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Science Teachers' Knowledge, Understanding and Perceptions of Competence-Based Curriculum in Three Secondary Schools in Rwanda

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Abstract: Teachers play an important role in helping students improve their learning and achieve the intended curriculum outcomes. Therefore, it is essential to look at teachers' knowledge, understanding, and perceptions of any educational innovation. The present study aims to examine knowledge, understanding and perceptions of Rwandan science teachers with respect to the competence-based curriculum (CBC) introduced in 2015. The 2015 curriculum framework included features like the rationale for its adoption, the concept of competence, different competences to be developed by learners upon CBC implementation, principles guiding CBC implementation, and cross-cutting issues to be addressed by CBC implementation. This research is a multiple case study that adopted a qualitative approach with interpretivism paradigm. Twelve science teachers from three secondary schools, selected based on their differing teaching experience, participated in the study. Data were collected through semi-structured face-to-face interviews. The data were transcribed and qualitatively analyzed using content analysis. The findings revealed some satisfactory knowledge, understanding and perceptions of science teachers. Further, knowledge and understanding gaps as well as negative perceptions of CBC were identified. Towards the effective and efficient implementation of the CBC, this research suggests appropriate training and establishment of the school community of practices for improving teachers' experience of the CBC.

Keywords: *Competence-based curriculum, science teachers' knowledge and understanding, science teachers' perceptions.*

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Introduction

Worldwide, school curricula have been and are now being revised to respond to each nation's needs. In this regard, in 2015, the government of Rwanda shifted from the knowledge-based to the competence-based curriculum (CBC) as a curriculum that focuses on knowledge, skills, and attitudes to be applied and demonstrated by learners rather than focusing solely on knowledge as in the previously implemented curriculum (Rwanda Education Board [REB], 2015). The shift from knowledge-based curriculum to CBC was done following the changes in the medium of instruction from French to English by 2009 and learner-centred pedagogy by 2006 (Nsengimana et al., 2014). All those changes were made to develop a knowledge-based society and economy, as well as dealing with regional and global competition in the jobs market (REB, 2015).

The new curriculum puts an emphasis on both basic and generic competences needed for the 21st century. Different principles guiding CBC implementation including competence-based, learner-centred, and interconnection with cross-cutting issues including genocide as one that is specific to Rwanda; attitudes and values for Rwanda, and formative assessment were all included (REB, 2015). To achieve CBC requirements, lessons are expected to help learners develop competences particularly the generic competences such as critical thinking and problem solving, creativity and innovation, communication in official languages, research, cooperation, interpersonal relations and life skills, and lifelong learning; and to make use of them throughout the subjects that they study and even beyond their study; and teachers are to adopt approaches that encourage and enable students to develop the generic competences, think critically, carry out research, solve problems, be creative and innovative, communicate, co-operate and become life-long learners. Assessment should move beyond the recall of information to understanding-application of learning (REB, 2015).

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Towards CBC implementation, some interventions including cascade training of mentors at national, district, sector, and school levels were organised by REB (Ndiokubwayo & Habiyaremye, 2018). The teachers, once trained, were supposed to go back, and train their colleagues for effective implementation of CBC (REB, 2015). Also, hard copies of teaching syllabuses and textbooks were provided besides other online learning resources that were provided through the website of Rwanda Education Board (www.reb.rw).

Despite the aforementioned efforts made by Ministry of Education towards CBC understanding and its better implementation, science curriculum implementation in SSA countries, Rwanda included, still faces a number of challenges such as large class size, scarcity of teaching and learning resources, inadequate teachers' knowledge and understanding, limited teacher capacity and lack of individual teaching experience (Chisholm & Leyendecker, 2008; Nsengimana et al., 2017; Nsengimana & Mugabo, 2020; Rogan & Aldous, 2005; Rogan & Grayson, 2003; Schweisfurth, 2011; Verspoor, 2008). Likewise, teachers' perceptions may be another important issue as it has hampered the implementation of the other educational ideas such as inquiry-based learning methods and learner-centred pedagogy. As Sudsomboon (2007) argued, sustainability and success of any education reforms, particularly those of curriculum, mostly count on teachers' changes in terms of knowledge, understanding and perceptions about new educational reforms. A Rwandan proverb says, "*The less you have, the less you offer*" "*Ntawe utanga icyo adafite.*"; which reflects the need for teachers to be equipped with necessary knowledge and skills in order to facilitate learning suitably.

Knowledge is defined in Cambridge advanced learners' dictionary and thesaurus and American dictionary as "person's information, ideas, facts, awareness or understanding of a subject that people get by experience or by study." Knowledge is simply information known through learning whereas understanding is what they know by life experience or practice which constitutes the wisdom of that knowledge. Despite different definitions given on the knowledge, the latter is what a specific knowledge-pertained system accepts knowledge cannot universally be defined as there are different systems that create knowledge and what is accepted strongly depends on the criteria for truth and justification among community or group members (Oeberst et al., 2016). On the other hand, perception is the way people, in this case teachers, think, interpret, or feel about the CBC based on how it is designed and how it is expected to be implemented. Both knowledge and understanding are mental processes while perceptions are the thoughts about something and the ideas of something they have experienced. Perception changes with someone's point of view which is not the same as the knowledge. In this context, teachers' knowledge and understanding are explored in the subject of the CBC framework specifically in science subjects.

Against this background, it is important to explore the knowledge, understanding, and perceptions of Rwandan secondary school science teachers on CBC as there is no study conducted with an assumption that if a teacher is knowledgeable and has clear and deep understanding of CBC, issues related to teaching and learning resources, class size among others can be addressed by teachers themselves. Thus, the study intends to answer the two main research questions:

1. What knowledge and understanding do Rwandan science teachers have on the competence-based curriculum?
2. What perceptions do science teachers have on the competence-based curriculum?

This paper explores the knowledge, understanding and perceptions of Rwandan science teachers on the CBC and its implementation. In particular, the paper addresses how inadequate knowledge and understanding as well as unsatisfactory perceptions of teachers vis-à-vis the CBC could be improved to strengthen the implementation of science curriculum in Rwanda and in other Sub-Saharan African countries.

Literature Review

Origin and Meaning of Competence-Based Education

The idea of competence-based education, as cited in Mulenga and Kabombwe (2019), began in 1957 from the United States of America due to the perception of the failure of its education system which was viewed as falling behind that of Soviet Union, when the latter launched Sputnik I, the first satellite into earth orbit. In developing countries of Sub-Saharan Africa, the adoption of the curriculum is closely linked to a country's vision as well as aspirations and popularized by international organisations and donors or sponsors like Organisation Internationale de la Francophonie (OIF), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations International Children's Fund (UNICEF), World Bank or European Union (Akkari et al., 2012).

The commonality between Competence-Based Education (CBE) and Outcomes Based Education (OBE) is the focus on the outcomes or competences rather than the process of the curriculum. Those programmes are linked with learning theories of behavioristic psychologists like Watson, Pavlov, Thorndike, and Skinner who were focusing on observable behavior. Tyler (1949) and Bloom (1956) (as cited in Mulenga & Kabombwe, 2019), argued that the curriculum design needs to be established by explicit objectives expressed in terms of changes which are knowledge, skills and attitudes that are produced in the behaviour of students. Such programme firmly links to assessment and regulation of proficiency, but is less connected to teaching and learning activities (Morcke et al., 2013).

According to Mulder (2011), competence is the set of integrated capabilities which consists of knowledge, skills and attitudes which are necessary for individual to effectively perform roles and tasks in a contextualized setting like organization or profession while a competency is a determination of what skills and qualities someone needs to use in his or her life when performing job (Albanese et al., 2008). On the other hand, an outcome is a clear, observable demonstration of student learning that occurs after a significant set of the learning experience (Spady & Marshall, 1994).

Teachers' Knowledge and Understanding of Science Curriculum

Komba and Mwandangi (2015) reported improper knowledge and understanding on the concept and objectives of the CBC of science. Moreover, the majority of teachers from Teacher Training College in Tanzania had difficulties in explaining some competence-based concepts and limited understanding in describing components of competency-based instructional approaches (Kafyulilo et al., 2013). Inadequate teachers' understanding is not limited to Tanzania since Nsengimana et al. (2017) identified questions and answers, doing experiments, and putting learners into groups in which they work on a given task as the only ways of learner-centred pedagogy applied in Rwanda. Such practices are associated with what all interviewed Rwandan mathematics and science secondary school teachers mentioned that they understood learner-centred methods as question-answer, group discussion, and experimentation.

Perceptions on Science Curriculum Change and Implementation

Curriculum changes were positively perceived as they were related to socio-economic development demands, needs and aspirations, as well as technological advancement. However, some negative perceptions associated with implementation do exist and were still observed by various studies.

The positive perceptions were confirmed by different studies as Tanzania Institute of Education (2013), argued that CBC or Outcomes Based Curriculum (OBC) was adopted with the intention of addressing nations' political, social and sometimes harsh economic realities caused by lack of relevant knowledge, skills and real-life competencies for the learners.

Teachers positively perceived the relevance of the newly introduced educational reforms since they are aligned with country's expectations (Kibirige et al., 2014). For example, the majority of Korean teachers (65%) positively thought that Science, Technology, Engineering, Arts and Mathematics (STEAM) education motivated learners and improved their learning (Lee et al., 2013; Lim & Oh, 2015; Park et al., 2016; Shin, 2013; Shin & Han, 2011). Relevant and diverse courses, content updates and reorganization are major changes made in Australia with the aim of attracting more students and reducing the drop-out as the previous courses were not relevant to modern society (Krüger et al., 2013). The new curriculum changes are believed to play a greater role in motivating learners, leading them to autonomy and critical thinking, contextualizing learning, and increasing the relationship between teacher and student (Bettencourt et al., 2011).

Perceived Impediments of Science Curriculum Implementation

Despite the importance of educational changes, there are a number of new demands considered as challenges to teachers. Without considering their level of magnitude, the change that should get the first attention is that most teachers are not being involved in new curriculum development and are being requested to implement a change that they didn't take part in developing (Al-Kathiri, 2016). Another challenge is finding the necessary teaching and learning resources associated with implementing inquiry-based learning (Zerafa & Gatt, 2014). Also, a challenging issue is the lack of teachers' expertise in STEAM education and not having time for preparing STEAM lessons due to being overloaded (Han & Lee, 2012; Lee et al., 2013; Lim & Oh, 2015; Shin, 2013).

Lack of time to plan and prepare learning activities is also identified when implementing the Science-Technology-Society Education idea by Bettencourt et al. (2011) because teachers need to create diverse teaching and learning strategies and develop more awareness of everyday life experience for the full involvement of learners. Specific to STEAM implementation, there was also a lack of understanding of the relationships among content areas for content convergence and difficulty in cooperating with other teachers (Lee et al., 2013; Noh & Paik, 2014). The issue of understanding is not limited to the content areas as it was also found in assessment whereby teachers have difficulties in defining the assessment criteria, as well as dealing with many assessment instruments (Bettencourt et al., 2011).

Another identified challenge is the use of English as the medium of instruction for non-English native language students which affects learners' understanding of scientific concepts as is the case for Arabic speaking students. Challenges are also caused by inappropriate professional development support of the cascade model provided to teachers when it was given by staff not completely competent in the topic (Kadbey et al., 2015). Further, it is associated with teacher training programmes which are not providing in-depth knowledge of the curriculum. Consequently, teachers are not capable of articulating scientific content with a real-life context (Bettencourt et al., 2011).

A Four-Dimensional Curriculum Framework

A four-dimensional curriculum highlights four key elements of the curriculum. Those are (a) why- the big picture decisions, (b) what-the capabilities of graduates, (c) how-the teaching, learning and assessment and (d) where- the organization.

According to the Australian Curriculum Studies Association (2009), a curriculum is a programme of knowledge and learning that contributes directly to the shaping of professional, social, economic and personal futures through the production of graduates who enter the workforce with the particular knowledge, skills, and attitudes as it is conceived based on social, historical, political, economic, professional and educational forces.

The second dimension is concerned with identifying sets of learning outcomes, expressed in relation to standards and sets of attributes, knowledge, skills, and capabilities as well as dispositions, values, and attitudes, articulated within the idea of professional practice (Barrie, 2006). Regarding the capabilities, Green (2009) and Schatzki (2001), argued that they are complex and developed in situations where they are enacted. According to Barnett and Coate (2005), capabilities are defined as an articulation between knowing, doing, and being.

The third dimension is mainly about educational activities of teaching, learning, and assessment for enabling learners to be capable and show capabilities. For learners' capabilities, the contemporary mode of teaching and learning stipulates collaborative, inquiry-based, team-based, work-based, or simulation-based modes among others.

The fourth dimension is overlooked as 'outside' as it considers the organizational and administrative context in which the curriculum is structured, implemented, and experienced (Ball, 1990). This fourth dimension addresses the complex cultural challenges and accommodations of translating curriculum ideas into curriculum practices that are enacted and experienced by teachers and students among others.

Methodology

Research Design

This study employed a qualitative research approach to collect data for exploring knowledge, understanding, and perceptions of secondary science teachers on the competence-based curriculum implemented in Rwanda since 2016. The use of qualitative research fits better in this study because it helps to address a research problem where the researcher does not know the variables but needs to learn more from participants through exploration (Creswell, 2012). Considering this, participants were allowed to give their own viewpoints without being limited by a structured set of questions. This research was basically interpretive in nature due to its suitability in investigating and describing the experience of secondary school science teachers within their contexts.

Selection of Schools and Participants

This study purposively involved twelve science teachers from three schools selected based on the teachers' experience in implementing CBC and school socio-economic diversity brought by school history and location. The selected teachers are those teaching at least one science subject (Biology, Chemistry and Physics) in the lower secondary school level. Based on teachers' experience, six selected teachers had more than three years of teaching experience while six others were new in their career. The one who was more experienced had already spent four years teaching when this study was conducted. The commonalities for the majority of teachers were majoring in the subject they teach and hold a teaching degree or with a diploma in education. Two of them, based on their future plan, were graduated or upgraded in developmental studies, a subject different from mathematics and physics or biology and chemistry which they were teaching. Both males and females were included. The group consisted of four females and eight males.

Data Collection

To explore the issue under study, data were collected through in-depth face-to-face interviews with twelve science teachers teaching at a lower secondary level of education in Rwanda. The reliability and truthfulness of the collected data were verified from another series of data collected from classroom observations as well as document analysis and non-structured interviews related to what has been observed by simply asking why such practices happen. Also, participants were given the transcribed data for their confirmation and minor editing on the information provided. This is confirmed by Patton (2002) who argued that interview transcripts should be sent out along with our tentative interpretations to the participants to check for accuracy and plausibility. The English language as the medium of instruction, yet is not the mother tongue, was used in conducting interviews. Paraphrasing as well as freedom of expressing in the language that they feel comfortable helped in obtaining all needed data.

The sample interview questions that are related to teachers' understanding as well as the perceptions include:

- Why does Rwanda adopt and implement the CBC?
- What do you understand by the term "competence?" Who is a competent student?
- What are the competences to be developed by learners?

- How do you help learners develop competences?
- What are the cross-cutting issues to be addressed by CBC? And how are they to be addressed?
- What are the principles guiding CBC implementation?
- How do you perceive CBC in terms of planning for teaching and in teaching delivery? What are the perceived challenges pertained to CBC implementation?

The interviews were recorded to avoid losing any information in the researcher's notes. Then, a verbatim transcription was done for the analysis.

Data Analysis

A four-dimensional curriculum framework composed of why, how, what, and where was used to investigate the knowledge, understanding as well as perceptions of science teachers on CBC. This is because CBC framework justifies why it was adopted, how it is to be implemented for competences development, what learners are to study, and activities learners are to undertake and what was learned. The analysis follows the content analysis method. Evaluated initial interview questions served as major categories; a coding list was developed as patterns emerged from the data. The major coding categories were formulated into themes. The study followed interpretive nature for understanding the subject world of human experience (Cohen et al., 2007). After the codes were constructed, the data were examined for patterns across all participants. Also, explanations of the features were made from the identification of the patterns of what was understood or perceived using a curriculum theory as analytical framework. The collected data were also correlated with those obtained in the investigation of CBC implementation presented in another paper to identify patterns of the practices related to the knowledge, understanding and perceptions of the CBC implementation. On the other hand, the reliability of the data was ensured by exploring and comparing participants views which enabled us to make a profound explanation related to teachers' knowledge, understanding, and perceptions.

Ethical Issues

Ethical issues were examined by the Directorate of Research and Innovation of the university which granted the first author an authorization paper describing what was going to take place and requesting the concerned authority's and participants' support in this study by providing information related to the objectives of the study. Prior to data collection, the researcher presented to the school an introductory letter, and the purpose of the study was explained to school authorities at first and to the participants. Furthermore, explanations on how data were to be collected were provided. It has been clarified that no part of the data would be given to a third person and therefore, the consent was granted.

Findings

Science Teachers' Knowledge and Understanding of CBC

The study revealed some proper and unsatisfactory knowledge and understanding of science teachers *vis-à-vis* the CBC framework as summarized hereunder. Concerning teachers' knowledge and understanding of why CBC was adopted, most teachers are aware of the potential advantages of CBC upon its successful implementation. This was confirmed by their views as teachers (T1, T2, T7, T8, T9) reported that CBC has the possibility to equip learners with knowledge and skills, for example, a chemistry teacher understood that CBC was introduced as "a solution to the country as it will equip knowledge and skills to Rwandan citizens." For a physics teacher, CBC was adopted "as a way of developing skills among students, deepen students' knowledge and understanding, and enhancing attitudes and values." Others (T3, T4) understood that CBC will help in solving socio-economic problems after schooling as indicated in this response - "I think the government of Rwanda decided to implement CBC because some of the students after their schooling were not capable of solving some problems, thus CBC expects students to be able to solve many problems of the society after their schooling; enabling learners do and produce something (T3, T10). One teacher mentioned that "incompetence in many services" is the root of CBC adoption for overcoming that since CBC is expected to produce a student who is capable of doing something (T10). Also, learners will be critical thinkers, job creators, and innovative (T4, T5, T6); CBC was introduced because the old curriculum was focusing on the knowledge rather than on practice; benefits at the societal level such as peace-building (T1, T5)

About teachers' understanding of the term 'competence' and who is a competent student, teachers have the proper knowledge and understanding in that they replied 'competence' is understood as a "combination of knowledge and understanding, skills, attitudes and values;" "ability to do or perform a task;" "different skills that help to distinguish people from one another in how they understand things, explain things, and in way of doing things." On the other hand, other teachers said that a competent student is one capable of giving his or her own way of understanding, demonstrating different skills and behaving in a proper manner; the one capable of doing things or performing tasks nicely which is somewhat incorrect since with knowledge-based curriculum also students could do things in correct way. For others, a competent student should be the one with large enough knowledge and mastery of the content and who can perform a task easily. Another view on that question was that a competent student is one who can compete with others, one who is

able to participate in the job market and who changes behavior from acquired knowledge. Yet another response was "The one to find solution by him or herself, able to discover by him or herself and to be innovative' is a competent student. Such science teachers' knowledge and understanding are not different from the concept of competence and a competent learner as Mosha (2012) noted that a competence is set of skills, knowledge and behaviours that an individual needs to perform tasks at school and in the world of work.

Concerning the competences that are needed in different socio-economic situations, interviewed teachers were aware of both competences. For the generic ones, the mostly repeated competences were mainly critical thinking and cooperation. Others like problem solving, interpersonal skills, innovation and creativity, communication in official language, research and lifelong learning; were mentioned by only four teachers. Regarding how the generic competences should be developed, except for one teacher, others understood that CBC should be implemented in active ways of group work as well as question-answer methods followed with group report presentations as if all generic competences are to be developed through group work as if all generic competences are the same. This revealed limited knowledge and understanding on learner-centred methods (Nsengimana et al., 2017), and how generic competences could be developed among learners. Therefore, teachers need to make efforts and be supported to understand how different learner-centred methods could be used for generic competences development instead of seeing things through a single lens.

About the cross-cutting issues by CBC implementation, majority of teachers mentioned three of them, namely (a) environmental protection and sustainability, (b) gender, (c) peace and values whereas CBC describes eight. Environment and sustainability, one of the cross-cutting issue was common to all Biology teachers as one teacher said, "Environment and sustainability is the only one cross-cutting issue concerning a biology teacher". The standardized culture was specific to Chemistry teachers. Regarding how those cross-cutting issues could be addressed, many of interviewed teachers were not easily giving ways on how they can address them. Those who tried simply said that they tell students how those cross-cutting issues are worthwhile.

Regarding the principles that guide CBC implementation, the study revealed inadequate knowledge about those principles as many of teachers hesitated about principles asking, "What do you mean by principles?" Even after paraphrasing the question, in inconsistency even incompleteness about the principles guiding CBC implementation remained. For this aspect, CBC framework stipulates seven principles including learner-centred, competence-based and interconnection with cross-cutting issues.

Science Teachers' Perceptions of CBC

In CBC implementation, teachers' knowledge and skills come first. With that, teachers can then plan for teaching and later implement the teaching. In this regard, having explored their knowledge and understanding, we also explored their perceptions pertained to planning for teaching and conducting what has been planned.

Regarding their perceptions of planning for teaching, teachers reported that CBC is more demanding for teachers. One finding was that the majority of teachers understood planning, as solely making a lesson plan, to be easy. Here some participants (T8, T11 and T12) voiced out, "completing the lesson plan format of REB is very easy", "with CBC, "lesson plan is easy to make as they have a format to fill in". However, one experienced teacher argued that even though making a lesson plan is easy, the ones planned do not show the content and they are not of good quality. For a master trainer who among others understood what really planning for teaching means, said, "I see CBC in terms of planning as too demanding of teachers whereby a teacher has a lot of to do such as planning lessons by completing the format designed by REB, planning different teaching and learning resources etc. Another said, "It is difficult to make materials, planning for many groups of students; it is very hard."

Regarding whether there is a change in teaching, some teachers interviewed believed they had made changes but others didn't believe so, as one master trainer highlighted "Changes have been done but not too much, as lecturing type of teaching still dominating for finishing the syllabus with the purpose of allowing students to sit and pass national exam;" another teacher said "I don't follow the CBC guidelines because the target is to finish the syllabus," and added that "with this in mind, I ignore some ways of learner-centred teaching." Other teachers do believe to have mixed both student and teacher-centred methods as students are to perform tasks and also get explanations from a teacher. For the ones who have implemented the old and new curriculum said, "Large part is in the old curriculum and a small part in new curriculum due to lack of materials, products, and students who are weak in English language." It also appears that teachers are still implementing lessons as they were in the old curriculum where teacher-centred methods dominate and when it comes to many experiments, teachers explained, especially for those from less resourced schools that they did demonstrations due to few materials comparing to the big number of students "I perform to show them, and they imitate what I have done." One teacher interviewed said "Honestly speaking, according to me, CBC is not yet implemented; we still teach as in the old curriculum." Such practices, as some teachers mentioned were related to issues of teaching resources as one teacher said "We are using the old textbooks". For students with learning difficulties, which may be also be attributed to teachers teaching difficulties depending to individual teachers as some teachers said, "Implementation of CBC is perceived to be difficult as student level is doubtful; they don't understand questions and tasks."

For assessment, teachers believe not to have changed their practices as stipulated by CBC because of the large content to cover and due to the national exams. Sometimes the questions which require students to think critically are asked even though some teachers believe students cannot understand them. The mismatch between classroom teaching content, which is at the highest level, and the final national examination tests was also noticed by one teacher. Most teachers confirmed that not changing their ways of assessment is due to not being shown how CBC will be assessed.

Considering whether the teaching reflects learners' life experiences, the science teachers mentioned some stories related to the concepts taught. However, teachers are still faced with how they can find some application of what is taught in chemistry.

For the perceived challenges that hinder smooth implementation of CBC, all science teachers reported a heavy workload (almost 9 hours period per day making around 39 periods a week) without a day off. With this, they don't have time for planning their teaching which is dealing with the issue of large class size and amount of content to cover. The problems specifically for those teaching in less resourced schools, were about the language barrier, some content which is not the level of learners, scarcity in teaching resources particularly textbooks as the school only had 5 or fewer for 45 students and automatic promotion makes learners reluctant in their studies, as well as lack of interest to study when they see other students who enrolled in the same school being jobless. Other common challenges are some fragmented content, which leads to a tendency to repeat what might have been covered as they find it difficult to identify topics or units already covered. Also, textbooks are overloaded with 400 pages and too much content and new concepts. Some teachers perceived not to have received quality training as one said, "Truly teachers are also not well trained." Training was not provided in the right time. Being trained by incompetent trainers selected unfairly was a problem. Some other challenges were school leaders who lacked understanding of how science should be implemented; hence no provision of science equipment and supplies was made. Insufficient supportive staff was a problem for ICT smart classroom as there were two classrooms with one ICT staff, was mentioned.

Discussion

The findings of this study revealed adequate knowledge and understanding of why CBC was adopted and being implemented in Rwanda. This is justified by interviewed teachers' views aligned to the Rwandan education philosophy, which is to ensure that young people at every level of education achieve their full potential in terms of relevant knowledge, skills and appropriate attitudes that prepare them to integrate in society and take advantage of employment opportunities (REB, 2015). Their views reflect Rwanda's intent of developing a knowledge-based society and the growth of regional and global competition in the jobs market. (REB, 2015). The meaning of the term 'competence' and who is a 'competent student' was appropriate as the views of teachers fall respectively into the definition and descriptions of Mulder et al. (2007) and Mosha (2012). Such understanding could serve as good starting point from which training should build.

On the other hand, a limited understanding of group work and presenting what comes from groups as ways through which generic competences could be developed and ways in which cross-cutting issues could be addressed was noticed. Such inadequacy was also associated with the knowledge and understanding of both generic competences and cross-cutting issues since teachers interviewed could mention only a few of them. This revealed that teachers' curriculum knowledge and pedagogic content knowledge on how CBC should be implemented is not sufficient. To strengthen their curriculum content knowledge and pedagogical content knowledge which are necessary for the effective translation of the curriculum in the classroom settings, proper conditions of the social system in which knowledge is constructed have to be established and maintained. This is supported by the view that knowledge construction is possible if the social system which creates and accepts knowledge of a given concept provides the proper conditions (Oeberst et al., 2016). Considering this, teachers are urged to take responsibility for that common good, here the CBC framework and other related documents, if they are to deepen their knowledge and understanding about it.

As teachers' knowledge and understanding of new educational changes are important for its sustainability and success (Sudsomboon, 2007), more should be done for teacher professional programmes so that Rwandan science teachers could deepen knowledges and understandings on how they should help learners develop generic competences and on how different cross-cutting issues could be addressed. To respond to science teachers needs in terms of knowledge, understanding and perceptions; strong in-service teacher training through school community of practices (Nsengimana et al., 2020), in which teachers will discuss about CBC ideas, is to be embraced and established in all schools for improving competences of teachers for the appropriate implementation of the CBC. Further, teachers should take part in responsibilities like being trainers and leading others in their schools for the common good here the curriculum (Oeberst et al., 2016). In addition, teachers should be involved in different activities of professional development as it was found that teachers who have been involved in curriculum implementation demonstrated better classroom practices (Nsengimana et al., 2021).

Teachers should not stay with the single mindset that all things would be done through group discussions, as if content to teach as well as the generic competences to develop and cross-cutting issues to address are the same. As such, knowledge and understanding gaps expressed by interviewed teachers were attributed to somewhat inadequate

knowledge and skills of some trainers in addition to limited training time that dilutes the content as well as pedagogic knowledge related to CBC.

To address this issue, there is a need to invest more in both pre-service and in-service education and streamline teacher training programmes to produce teachers equipped to disseminate what they understand and what they are able to do as reflected in the Rwandan proverb saying that no one is giving what one does not have. This is supported by Bettencourt et al. (2011) who highlight that investing in teacher education is crucial. Since the implementation of new ideas requires teachers to think and act in new ways as Voogt et al. (2019) argued, may be problematic to the majority of Rwandan teachers; regular and strong training should be provided to both pre-service and in-service teachers. This was highlighted by Elmore (2006) who said that the mastery of what to do is worthwhile for implementation and 'learning' is something you do when you don't yet know what to do." Additionally, since schools have to own educational changes, "*zone of feasible innovation*" of Rogan (2007), could be adopted at the school level as the diversity in schools involved in this study is remarkable; therefore, each of the school may plan according to what staff are capable of doing.

Even though Rwandan science teachers were found to have positive perceptions on CBC in terms of lesson planning, different negative perceptions revealed by this study should be addressed by responding to the concerns raised by teachers. One way of doing so is to introduce and strengthen CBC related theories and practice in pre-service teacher programmes. As Brackenreed and Barnett (2006) argued, the number of positive perceptions increases when pre-service teachers are introduced to new education reform before they join their careers. Further, the follow up and support of novice teachers in the early implementation phases of the CBC implementation in new system, here the school context will enable them to construct and deepen knowledge (Oeberst et al., 2016), if the social system which creates and accepts knowledge provides the proper conditions for the individuals to learn. The latter are noted to be essential not only for effective teaching (Tweed, 2009), but also for effective learning. In this way, teachers will not be disheartened due to the lack of effective pre-service and in-service programme to enable teachers to get new innovative ideas.

Conclusion

Science teachers were aware of the potential advantages of CBC upon successful implementation of both basic and generic competences, as well as the cross-cutting issues to be addressed upon intended CBC implementation. The study also revealed some teachers' knowledge and understanding of the key concepts found in the CBC framework. The study revealed limited teachers' knowledge and understanding related to the generic competences, cross-cutting issues and how the competences could be developed. However, a curriculum that is too demanding, large class sizes, too much content to cover, and some students who lack the interest to study, and lack of timely and quality training incompetent trainers were identified. These lead us to question how the science CBC embraced in Rwanda is being implemented and what can be done for its effective implementation.

Recommendations

If the CBC is to be implemented as it is intended, teachers as the key players in curriculum implementation have to be supported professionally so that they are enabled to offer what they are capable of doing. As the provided professional development appeared to have weaknesses, the way teachers are trained should be improved whereby teachers should be trained based according to their needs. Further, the selection of the trainers who are capable has also to be done seriously. For the sustainability of the teachers' professional development, a cost-effective support for teachers through school community of practices such as lesson study practice is recommended to respond to schools' diversity. In the future, further studies at large scale to investigate science teachers' knowledge, understanding, and perceptions of the CBC and how their knowledge, understanding and perceptions of the CBC are translated in the classroom are to be conducted. In addition, the research is to be carried out to look at how teachers are trained for competences development if they are to train citizens who are to compete at job labour market and contribute to the socio-economic development of the country.

Limitations

This research was limited in three schools and twelve science teachers teaching at lower level of secondary education in Rwanda. Those teachers were selected as being science teacher whose experience varied as some have been implementing the old curriculum for years while others were fresh graduates. Their qualification differed; some were with high school certificate, others held diploma and bachelor's degree.

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Authorship Contribution Statement

Nsengimana: Conceptualization, design, analysis, and writing. Mugabo & Ozawa: Editing and critical revision of the manuscript. Nkundabakura: Supervision, critical revision of the manuscript and final approval.

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