centred methods and whether their teachers apply such methods in their teaching of Mathematics and science.

Analysis of data

Data were analysed using the analytical framework developed by researchers. This framework was based on the collected data and referring to one of the components developed by Rogan and Grayson (2003) as modified by Nsengimana et al. (2014) in the study of science curriculum implementation in three schools in Rwanda.

The developed framework focuses solely on the profile of implementation as given in table below.The observed and video-recorded lessons' data were used to rate lessons on a scale of 1 up 4.

Analytical framework table

Sub-construct	Level and its descriptor
Teaching and learning activities	1. Activities are primarily traditional: Teacher explains and learners follow and copy notes. 2. Activities are not only traditional but include some hand on activities: Instructions and tasks are given to students. 3. Activities include observation, research, solving world problems, experiment, discuss in groups. All those activities are facilitated by the teacher. 4. The activities primarily consist of hand one activities including observation, research, solving world problems, experiment, discuss in groups. Their outcomes are shared in all class through the presentation and discussion of findings.
Interaction in a classroom	1. Teacher neither interact with students nor encourages the interaction between students in a lesson. 2. Although the teacher interacts with students and encourages the interaction between them by questioning, giving task and /or in science practical work, the teacher does not follow up on the answers and/ or the outcome of students' tasks. 3. The teacher actively interacts with his or her students and encourages the interaction between students through following up the feedback from students on their answers or outcomes. 4. The teacher actively and attentively interacts with his or her students in a whole class and individually, as well as encouraging the interaction between students through following up the feedback from students on their answers or outcomes.
Lesson in daily life	1. In the lesson, no linkage between lesson and daily life is mentioned. 2. In the lesson, the linkage between Mathematics/science and daily life is just mentioned without providing any facts or examples. 3. In the lesson, facts or examples are provided in terms of application of Mathematics/science in daily life. 4. In the lesson, the linkage between Mathematics/science and daily life is mentioned based on the concrete relationship between students' immediate learning environment and application of Mathematics and science.
Assessment	1. No form of assessment is seen. 2. Assessment is superficial: Only a few simple questions which do not cover he lesson contents. 3. Continuous individual or group type of assessment: Oral or written exercises or test, small practical exercises, experiment are given but not verified. 4. Assessment takes place with well-structured questions according to the Blooms' taxonomy focusing on individual students.

Results

Mathematics and science teachers' understanding of learner-centred education was obtained from 40 semi-structured interviews with teachers. The findings reveal that all participants were aware that learner-centred approach puts emphasis more on the learner than on the teacher. Twenty eight science teachers on the one hand stated that they understand learner-centred instruction as "putting students in groups where students work or discuss on a given task". On the other hand, they reported that they understand learner-centred teaching approach as "asking questions to learners and in turn learners respond to teacher and / or vice versa". Conversely, twenty science teachers said that they understand learner-centred instruction as "hands - on activities through doing experiments" particularly in science lessons. Twelve Mathematics teachers, understand learner-centred instruction as "group works or tasks given in terms of exercises or solving word problems, additional to questions and answers like science teachers.

Regarding the learner-centred education methods known by Mathematics and science teachers in Rwanda, all science teachers interviewed mentioned question - answer, group discussion, and experimentation. These methods were also mentioned by Mathematics teachers, with the exception of experimentation or inquiry based method. For the question relating to whether Mathematics and science teachers have heard and/ or are aware of problem solving, open ended, close ended, problem tree, memory card, concept map, backward teaching, discovery, project based, teacher directed, resource based, brainstorming, and KWL (Know, Want and Learn) chart methods to teaching and learning, a big number of interviewees mentioned that they are familiar with teacher directed and discovery methods; the latter was mentioned to be used in introductory part of the lesson.

Data from 57 observed and recorded lessons from nine schools reveal that oral question- answer, group discussion, exercising and/or experimentation methods were applied in the teaching and learning of Mathematics and science. Common methods found to be applied in the teaching and learning of Mathematics and science being the first two. Even though the study revealed that the only 3 methods of learner-centred education were found to be applied in Mathematics and science teaching, they were found to be applied at different levels according to the subject. In science, question and answer was dominantly applied by 75% teachers, followed either by group discussion or experimentation which was used at 25% each. In Mathematics, question and answer was also dominating like in science and was followed with either group discussion on the given mathematical problem or doing exercises.

With regard to the link between teachers' theoretical understanding of student-centred pedagogy and its applicability in Mathematics and/or in science lessons, when asked about the approach of teaching they apply and why they apply it, they said:

"Most of the time I use teacher-centred methods due to a big number of students, learner-centred methods are time consuming", "I use teacher - centered methods in physics because many things are new and learner-centred in Mathematics because Mathematics is the same from senior one to senior 3", " I use learner-centred methods because they are the ones which help students to know what I may need them to know", "I use both in orderto enable students understand so that I progress in my teaching", I use both where I have to introduce and

then students have to work, to do experiment and to share ideas", " I use both approaches where I expose what I know, students are involved in answering questions or in working in groups, and then teacher synthesizes", " I use the methods which make students to be always aware of being questioned and students take summary, and I give exercises to students when necessary", "I use the one which enables me quickly progress in the teaching", I mix up in order to enable students understand and for progressing well"I use question- answer method because group discussion in Physics is not applied", " I don't know very well how to use different forms of learner-centred methods".

In nutshell, the findings reveal that even though some teachers employ teacher-centred instruction as given in above quotes, what other teachers somehow understand to be a learner-centred lesson is somewhat reflected in class.

Discussion

Considering Mathematics and science teachers' understanding of learner-centred education, the findings indicate that all Mathematics and science teachers who participated in the study understand learner-centred instruction. Although, the understanding of a few number of teachers involved in this study is limited to oral question-answer and group discussion methods in both Mathematics and science subjects in addition to exercising which was particular in Mathematics and experimentation in science.

This limited theoretical understanding is justified with the lack of pedagogic knowledge on other methods of learner-centred education such as problem solving, open- ended, close- ended, problem tree, memory card, concept map, backward teaching, teacher directed, discovery, project based, resource based, brainstorming, and KWL (know, want and learn) chart as the majority of Mathematics and science teachers reported not being aware of these methods. Such unsatisfactory pedagogic knowledge prevents teachers from teaching effectively since effective teaching necessitates pedagogic knowledge (Shulman, 1987) and institutionalised system for gradual, incremental improvements over time (Stigler and Hiebert, 1999). It also hampers the construction of knowledge as argued that knowledge is constructed through social interaction and is shared rather than an individual experience (Gergen, 1995; Vygotsky, 1978). As a result, we are now concerned about how Mathematics and science teachers would help learners to acquire knowledge, skills and attitudes that are needed in current situations and cope with individual differences without being aware and using various learning ways. As highlighted by Bandura (1971), one of the possible solutions to this concern is to provide teachers with, and expose them to, a wide range of learner-centred practices applied in classrooms as behaviors are acquired by watching one another performing the behavior.

Based on data from the observed and video-recorded lessons, the study found that oral question-answer, asking students to answer exercises in class or exercising; pair or small group discussion, and experimentation were used in the teaching and learning of Mathematics and science subjects, even though they were not effective for equipping students with satisfactory knowledge and skills. Such ways of implementing learner-centred education were also observed during our supervision of the interns who were about to complete their undergraduate studies in the College of Education. The limited number of learner-centred methods applied in Mathematics and science teaching and learning were not only observed among Rwandan teachers but also

among American teachers. The latter are competent but the methods they use are severely limited and there was no system in place for getting better, their teaching not teachers must be changed as argued by Stigler and Hiebert (1999). Such change in teaching is also very much needed to ameliorate Rwandan Mathematics and science teachers' teaching and learning.

For those methods; we wanted to know how oral question-answer strategy was, types of questions being asked to students, how group discussion was, what students discuss about and how they conduct experiment. On this, the findings show that in reality students are not much encouraged to think critically. For this reason, they have to be involved and engaged so that they can construct their knowledge as suggested by learner-centred education thinkers including Jean Piaget and Lev Semyonovich Vygotsky. These scholars and experts, in their theory of constructivism, say that students should be more involved for a meaningful learning rather than being passive.

Ineffective use of oral question-answer method found in Rwanda has also been found in Zambia where teachers were asking teacher – led responses and students were almost forced to give the reply that the teacher expects without being given time to think both mathematically and scientifically on the question (Ikeda & Matsubara, 2017). It relates to poor questioning style characterized by simple questions in which students are asked to give, to state, to list et cetera without "What, How and Why" types of questions that have proved to promote high order thinking capacity. Without such type of questions, researchers are curious to know how Rwandan students can develop their critical and analytical thinking skills, being open mind, creative and innovative which are some of the key skills to be developed from the newly adopted competent -based curriculum (Rwanda Education Board, 2015). Such poor questioning style may be due to either the poor questioning skills that teachers have or just the fact that they want to make things easier. In this regard, to make it effective, teachers should rely on Bloom Taxonomy in which both the lower order and the high order of thinking should be followed in a way which is almost balanced so that a holistic intellectual development of student may be attained.

Furthermore, in order to promote learner-centred approach to teaching teachers can jointly plan lessons, observe, analyse, and refine actual classroom lessons. This has been implemented in many Japanese Mathematics and science schools and has generated positive results (Burghesb, D., Robinson, D. (2009). Such an approach is not different from social interaction (Vygotsky, 1978) and can benefit Rwandan Mathematics and science teachers. It is simply understood as a cycle where there is a peer–to-peer learning among teachers through a co-planned, co-conducted, co-reflected and then co-revised lesson. As mentioned above, the approach is used among Japanese teachers and has enabled them to successfully shift their methods to teaching science from teaching as telling to teaching for understanding (Lewis, 2000). Thus, teacher training institutions in Rwanda should encourage their pre-service student - teachers to be actively engaged with their peers, so that they may compare their thinking or reasoning to that of their peers and reflect to the thoughts of the colleagues.

The group discussion was also found to be applied in ineffective way, since students spend much of their time working on unstructured or unplanned tasks. To make it effective, teachers should plan tasks which are

challenging to make students think critically. Tasks have to be done either in pairs or in a group of no more than six students where each and every student are actively involved and later on, different groups have to share their work with the whole class. The outcomes from individual or group activities can also be shared at first in pairs, where one of the participants presents to his or her colleague and later on each of them is given the time for reflecting to what his or her colleague presented about and then by doing so, students will construct and develop different knowledge, skills, and values through constructivist approach as emphasized by Jean Piaget ". Group discussions are useful in students' learning through a social interaction among students as emphasized by Lev Semyonovich Vygotsky. Therefore, teachers are advised to use them for a kind of synergic strategy in learning.

It has been further identified that experimentation method used in science lesson was also seen not to give chance to students for developing their thinking capacity through either prediction or presentation of the findings.

The same challenge of not permitting students to develop their mind was also found in when they were requested to answer Mathematics exercises in classrooms. For Mathematics teachers, it is much imperative to use other methods such as close and open ended questions for helping learners develop their thinking capacity so that they can be able to deal with today's daily challenges.

From the identified practices, we are asking ourselves how teachers with limited practical skills and knowledge of learner-centred methods effectively implement a competence - based curriculum currently adopted in Rwanda. The possible way to deal with the aforementioned challenges is through capacitating prospective teachers and in-service teachers. Thus the capacity to innovate according to Rogan and Grayson (2003) is critical to effective implementation of the curriculum. According to these authors, a zone of feasible innovation has to be created where individual teachers at first identify their strengths and weaknesses and then after consider them for building on what he/she is able to do. After that, he or she will be exposed to various methods of learner-centred education.

Implications for policy and practice

The findings of this study call for possible solutions to the identified challenges so that the currently adopted competence - based curriculum in Rwanda can be implemented effectively using a learner-centred approach. It will be recalled that the study found that most of the Mathematics and science teachers are not aware of the new learner-centred methods namely problem solving, open- ended, close- ended, problem tree, memory card, concept map, backward teaching, teacher directed, discovery, project based, resource based, brainstorming, and KWL(know, want and learn) chart. It is therefore, very important for the policy makers to incorporate the aforementioned learner-centred teaching methods in curriculum documents. Additionally, various institutions which are in charge of teacher training should expose to their students as well as to both secondary school and University teachers updated knowledge and skills relating to learner-centred learning methods and improve the ones reported to be known. This in turn will help individuals to acquire various knowledge, skills and attitudes needed for socio-economic transformation of the country. Also, since student-teachers are not equipped with

sufficient pedagogical content knowledge and skills, the study suggests that pre-service training needs to put much emphasis on pedagogical content knowledge and skills (Shulman, 1987). In addition, Rwandan teachers should practice lesson study (i.e. peer-to-peer learning) as one way for improving their teaching knowledge and skills at the school level. On this, it is believed that, as in Rwanda, co-planned, co-conducted, co-reflected and co-revised lessons which are the components of the lesson study; can lead to effective teaching and learning of science and Mathematics as it was the case in Japan (Burghesb, D., Robinson.,D, 2009).

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