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Towards Understanding Zimbabwe's Competence-Based Science Curriculum and its Implications on the Study of Science, Technology, Engineering and Mathematics

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Abstract

This study sought to gain an understanding of the Competence-Based Science Curriculum - CBSC as an approach that enhances students' acquisition of Science, Technology, Engineering, and Mathematics - STEM knowledge, skills, and attitudes. In this conceptual paper, structural analysis formed the methodological framework that guided the cross-examination of the purposively selected research articles and document policies. Structural content analysis was used to interrogate the generated data. From the findings and discussion, it was noted that the CBSC was seen as an approach that is learner-centred and grounded in constructivism and perennialism philosophies. Thus, it promotes students' interaction with their environment during the STEM learning process. Though, CBSC can be well planned, designed and documented, it is marred with some challenges. From this the discussion forwarded possible solutions geared towards equipping teachers with relevant knowledge, and skills such that they can effectively implement the new approach in learning activities. From this discussion it can be concluded that CBSC as an approach if effectively implemented can promote the acquisition of STEM knowledge, skills, and attitudes.

Keywords: *Competence-Based Science Curriculum; Science, Technology, Engineering and Mathematics; understanding; Zimbabwe*

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INTRODUCTION

The curriculum which was inherited from colonial governments in most African nations was targeted at producing students that were strangers in their own homes (Mgqwashu 2016). Thus, the education system was seen as producing products with a narrow comprehension of themselves (Chimbunde 2023). In this regard, the new government embarked on a long and arduous curriculum reform process to address the imbalances left behind by the settler regime. For instance, the government in 1998 commissioned the Presidential Commission of Inquiry into Education and Training mandated of interrogating the curriculum with the view to identify gaps in teaching-learning (Machisi 2023). In this context, the commission made some recommendations that were viewed as having far-reaching socio-economic benefits to society, such as the need to craft a curriculum focused on skills development (Nziramasanga 1999). Thus, the idea was to have a curriculum geared towards preparing students for future tasks and professions in a context, which allows them to have a hand-on approach teaching-learning (Halasz and Michel 2011).

Nevertheless, achieving some of these aspirations seems to be difficult due to the lack of employable skills and generic competencies in learning activities (Maodzwa-Taluvinga and Cross 2012) (Nsengimana et al. 2020).

It is against this background that the Zimbabwe's Ministry of Primary and Secondary Education reviewed the curriculum grounded in the Nziramasanga Commission of Inquiry's recommendations. This facilitated the education system's shift from being knowledge-based to one that is practical-oriented (Gory et al. 2021). This meant an earnest implementation of the Competence-Based Science Curriculum - CBSC with the view to model students towards the acquisition of Science, Technology, Engineering, and Mathematics - STEM knowledge, skills, and attitudes for personal and economic imperatives (Machin et al. 2015). This new approach to STEM teaching-learning is all about the application of knowledge, skills, and attitudes in real-life contexts (Education 2014). However, this CBSC begins with multiple decision-making points that depend on how diverse stakeholders conceptualize and construct their appreciation of the STEM teaching-learning (Ministry of Primary and Secondary Education 2020) (Mufanechiya and Mufanechiya 2020). It is against this background that this review sought to gain an appreciation of Zimbabwe's CBSC and its implications on the study of STEM. Thus, Zimbabwe's 'Education 5.0' doctrine, CBSC, is viewed as an instructional strategy that is student-oriented approach and it undertakes to encourage and support students' participation in STEM teaching-learning (Joughin 2009) (Ministry of Primary and Secondary Education 2020). In support, postulated that it is when students' participation in STEM teaching-learning activities is grounded in a set of instructions, which require teachers to provide appropriate feedback through monitoring the assigned tasks (Carless 2007). However, a lot of questions have been raised concerning STEM teachers' competence levels, as they are seen to be struggling to comprehend and integrate the new approach into the identified teaching-learning areas (Mufanechiya and Mufanechiya 2020). It is in this context that this conceptual paper sought to explore CBSC as an instructional strategy and its implications on the study of STEM teaching-learning

METHODS

In this conceptual paper, the research methodology was grounded in structural analysis and it involved an online search query of the issue under investigation from journals, proceedings and institutional repositories. Hence, researchers reviewed the available empirical and theoretical literature about CBSC. It is significant to acknowledge that the focus was particularly on the implementation of CBSC in STEM related subjects teaching-learning process. Thus, the reviewed literature was purposefully selected on the belief that they were focused on the nature of CBSC, the motive behind its embracing, and strategies employed in STEM teaching-learning (Oyao et al. 2015). This called for the inclusion of structural content analysis in interrogating research articles and government documents on the curriculum in general and CBSC implementation (Mertens et al. 2013). In this context, the following constructs were crafted to interrogate CBSC issues at the centre of this discussion: CBSC as a concept; philosophies underpinning CBSC; challenges encountered when implementing CBSC; and possible solutions. The identified constructs were selected based on their suitability to the context of the issue under review and their capability to structure the discussion.

FINDING AND DISCUSSIONS

The Ministry of Primary and Secondary Education's new curriculum framework is grounded in a transformative model that focuses on the continuous assessment of competencies in different learning areas. It targeted altering the interaction between the institutional, cultural, technological, economic, and ecological dimensions in STEM teaching-learning (Mersmann et al. 2014) in Zimbabwean secondary schools. It is against this background that this discussion centres on understanding Zimbabwe's CBSC.

Competence-Based Science Curriculum as a Concept

This conceptual paper defines curriculum as all the planned experiences accorded to students under the auspices of the school (Ogar and Awhen 2015). It is in this context that the reviewed the curriculum with the aim of providing students with relevant opportunities in the formal and non-formal education setting (Education 2014). This new curriculum framework is a product of the Nziramasanga Commission of Inquiry into Education and Training's recommendations, which gave emphasis on Science, Technology, Engineering, Mathematics and Heritage Studies (Sibanda 2018). Schools need to put in place strategies to facilitate the acquisition of knowledge, skills and attitudes by the students. Hence, this adopted blue-print targets at translating the aspirations of the students into tangible reality (Ngwenya 2020). In this regard, CBSC has evolved from a philosophy and the need for practical education and training (Barrick 2017). In this regard, CBSC has been acknowledged as being multi-dimensional field of meanings, which cannot be narrowed into a single dimension (Mulder et al. 2007).

Hence, the need to acknowledge that the interest of the scholars (Asale 2017) (Ferreira and Schulze 2014) CBSC's demand for accountability has created opportunities for students to learn at their pace and increased the quality of learning in line with society's expectations. This argument gives an idea for the need to call for interactions in the teaching-learning process that endows STEM students to play a dynamic role in issues to do with their lives (Kwaira 2017). In this review, CBSC refers to systems of instruction/methodologies, assessment, grading, and academic reporting centred on the learners (Kabombwe and Mulenga 2019). Thus, they are supposed to demonstrate that they have learned the STEM knowledge, skills, and attitudes required by the curriculum. Thus, CBSC is premised on what students have to do rather than what should be known in STEM teaching-learning (Balsiger et al. 2017) (Dokora 2015). In this regard, CBSC can be considered as a framework for the subsequent detailed development of competencies, associated methodologies, practical, and assessment resources.

It is important to realise that the Ministry of Primary and Secondary Education's efforts to review the CBSC was meant to put into effect recommendations of the Nziramasanga Commission (1999). It was aimed at rejuvenating the old curriculum with the view to improve the quality of instruction in teaching-learning (Education 2016). It is against this background that this new approach to teaching-learning advocates for students' hands-on approach to learning (Ngwenya 2020). This creates a platform for students' empowerment through the acquisition of STEM knowledge, skills, and attitudes. Hence, this new curriculum encompasses some educational and instructional practices that have a strong bias towards linking secondary schools with relevant scientific and technological workplaces (Gasva and Phiri 2020). In other words, CBSC lays a proper foundation that exposes students to real life-long learning contexts through their interaction with the environment. In CBSC, these setting students are in-charge of their learning, and they are active problem solvers, with teachers acting as facilitators (Mkimbili 2018) (K.L and Tschepikow 2013).

In this context, this CBSC seems to be grounded in a philosophy tailored made to develop self-reliant knowledge and skills in students through STEM. In this regard, CBSC is acknowledged as the engine for the integration of STEM in scientific and technological development in Zimbabwe (Shizha and Kariwo 2011). Thus, this enables students to integrate knowledge, skills and attitudes to better position themselves in the quest for industrial development (Milutinovic 2013). This calls for the integration of CBSC into teaching-learning. This CBSC is derived from the analysis of competencies that certify students' progress based on the demonstrated performance in terms of the acquisition of relevant knowledge, skills, and attitudes. In this regard, students are accorded the opportunity to perform tasks and roles to the required expected standards, and this translates into the quality of being capable to achieve set goals (Mosha, 2012). This is based on the CBSC approach which promotes the shifting of teaching-learning from the content-based approach of the past, but to one that develops knowledge, skills, and attitudes (Chikuvadze et al. 2022) (Tomlinson 1995). Thus, it fosters

lifelong learning and empowers learners through the acquisition of essential competencies such as critical thinking, creativity, innovation, communication, and collaboration, among others.

Philosophy Underpinning the CBSC

The Zimbabwean CBSC is grounded in a philosophical framework comprised of constructivism and perennialism. Thus, this conceptual paper is premised on the belief that CBSC learning is a product of mental construction, hence students construct their own understanding of the nature (Muijs and Reynolds 2011). In this scenario students learn through their interactions with the environment. Students' understanding and knowledge construction enable to engage their prior conceptions of the environment (Mudavanhu 2016). Hence, this philosophical framework acknowledges knowledge and skills as products not transferrable from the teacher to students, instead are a result of learning done by students themselves either individually or in groups as they interact with their environment under the guidance of their teachers (Wisselink et al. 2007). In this regard, CBSC centres on the personal construction of knowledge and are affected by the interaction of new and previous events with an emphasis on a holistic approach to teaching-learning.

This framework has multidimensional facets that give emphasis to continuous assessment of knowledge, skills and attitudes in STEM disciplines (Chanda 2022). This promotes students' acquisition of competencies that facilitate their intellectual growth, psychomotor skills development as well as character building (Adeyemi and Adeyinka 2002). Therefore, this calls for the need for the inclusion of the aspects of 'humanism' to oversee human needs, interests, and dignity. This brings the importance of embedding 'unhu/ubuntu' as an essential norm of interdependence and humanism in CBSC. This approach to teaching-learning develops the much-needed human capital base with competencies that ensure sustainable scientific and technological advancement. It is in this context that the approach to teaching-learning has shifted from the traditional teacher-centred to a student-centred approach (Crawford 2014).

This new approach to teaching-learning requires students to be actively engaged in the interactions, and not only as receivers of the information (Mkimbili 2018). Hence, during interactions the students apply the acquired knowledge, skills, and attitudes in solving real-life problems (Ogunniyi and Rollnick 2015). Thus, as opposed to the content-based practice, this new approach promotes the acquisition of knowledge, skills, and attitudes that students can use in problem-solving (Kimaro 2012). This enhances students' understanding of STEM ideas, and concepts, acquire skills and attitudes, with the ultimate goal of applying them in their everyday lives (Crawford 2014).

Challenges Encountered when Implementing CBSC

The attainment of the CBSC's set goals is contingent fundamentally on its effective implementation (Ahmadi and Lukman 2015). It is the implementation stage where most of the excellent CBSC is marred with some challenges deprived of any suggestion (Mkpa 2007). This is so since implementers are considered the cornerstone for the successful implementation of the CBSC. However, secondary schools have been experiencing critical shortage of qualified STEM teachers and this hurts the effective execution CBSC (Munikwa 2016).

According to (Esau and Mpofu 2017) one remarkable story of the Zimbabwean education system has been an incredible upsurge in enrolment. Regrettably, all signs point to an enduring gross under-funding of the teaching-learning (Gwany 2006). This is a serious issue in CBSC implementation mostly in secondary schools since there is no institution that can function effectively without adequate funding (Tarisayi and Manik 2017). This in a way affects the implementation of CSBC as there will be inadequate funding to meet its demands in terms of equipment, laboratories, furniture, and other facilities (Munikwa 2016).

With the above discussion, Moyo and Hadebe (2018) teaching-learning materials are seen as an alternative channel of communication in CBSC activities. Thus, STEM teachers are expected to use these to convey information that makes concepts, procedures, and processes more vivid to

learners. In other words, this tends to make teaching-learning processes easy, meaningful, and understandable (Ahmadi and Lukman 2015). In the absence of adequate of infrastructure in schools the student-centred CSBC is deemed to miss the intended goals. This results in the new approach to teaching-learning being ineffectively implemented. The consequence of such a scenario is the limited acquisition of STEM knowledge, skills, and attitudes by the students (Ajayi 2009). In line with the above-mentioned challenge (Gondo et al. 2017) postulated that the success of CBSC implementation can to a greater extent be influenced by the inadequacy of learning materials.

In addition, though STEM teachers are the implementers of this new approach to teaching-learning, they have limited participation in the CBSC planning and decision-making phases in Zimbabwean education system. In this case STEM teachers are intentionally ignored when the most important pronouncements on CBSC are taken (Mkpa 2007). Under such a scenario where teachers are side-lined in both the planning and decision-making on issues to do with CBSC from the inception, set STEM objectives will not be achieved. Therefore, the non-involvement of STEM teachers, equally impedes the effective implementation of CBSC, since they would not be well-oriented to facilitate the teaching-learning process (Majoni 2017). In the same line of thought, this can also affect the STEM teachers' level of motivation when it comes to the implementation of the CBSC. Thus, this hinders their performance and causes stress and frustration all of which can affect the quality of the service and product (Moyo and Hadebe 2018). This concurs with Ipaye (2012) who affirmed that for a worker to live up to expectations must be motivated by availing resources that meet his/her needs. Further, the integration of Information Communication Technologies-ICTs in learning activities has proved useful and effective (Ramesh and Dibaba 2017). However, STEM teachers' incapacity to integrate ICTs into teaching-learning activities can be one of the challenges that act against the effective implementation of CBSC (Bukaliya and Mubika 2012). Thus, STEM teachers do not use computers in their CBSC learning activities and this can be as a result of various factors among them the erratic electricity supply (Ncube & Tshabalala, 2016). In this regard, school and teacher-based challenges in this conceptual paper are considered as critical determinant of the success or failure of the CBSC (Alonsabe 2005).

Possible Solutions to Challenges Encountered when Implementing CBSC

The successful implementation of the CBSC depends on STEM teachers' understanding of its structure, materials, transformation in practice about activities, knowledge, skills, and their views concerning their position in the new approach to teaching-learning (Komba and Mwandanji 2015). In addition, successful CBSC implementation is subject to how STEM teachers have positioned the new curriculum policy in terms of their different career stages, experience, and competencies. In this context support to STEM teachers implementing CBSC needs to be all-embracing and exhaustive about the new pedagogical approach. Therefore, this requires mindset transformation and self-efficacies necessary to facilitate the implementation of CBSC with the view to achieving the new curriculum's ultimate goals (Ozadowicz 2020). Thus, this spirit of CBSC change is subject to the STEM teachers' recognition of the new curriculum changes and innovation; notwithstanding their anxieties talked about in a bid to put transformation thoughts into reality (Fullan and Langworthy 2014)

CONCLUSION

The discussion above CBSC has been portrayed as an approach that when effectively implemented in STEM-related subjects can promote the acquisition of knowledge, skills, and attitudes. This is so since it addresses the students' cognitive, psychomotor, and affective needs. Thus, its hands-on approach to teaching-learning propels students to develop holistically. However, the issue of CBSC can be regarded as 'easier said than done' in the Zimbabwean education system since it is marred by various challenges that affect the quality of service and products.

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