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Depicting science teachers' concerns regarding the Tanzanian inquiry-based science curriculum

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ABSTRACT

Secondary school teachers in Tanzania have been attempting to implement the inquiry-based science curriculum since 2005. This study is descriptive and was designed within the realms of a Type IV case-study design (Yin, R. K. 2014. *Case study research: Design and methods* 5th ed. SAGE) to investigate their concerns in dealing with this curriculum. It employed the Concern-Based Adoption Model (CBAM) as its lens and collected data using the Stage of Concern (SoC) questionnaire. In addition, the study used background information of the participants themselves and their context collected using one-on-one interviews to enrich the interpretation of revealed concerns. The findings revealed variations in the nature and intensities of concerns amongst science teachers in the case-study schools. These variations were partly due to the differences in contextual and background characteristics of staff of the three case-study schools. The implications of these findings for both policy and practice are discussed.

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Tanzania; science curriculum; inquiry-based pedagogy; Concerns-Based Adoption Model (CBAM)

Introduction

Because schools operate in a dynamic global atmosphere, Gerver (2010) notes that the nineteenth century schooling system, which emphasised compliance and conformity ('do-as-I-do') in instructional processes, is less relevant today. Having similar thoughts, Jacobs (2010) and Alexander and Potter (2005) remind us of the need to update and inject life into our curricula and alter schooling systems to prepare today's children for the present and emerging future world demands. For this reason, we are currently witnessing major educational reforms in the world, attempting to create a 'learning-to-learn' schooling system.

Much like the rest of the world, Tanzania has reformed its education system many times since its independence in 1961. The most recent reform movement started during the early 2000s and resulted in the 2005 Tanzanian Inquiry-Based Science Curriculum (2005TIBSC) (MoEVT, 2007). However, the Tanzanian government (MoEVT, 2010) and some academics (e.g. Komba & Mwandanji, 2015; Makwinya, 2020; Mkimbili et al., 2017; Paulo & Tilya, 2014) believed that it was necessary to replace the previous

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curriculum because its design had too much focus on the *what* at the expense of the *how* of the teaching and learning processes, implying that it influenced teachers and students to pay more attention to the content coverage than to mastery of essential skills. On these grounds, its implementation is believed to have produced graduates who lacked key skills required by the demands of the twenty-first Century.

Aimed at bringing about a difference in the quality of graduates, the peculiar feature of the 2005-TIBSC is its pedagogical stance. This curriculum is structured on constructivist ideals (MoEVT, 2010; Nzima, 2016) to promote the creation of rich opportunities for students to interact and integrate their out-of-school knowledge and experiences with what academics refer to as already established science. The 2005-TIBSC, according to MoEVT (2010) and Nzima (2016), calls for science teachers to change their relationship with learners and challenge their roles in educational activities. Rather than simply telling their students what they should understand, this curriculum demands instructors act as knowledge resources who demonstrate intellectual skills and support and guide their students as they try them out. The key assumption in this curriculum reform is the constructivist ideals it enshrines as the best ways to organise and lead science learning.

Inquiry-based instruction

The role of Science, Technology, Engineering, and Mathematics (STEM) in realising social and economic development is well acknowledged (Fitzgerald et al., 2019). Thus, improving science instruction has become the world's top priority. To this end, there have been global campaigns for science teachers to move away from perceiving science education as a process involving the transmission of ready-made knowledge to learners towards recognising knowledge their students bring into classrooms and making them responsible for their own learning.

The inquiry, an interactive and student-driven process of learning (Fitzgerald et al., 2019; Kinyota, 2020), is one of the approaches to science instruction that has been strongly promoted globally to attain this desire. In contrast to the traditional learning paradigm, which requires students to memorise facts a teacher provides, an inquiry encourages students to participate actively in the learning process. The inquiry approach to learning views science as a question-driven discipline (Kinyota, 2020). On this ground, inquiry instruction demands instructors help students systematically answer questions about the world around them (Stott & Hattingh, 2020). During the inquiry, students learn how to gather evidence, establish and evaluate knowledge claims, and finally communicate the knowledge they developed to the public (Quigley et al., 2011; Constantinou et al., 2018). As can be seen, this pedagogy is grounded on the founding works of Dewey (1938) and Bruner (1996) and enriched with the constructivist learning philosophy.

Promoting the use of inquiry in science education is based on the belief that this pedagogy improves learners' self-regulated learning skills (Gaigher et al., 2014; Constantinou et al., 2018) and their understanding of ways in which knowledge is generated and extended (Capps & Crawford, 2013; Cairns, 2019; Kinyota, 2020). Another reason for advocating this pedagogy is students' potential to develop higher-order thinking abilities and interest in science (Constantinou et al., 2018).

While this explanation provides a better understanding of the inquiry-based instructional method and its merits in promoting science literacy, research suggests that this pedagogy is not sufficiently employed in schools (Kinyota, 2020; Nsengimana et al., 2020). In those places where researchers (Capps & Crawford, 2013; Mkimbili et al., 2017; Ramnarain & Hlatswayo, 2018) had observed aspects of inquiry in science classrooms, it was simply essentially teacher-initiated, and the processes could not embrace core characteristics of inquiry. For this reason, Cairns (2019) concluded that school science learning processes hardly help students build their critical thinking skills.

It is worth noting that this concern is less critical in developed countries when compared to developing countries (Ramnarain & Hlatswayo, 2018). As revealed by Mkimbili et al. (2017) in Tanzania, Mohammed et al. (2020) in Ghana, and by Nsengimana et al. (2020) in Sub-Saharan African countries, school-based inquiry activities are confirmatory. Many science instructors in developing countries explain science phenomena and then direct their students on how to deal with them only through prescriptive activities.

Several initiatives launched in developed countries to enhance science teachers' competence in science instruction appear to explain this difference. Professional development for teachers (Nichols et al., 2017) and the promotion of partnerships between industry scientists and science teachers (Morris et al., 2021) are only a few examples of such initiatives. On the other hand, the poor implementation of this pedagogy in developing countries is essential because inquiry aspects were included in curricular frameworks without providing teachers with sufficient in-service training (Mohammed et al., 2020) or acceptable levels of support from curriculum leaders (Makwinya, 2022). Thus, where resources have not been an issue, the lack of profound knowledge of the inquiry instruction and the principles that underpin this pedagogy has significantly affected how science instructors implement it in their classrooms (Gaigher et al., 2014; Kinyota, 2020; Ramnarain & Hlatswayo, 2018).

Teachers' response to the 2005 Tanzanian inquiry-based curriculum

Fundamentally, implementing educational reform is a complex endeavour and results do not often tally with the intended outcomes (Fullan, 2007). The mismatch between the implementation envisaged by change designers and the teachers' actual practices is argued to be one of the key reasons. Such views likely reflect the transition from the traditional 'do-as-I-do' to inquiry-based pedagogies in Tanzania. However, abundant evidence (e.g. Komba & Mwandanji, 2015; Mkimbili et al., 2017; NECTA, 2020) suggests that attempts to design the inquiry curriculum in Tanzania have partly failed to develop the envisioned twenty-first century competencies in secondary school students. This leads to the skill shortage problem and constraining the operations and growth of relevant sector firms in the country (Tan et al., 2016).

Earlier research has linked this failure to a wider gap between curriculum planners' desires and teachers' actual implementation practices. For example, Mkimbili et al. (2017) report that science instruction and learning are still *traditional* as most science teachers in schools they investigated failed to adhere to the demands of the 2005-TIBSC. The study by Komba and Mwandanji (2015) revealed further that most science teachers in the schools they investigated could not even plan science lessons based on constructivist ideals cherished by the 2005-TIBSC.

The literature we reviewed indicated that the poor implementation of the 2005-TIBSC was because teachers lacked a sound understanding of the constructivist premises upon which this innovation had been designed. Kopweh (2014) informed us that this problem was partly contributed by the insufficient involvement of frontline teachers in the entire process of bringing about the 2005-TIBSC. As the diffusion of this change relied more on the cascade strategy, its theoretical details diluted as it trickled down the chain. According to Makwinya (2022), even using change agents such as school-based leaders did not prove effective because many lacked change-leadership skills. Contextual factors, particularly ill-resourced and overcrowded classrooms, were the additional reasons for the teachers' failure to comply with the demands of the 2005-TIBSC (Mkimbili et al., 2017). Based on this literature, one may conclude that the mandate to teach through inquiry approaches faces many challenges. Despite so many years of attempting to deal with this change, the Tanzanian secondary school science teachers still face concerns regarding it.

While the earlier research findings are useful feedback, they could not provide sufficient information about the types and intensities of such concerns. Therefore, it is crucial to systematically address this issue for policymakers to develop adequate intervention programmes to increase the chances of successfully implementing the 2005-TIBC. It is for this reason we designed this investigation, guided by the following research questions:

- (1) What are teachers' concerns regarding the 2005-TIBC?
- (2) Which background and or contextual factors account for the various types and intensities of, and trends in, science teachers' concerns regarding the 2005-TIBC?

Theoretical framework

This study employed the Concern-Based Adoption Model (CBAM) as its framework for evaluating teachers' concerns in implementing the 2005 TIBC. The CBAM is a multi-dimensional model comprised of the stages of concerns, levels of use, and innovation configuration. It is mainly concerned with describing, measuring and explaining the change process from change users' viewpoints. This model is widely accepted in monitoring and leading the educational change process and in conducting change-related research.

An extensive body of change-process research conducted over many years (e.g. Gudyanga & Jita, 2018; Hall et al., 1977; Nawastheen, 2021) has revealed that no matter how promising the innovation, and no matter how strong the support it receives, users will experience concerns regarding the meaning, goals and beliefs related to the innovation, and to its means of dealing with it. According to Hall and Hord (2015) and Pieters et al. (2019), these concerns largely result from the individual levels of awareness caused in part by the extent to which users of change participated in bringing it about. It is, for this reason, Fullan (2007) and Hall and Hord (2015) maintain strongly that all changes elicit reactions that often vary markedly amongst the implementers. Gudyanga and Jita (2018) consider it pertinent for academics and policymakers to

acknowledge the influence of individuals' concerns on the change adoption process as doing so demonstrates respect for the change user's experiences and insights.

Essentially, knowledge about change-related concerns among programme users is based on foundational work by Fuller (1969), who examined concerns of small groups of student-teachers about their careers. Such studies established that reactions to reform based on personal grounds dominated teachers' professional growth. For the first time, Fuller termed these reactions 'concerns', referring to feelings and considerations that someone gives to a proposed idea or change in practices. The knowledge about innovation-related concerns and their impact on the adoption process was further developed during the 1970s by a team of researchers, particularly Hall et al. (1977). By studying teachers' reactions to new educational programmes, Hall et al. (1977) revealed that concerns were generated in relation to each user's perceived meaning of the innovation; what the innovation demanded them; their perceived ability to succeed to deal with new ways of operating and their perceptions of the impact of the innovation (new programme) on students. Moreover, Hall et al. (1977) found that concerns occur at seven stages shown in Table 1. Using this knowledge, they developed the Stages of Concern Questionnaire (SoCQ) for assessing them.

Though CBAM has been used widely by educators to understand users' concerns about new educational changes, academics have criticised it. While the typical CBAM proposes a hierarchical progression of concerns, evidence suggests that change-users may experience a wide range of concerns related to different stages in no particular order (Hollingshead, 2009). Additionally, there are concerns that the original CBAM still fails to differentiate and formulate a statistically sound clustering of user's concern profiles (de Vocht et al., 2017). On these grounds, there have been calls for continuing studying the CBAM and in particular the SoC questionnaire and adjust it to provide more diverse and informative profiling of change-users' concerns. While the C-BAM studies published so far have used the typical CBAM model, some academics have attempted to adjust it, including the use of a few items from the original SoCQ as was done by Bitan-Friedlander et al. (2004). In view of improvements done on the CBAM framework, our study employed the SoCQ designed by George et al. (2006).

Method

We were aware that the types and intensities of teachers' concerns about an innovation depend on their work context. Therefore, we considered it useful to examine teachers' concerns regarding implementing the 2005-TIBSC in their contexts. To refine our

Table 1. Stages of Concern and Typical Items.

Stage of Concern	Typical statement
0. Unconcerned	'I think I heard something about it, but I'm too busy right now with other priorities to be concerned about it'
1. Informational	'This seems interesting, and I would like to know more about it.'
2. Personal	'I'm concerned about the changes I'll need to make in my routines.'
3. Management	'I'm concerned about how much time it takes to get ready to teach with this new approach.'
4. Consequence	'How will this new approach affect my students?'
5. Collaboration	'I'm looking forward to sharing some ideas about it with other teachers.'
6. Refocus	'I have some ideas about something that would work even better.'

understanding of how school realities relate to teachers' types and levels of concerns, we investigated and compared science teachers working in different schools. Therefore, we designed our study based on the Type IV multiple case study designs (Yin, 2014). Our cases were three schools that exhibited consistent differences in academic performance during the past three years (a Higher Performing School—HPS, a Medium Performing School—MPS, and a Lower Performing School—LPS). All of the three case-study schools were located within one town, about equal distances from the town centre. Importantly, we investigated schools that were owned by the Tanzanian government only. We were mindful of the significant differences in academic performance between students who attend private and public schools in Tanzania. Therefore, investigating only public schools helped us reduce findings' disparities due to differences in milieus operating in such school categories. It is worth noting that focusing on such 'polar-type' cases was only for the theoretical replication purpose (Yin, 2014). That is, it was for us to determine ways in which contexts inform science teachers' concerns about the 2005-TIBSC, which we hypothesised to differ across the three case-study schools. We developed and used the criteria shown in Table 2 to select the three case-study schools.

The HPS was for girls only and had 22 classrooms and well-furnished and richly resourced science laboratories. Five hundred students attended lower-level secondary education in the HPS, but only 300 studied sciences. The MPS had 700 students, both girls and boys, 340 of whom attended the lower secondary science education level and were day attendees. Laboratories were well-furnished, but equipment, apparatus, and reagents were insufficient. It is worth noting that only same-subject teachers were allocated to one office in this case-study school. Like the MPS, the LPS admitted both girls and boys. Unlike the HPS and MPS, this school provided only lower-level secondary education. At the time of this study, the LPS had 520 students, 240 of whom were not studying science. The LPS had ill-resourced, smaller and not well-furnished laboratories with fewer classrooms compared with the MPS or HPS.

It is worth noting that the number of cases selected to represent each of these school categories was not important at this investigation stage. As suggested by Yin (2014), the potential of each selected case to allow us to gain sound insights about what we wished to investigate was what mattered the most to us. This decision was further strengthened by the fact that this study was only for exploratory purposes, that is, for us to explore the issue before conducting a country-wide investigation as suggested by Cohen et al. (2018).

In each case-study school, we selected two Biology teachers and two Chemistry teachers. We were aware that the types and intensities of innovation-related concerns vary with the length of time users have persisted with the innovation. This allows

Table 2. Criteria Used to Categorise Schools.

Category	Criteria
HPS	At least 70% of students passed the Final Exam for Lower Secondary School Education in each of the last three academic years
MPS	40 - 60% of students passed the Final Exam for Lower Secondary School Education in each of the last three academic years
LPS	Less than 40% of students passed the Final Exam for Lower Secondary School Education in each of the last three academic years

them to reflect on and try out new theories and practices individually and as a group (Hall & Hord, 2015). Considering this knowledge, we employed a snowball technique to select science teachers who, at the time of this study, had at least three years of experience in dealing with this new curriculum.

Data collection techniques and tools

We employed semi-structured interviews to investigate contextual factors that likely influence teachers' perceptions regarding this innovation. The interviews lasted for about 45 min. Interviews focused on collecting information concerning the teachers' professional backgrounds, including information about the teaching experience of the non-study participants in each case-study school and the ways in which they dealt with their concerns in dealing with the 2005-TIBC. Interviews were conducted in English and Kiswahili, for the latter was the participants' first language. The first author assumed this task for he was fluent in both languages.

To collect data about teachers' concerns regarding the 2005-TIBC, we employed the SoCQ. We adapted the original 35 SoCQ items to reflect both this innovation and the participants' first language. Considering the importance of linguistic equivalence and face and content validity of the Kiswahili-version of the SoCQ, we employed a 'forward and back' translation process (Teich, 2012).

Data analysis

Qualitative interview data were analysed manually. This process involved transcription, translation, coding, and theming of emerging issues. In addition, we employed a 'forward and back' process during the translation process to ensure that the translation was a valid reflection of what the translated Kiswahili words meant.

The Stages of Concern data analysis in this study was performed using the 'SoC quick scoring device' provided by Hall and Hord (2015, pp. 313–314). Raw scores for the 35 SoCQ items were first grouped into seven scales (each for one Stage of Concern). Then, we added these raw scores to produce a scale score from which we extracted a relative percentage intensity score using the Intensity of Concerns matrix provided by Hall and Hord (2015) and validated by Hall et al. (1977). A 100% level means a very high level of concern in this particular domain. We finally plotted these percentile scores on a graph for each teacher to produce a Stage of Concern profile to create a visual image (i.e. *profile*) of a respondent's feelings about this innovation.

Interpreting the SoC profile is typically a multi-step process. The most intense concern indicated by the magnitude of the peak identifies the issue most concerning to that particular individual. Similarly, the second most intense concern and its relationship to the most intense concern indicate what is bothering this individual. For example, if the peak concern lies at Stage 1-Information-Seeking while the second is at Stage 6-Refocussing, warning flags are raised because the individual does not yet know enough about this innovation but has ideas about how to do 'it' better. Another example of an issue profile is the one in which Stage 2-Personal concerns are higher than Stage 1-Information in someone whose peak concern lies elsewhere, for example, in Stage 0-Awareness or Stage 5-Collaboration. In the former case, the likelihood is that the individual is more

concerned about their ability to implement the change rather than seeking the information needed. In the latter case, the individual is concerned about their ability to undertake the innovation while learning about what his/her colleagues are doing in the implementation phase. Thus, interpretation of the profiles can provide management with information that allows better professional-development interventions to be designed so that the early concerns can be reduced, allowing teachers to focus on the later impact level concerns of improving student outcomes (Stage 4), engaging in collegial problem solving through collaboration (Stage 5) and, evaluating processes within the innovation to achieve better outcomes (Stage 6).

Results

We start by providing a brief background of the staff in each school. Coupled with the school-contextual backgrounds, this information will help the reader to understand better the levels and intensities of the teachers' concerns. We then display the collected concern profiles of the science teachers within a school concurrently in one figure. This approach allowed us to infer a SoC profile of each of the case-study schools by comparing similarities in the shapes and trends of the SoC profiles for the participant teachers while retaining their individuality. In this way, we determined situations by tallying how many of the participant teachers in each case-study school had their peak scores at each of the Stages of Concern. Averaging concern scores to produce a single SoC profile for a school was not our option. Because extreme scores tend to influence SoC results, averaging concern scores could obscure any reality regarding any teacher's individual experiences within the school.

Interview data helped us to triangulate the ways the physical context of the schools and/or their staff compositions covaried with the types and intensity of teachers' concerns in learning about the 2005-TIBSC in each school. It is worth noting that we strictly adhered to all the research ethics protocols as defined by the Tanzanian Ministry of Education and the University in which the authors were employed at the time of this study. This included ascribing pseudonyms to participants to maintain the anonymity of both the schools and participants.

The Higher Performing School (HPS)

There were 18 teachers teaching the natural sciences (6 Chemistry teachers, 6 teaching Biology, and 6 Physics teachers), two of whom had more than 15 years of teaching experience. Two of the 18 teachers had attended formal in-service training to deal with this new science curriculum and were, therefore, expected by the education department to train their colleagues as well as other teachers in the neighbouring schools. Amina, one of our four study participants, possessed both attributes; that is, she had received training on this reform and had 18 years of teaching experience. The number of students in her classroom did not exceed 45, a recommended enrolment by the Tanzanian Government (MoEVT, 2007).

As presented on [Figure 1](#), the intensity of concerns of Amina, Asha, and Alice was higher at the Stage 5-Collaboration level. Even Andrew exhibited relatively moderate levels of this concern. Collaboration, therefore, appeared to occupy the thoughts of all

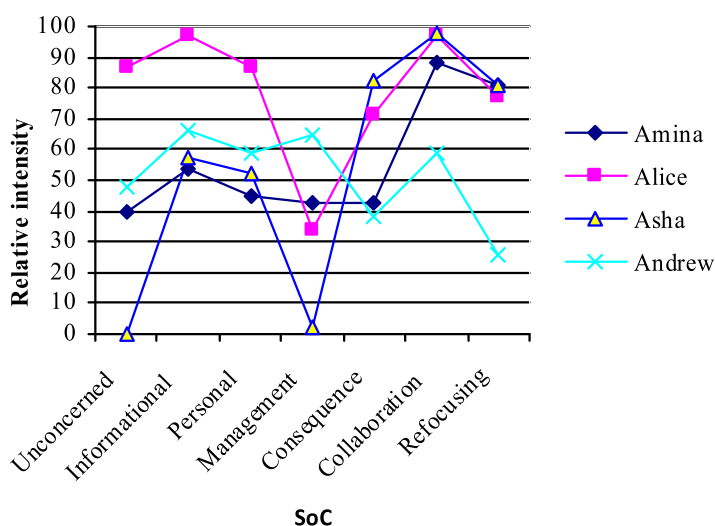


Figure 1. The HPS SoC Profile.

of the participant teachers at that particular time in the HPS. The Stage 1-Information seeking concern was Asha's and Amina's third most intense concern, while this was one of Alice's and Andrew's two most intense concerns. This may indicate that the science teachers in the HPS were somewhat not satisfied with what they knew about this innovation.

Findings showed further that the two teachers who had attended professional learning sessions in this school had not communicated their knowledge about this innovation to their colleagues. *'We are still waiting for appropriate logistics to be organised'*, Amina, one of the two resource teachers, defended their failure. Notwithstanding this situation, part of the data we collected suggested the presence of job-embedded collegial learning opportunities for teachers to learn about this curriculum. Our initial evidence of this tendency emerged from word frequency analysis; that is, analysis of the frequency at which participants used certain words or phrases during the conversation. From this analysis, we noted the repeated use of the term 'discussion' and 'meeting' in the interview transcripts.

Further analysis of the interviewee transcripts revealed that whoever experienced a challenge in this school did not hesitate to seek help from their peers or colleagues, more particularly from the two science teachers trained to deal with this innovation. *In our department, we often consult [name removed]. If you face a challenge, you quickly seek help from her* (Asha). Following this practice, teachers had the opinion that *'We are teamed up'* (Alice), and the best example was from the two Chemistry teachers who stated, *'We are more advanced in this issue'* (Amina).

Our further analysis of the SoC profiles revealed that all participant teachers in the HPS were interested in the innovation and had no intention to implement it in ways different from the proposed ones for their Stage 6-Refocusing concerns tailed down. Furthermore, their Stage 2-Personal concerns were lower compared to their Stage 1-Information seeking concerns, implying that they possibly had few reservations about their ability to deal with this change. Importantly, the pattern of their concerns as shown by the shapes of all of the individual profiles, especially from Stage 3 to Stage 6, were

broadly alike, which implied a similar progression in their understanding and adoption of this change. Considering the paucity of in-service training concerning this change, these were evidence that job-embedded daily collegial interactions had some influence on the teachers' professional growth in the HPS.

The Medium Performing School (MPS)

At the time of this study, there were seven Biology teachers, six Chemistry teachers, and three Physics teachers at this school. Their levels of experience ranged from 10 to 30 years. Beatrice and Bertha, two of our study participants, were among those with many years of teaching experience, having started teaching in the 1990s. Teacher Beatrice was the only study participant who had attended intensive in-service training covering this innovation, and the plan was to use her to cascade this change.

Figure 2 presents the SoC profile for the MPS. Stage 1-Information-seeking concerns were relatively intense in all of the participants. Whilst this is often influenced by different reasons, it could suggest that teachers in this case-study school desired more information about this innovation. Further, except for their variations at the Stage 3-Management level, we noted similarities in the concerns of three teachers: Batuli, Bertha, and Beatrice. The first similarity was in the trends and shapes of their profile. This suggested that their development in dealing with this curriculum was parallel. Second, they had the highest levels of concern at Stage 5-Collaboration, which could imply that their thinking was more about using their colleagues to improve their capacity to deal with this innovation.

We were attentive to Birgitta's SoC profile. She was the only one with no concern lower than the 55th percentile, suggesting that she was relatively concerned about all seven domains. Birgitta may be 'naturally anxious' about changes. Unfortunately, we lacked background information to complement our interpretation of her profile, and

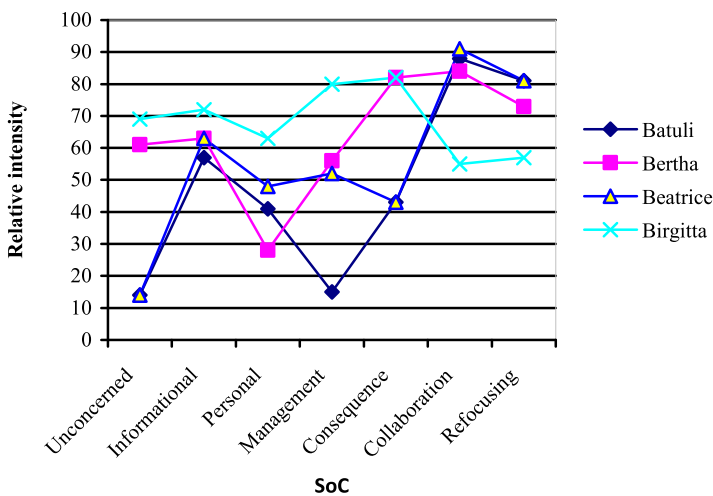


Figure 2. The MPS SoC Profile.

this is because we did not have the opportunity to interview her as she was unexpectedly transferred to a distant Secondary School.

We performed a word-frequency check of the interview data. It revealed repeated use of the terms ‘we agreed’ and ‘discussion’ in the participants’ accounts. These were our preliminary indicators that science teachers in the MPS tended to digest their concerns about this change collegially. From further analysis, we learned that the science teachers in this MPS had semi-regular discussions in their offices to reflect on their curriculum adoption progress. In one of their previous discussions, Bertha specified, ‘*We agreed to provide our students with more hands-on-experience opportunities*’. The participant science teachers acknowledged the help they accessed from their colleagues, and especially from Beatrice, who had been trained to deal with this innovation. ‘*The preparation of Lessons reflecting this pedagogy*’, Batuli stated, ‘*challenged most of us*’. ‘*But given that Beatrice attended in-service training on the implementation of this curriculum,*’ Bertha echoed in a separate interview, ‘*she helped us to solve this issue*’. Coupled with the fact that only same-subject teachers were allocated to the same office in this case-study school, it is possible that there were many opportunities for science teachers to push one-another to experiment with the inquiry pedagogies in this case-study school.

The Lower Performing School (LPS)

There were 60 teachers in this case-study school, and these were housed in only two large offices. Of the 60 teachers, 12 were of science subjects and their experience was somewhat limited, ranging from three to 10 years. All science classes contained more than 70 students. All science teachers were spread over the two offices, and the distance between these offices was considerable. This appeared to be a barrier to communication amongst the science faculty. In addition, none of the science teachers in this case-study school had attended intensive in-service training concerning this innovation.

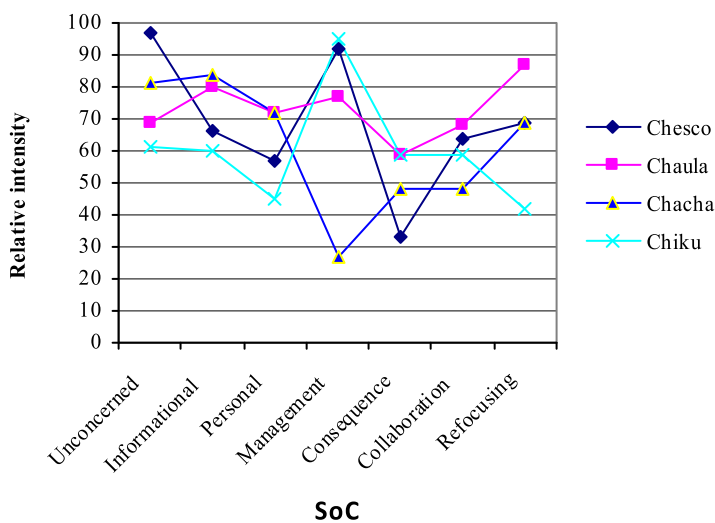


Figure 3. The LPS SoC Profile.

As depicted in [Figure 3](#), the participant science teachers in this LPS exhibited more intense Personal and Management concerns than the lower intensity of the Impact-related concerns. This is not surprising considering their background information and could suggest that science teachers in the LPS still struggled to solve their early-level concerns regarding this curriculum. Further, Stage 6-Refocusing concern appeared relatively intense for three of the participant teachers with their profiles tailing up. Having ideas in this domain while also possessing high levels of concern at Stages 0–3 is a troubling observation as it indicates that these teachers probably thought that they could do ‘it’ better compared with what the new curriculum demanded them to do. In fact, it seems that the science teachers in this case-study school had already started abandoning the inquiry pedagogies, an interpretation supported by the study participants’ own interview statements. ‘*I have tried it several times [to use the inquiry instructional practices],*’ Chaula stated, ‘*but trust me, this [the implementation of the 2005-TIBC] is almost impossible in our setting*’. This statement suggested that most science teachers in this case-study school reverted to traditional ‘teacher-centred pedagogies’, which were apparently ‘easier’ in their circumstances.

Our further analysis of [Figure 3](#) revealed substantial variations in the SoC profiles exhibited by individual teachers. This variation might mean that there was a lack of cohesion and teamwork among the teachers in the LPS. Our assumption was evidenced to be likely true by the other data sources. For example, we were informed: ‘*when a teacher reports to this school, she/he just finds and uses a working space of his/her choice*’ (Chacha). Coupled with the fact that all teachers in this case-study school were spread over and worked from the separated two large offices, it could mean that the science teachers lacked suitable settings for them to discuss issues specific to themselves and their subjects. Perhaps more importantly, whenever they attempted to consult each other, they likely failed to do so, for it was like the ‘blind leading the blind’ as none of them had a sound idea of the 2005-TIBSC or any experience regarding the change process itself. The fact that professional profiles of teachers in schools such as this often vary greatly, we were not surprised by the apparent problems reflected in the SoC profiles regarding this innovation.

Discussion, conclusion, and recommendation

One of the issues identified in this study was that science teachers were not sure what inquiry instruction meant in any satisfactory way (Stage 1-Information concern). This concern appeared the second most intense in both the MPS and HPS and the uppermost in the LPS. Part of the reasons could be the approach used to bring about and disseminate this innovation for use. Pieters et al. (2019) are of the opinion that instructors’ level of awareness of educational innovation depends on the extent to which they participated in the process of bringing it about. As previously described, this curriculum was centrally developed and then distributed to schools for implementation using a cascade technique. Like reports in many previous studies (e.g. Kopweh, 2014; Mtitu, 2014; Nzima, 2016), our study revealed that most of the science teachers in the schools we investigated had not attended any in-service training. Rather, they relied on those few colleagues who had been lucky enough to experience some professional training regarding this innovation. This finding extends the reminder by Fullan (2007), Hall and Hord (2015) and by

Fitzgerald et al. (2019) in that the curriculum structure does by itself lead to teachers' understanding of its meaning.

Characteristically, inquiry instruction does not work in settings with limited resources, especially considering the powerful influence of the resource issue as a blocking factor in adopting the sophisticated pedagogies central to this curriculum (Fitzgerald et al., 2019; Mkimbili et al., 2017). Our study findings echo and complement such remarks. The Stage 3-Management concern was 'an issue' in all of the three case-study schools, albeit with minor variations. It appeared much lower in the HPS and the MPS compared with the LPS, suggesting that the science teachers in the LPS perceived many and intense hindrances caused by the resourcing issue compared with those in the HPS and MPS. Teachers experiencing very intense management concerns, according to Hall and Hord (2015), are likely to abandon the innovation in favour of what seemed to work well with them in the past. This tendency appeared to be the case in the LPS, as indicated by the study participants' SoC profiles and their interview statements. Therefore, curriculum developers in Tanzania and elsewhere should learn that if these sophisticated pedagogies are to be implemented successfully in schools, the resource issues need to be resolved. Even where policymakers invest in both communicating and consulting widely at the initiation stage on the need for change and the form it should take, identifying and improving important features of the school realities in which the innovation will be implemented is important. More importantly, Tanzanian curriculum developers should equip all science teachers with the capability to continue to deal with this complex innovation in their resource-poor contexts as the government struggles to address it.

The importance of collegial interactions in influencing teachers' attitudes towards educational reforms is perhaps a noteworthy finding. Similarities in the SoC profiles in the HPS and MPS suggest that the science teachers' capacities to deal with this innovation in these schools were equivalent. This was possibly due to two issues. First, the influence of peer interactions is indicated by Stage 5-Collaboration concerns and participants' statements regarding the presence of such practices. Second, support from resourceful colleagues was important in these schools, where some were trained to deal with this curriculum. This finding strengthens the fact that teachers need continuous opportunities to learn how to deal with such new and sophisticated educational changes (Fullan, 2007; Hall & Hord, 2015; Fitzgerald et al., 2019).

The issues identified in this research have implications for policy and practice. They are relevant for both curriculum designers and professional development practitioners. First, these findings remind Tanzanian curriculum designers and professional development practitioners regarding the influence of school realities (e.g. 'qualities' of the teachers in-housed in the schools, school culture, and school infrastructures) on the success of educational change efforts. The present study findings illustrate the ways in which one or a combination of these elements influences both the types and intensities of teachers' concerns in dealing with educational change. To guarantee the success of educational changes in Tanzania, designers must identify and address such 'technical' elements in all schools that implement the change.

The second contribution of this study is on the need for the professional development of teachers. While top-down methods for educational transformation and the conventional *cascade* style of disseminating them are difficult to avoid in underdeveloped countries (Pieters et al., 2019), our findings concur with Fitzgerald et al. (2019) and

Nzima (2016) in that such approaches are ineffective. The need for more information about this 17-year-old curriculum initiative indicated by teachers in all three case-study schools is only one of the many examples of the weakness of such approaches to educational change processes. Given this fact, there is a need for curriculum designers in Tanzania to organise in-service professional training opportunities for science teachers to learn broadly how to deal with this change. Learning afforded through job-embedded collegial interactions (collaborations) in some of the examined schools exemplifies some of the benefits accrued from such professional training schemes.

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