The Social Sciences 13 (6): 1133-1141, 2018
ISSN: 1818-5800

Dialogic Communication: Reviving Mathematics and Science Pedagogy for the 21st Century

Sindiso Zhou and Nhlanhla Landa
University of Fort Hare, Alice, South Africa

Abstract: Mathematics and science are frequently perceived as complex and mentally demanding subjects by both teachers and learners. The prevailing perceptions of difficulty in conceptualizing scientific knowledge arise from the fundamental problematics of the role of communication skills in Mathematics and Science pedagogy. It is not enough for students to cram the periodic table and to master quadratic equations. Complex processes and abstract formulae require expression in simple, functional and concrete terms. For successful learning to take place, the teacher must be a skilled communicator who can select and unpack complex topics in order to facilitate shared understanding. This study proposes that functional communication skills in the learning of Mathematics and Science should involve exploitation of the dialogic approach to instruction as opposed to monologic methodologies. Given the background that knowledge without context is useless, this study argues that dialogic communication is an imperative instrument in the quest to contextualize knowledge. Furthermore, this study proposes a model that draws on Bakhtin's conception of successful interaction as rooted in dialogue to account for dialogic interaction in classroom discourse. The study seeks to demonstrate that integration of dialogue and mediation in the stimulation of higher cognitive functions could result in the achievement of positive outcomes in the learning of Mathematics and science. Dialogic instruction as an emerging pedagogy makes scientific knowledge accessible to students and relevant to society for human development in the 21st century.

Key words: Dialogic communication, Mathematics, science, pedagogy, dialogue, interaction

INTRODUCTION

Africa is home to more than 840 million people. As a continent, Africa is lagging behind in reaching the world's most critical Millennium Development Goal that aims to halve world poverty by 2015. One of the issues militating against Africa's battle with poverty is a poorly developed science and technology base. A poor science and technology foundation points to weak educational attainment in Mathematics and science subjects leading to fewer candidates pursuing science and technology careers. Such a negative situation makes it difficult for the affected economies to build innovation capacity and to contribute to the manufacturing industry and the global-knowledge-based economy. The understaffing predicament in the science and technology sector presents itself in the manner of a vicious cycle in which the most practical approach is to deal with one of the points that represent the weakest link which is the Mathematics and science classroom where engineers, technicians, pharmacists, molecular biologists, chemical engineers, physicists, medical and academic doctors are made. Mathematics and science methodologies have a critical role to play in motivating learners and ensuring high levels of attainment thus, the need to pursue science and technology careers. For the teacher to capture the interest of 21st century learners there is need to appeal to learner's dynamic, experimental and interactive nature that they have inevitably developed as a result of being continuously immersed in the unconventional lightning speed lifestyle of the globalised world of information and communication technologies (Abbey, 2010). Dialogic communication is analyzed in this study as an emerging methodology that suits the 21st century environment and student (Alexander, 2005a, b, 2008a, b). In this study, Mathematics refers to subjects that include arithmetic, algebra, geometry, calculus and statistics. Science subjects include Biology, Chemistry, Physics, General as well as Integrated Science.

Background: The prevailing situation in Mathematics and Science Pedagogy in Zimbabwe and elsewhere in developing nations in the world is that there are common preconceptions about the complexity and unpopularity of Mathematics and Sciences such as Physics and Chemistry. Furthermore, Mathematics and Science

Corresponding Author: Sindiso Zhou, University of Fort Hare, Alice, South Africa

instruction is mostly teacher-centered and authoritarian. This is because as fields of inquiry, Mathematics and Sciences have been exaggeratingly labeled as immensely complicated subjects that demand strict attention and critical thinking from both the learner and the teacher. This state of affairs is however not unique to Mathematics and Science pedagogy but is a shared predicament in the context of academic knowledge in general. Bias of complexity is a notion that has gained popularity over the years since traditionally, humanities and arts were the preferred subjects to sciences due to their affordability. Due to the costs involved such as textbooks, setting up, equipping and maintaining laboratories, schools generally favor arts, commercials and humanities unless there is specific targeted funding that can take the science project off the ground and keep it afloat. Shortage of mathematics and science teachers has indirectly turned these subjects into holy and special areas that deserve serious treatment and solemn instruction.

Ordinary level results statistics in Zimbabwe for the years 2003-2014 indicate a consistent failure rate in especially Mathematics. The Ministry of Primary and Secondary Education recorded the Mathematics pass rate at 21% in the year 2014. Research done by Dzinotyiwei illustrates that 80% of students fail 'O' level Science due to a critical shortage of science learning materials. Blaming either the teacher or the lack of requisite environment and resource materials for the low pass rate is the common conclusion of most researchers. While we appreciate the brain drain that resulted in untrained and trained non-science teachers teaching science and mathematics in Zimbabwe particularly at the climax of Zimbabwe's economic and political meltdown there is need to refuse to be convinced and satisfied by simple conclusions that only provide the easy way out. The current research goes a step further and critically appraises the methods used in the Mathematics and Science classrooms with specific reference to 'O' Level Mathematics and Science teaching and learning in Zimbabwe. This study proposes the use of dialogic teaching methodologies that are collaborative, cooperative and interactive (Koschmann, 1999) as opposed to existing strategies that are largely teacher centered with minimum participation of the learners themselves in their own learning.

Study area: The current research critically appraised the methods used in the Mathematics and Science classrooms with specific reference to 'O' Level Mathematics and Science teaching and learning at two high schools in Mashonaland Central Province in Zimbabwe.

Research problem: The prevailing situation in Zimbabwe at the time of the research in question is that the mathematics and science pass rate at 'O' Level is very poor. The current problem in the teaching of Mathematics and Science subjects emanates from the isolation of the learner from the content. Mathematics is problematized as a mental subject and Sciences are sophisticatedly labelled as process and experiment subjects where there is more of solving problems as opposed to talking at length and engaging in dialectic about how to solve problems and how existing solutions were arrived at. If present at all, communication is kept at a minimum. Classroom activities involve teacher exposition working out problems and more teacher instructions. Learners with mathematical and scientific savvy are the dominant participants in class activities while the slow to clueless learners are perpetually perplexed, quiet and submissive during class. The teacher's communication skills are limited to stating theorems and experiment procedures in skeletal and sketchy conversation. The under-utilisation of communication in its most basic sense in the Maths and Science classroom translates to the failure to harness the potent power of dialogic interaction in explaining abstract concepts and opening up learner's minds.

Literature review: Dialogic communication is still an emerging research area. It draws on the research of Russian philosopher and semiotician (Bakhtin, 1981). It highlights the interactive co-produced character of communication that can be enhanced or hindered through institutional and technical means. Dialogic teaching methodologies are those teaching practices that employ the Bakhtinian version of dialogue (Wells, 1999; Koshmann, 1999; Alexander, 2005). The Bakhtinian version of dialogue explicitly seeks to make attention and engagement mandatory and to chain interaction into meaningful sequences (Alexander, 2005a, b, 2008a, b). In concise terms dialogic communication insists on interpersonal involvement in the construction, negotiation of meanings and solving of problems through dialogue and collaboration.

Dialogic communication can be exploited by way of teacher-learner and learner-learner interaction in the classroom. Small Group Interaction (SGI), dialogic communication circles and collaboration circles are some of the strategies that researchers have developed from dialogic theory. Haworth (1999) undertook a direct and focused study on the potential of Small Group Interaction (SGI) to provide significant learning opportunities which Whole Class Interaction (WCI) is less well placed to deliver. In her research, Howarth pointedly argues that whole class interaction is the dominant genre in the classroom (1999). The role of dialogic talk in the classroom has its roots on socio-cultural principles of learning (Vygotsky, 1978). Pedagogic dialogue is a conventional classroom discourse that is teacher controlled in which the teacher owns the truth and corrects error. On the other hand, Dialogic Pedagogy is a participatory methodology in which dialogue is important and the teacher manages the interaction and encourages learners to voice their own evaluative judgments.

According by Alexander (2008) theoretical interpretations of the curriculum are the drivers of traditional instructional sequences in which the teacher is the centre of attraction while the learner is relegated to the periphery where they are less involved in the learning process. Mathematics and Science instruction provide a practical source of interaction that, if fully exploited can provide potential input which could lead to positive learning outcomes. In traditional Science and Mathematics pedagogy, the learner views the teacher as the ultimate source of knowledge, a situation that reflects a position of power rather than collaboration. As a result, the teacher stands out as an authority in the field. It therefore, seems to be a fundamental milestone for research to examine if dialogic pedagogy at Zimbabwe Ordinary level is the missing link between Mathematics and Science instruction and positive learning outcomes/high levels of attainment.

In relation to the current research, Haworth (1999) describes dialogic teaching methodologies as methods whose essence is egalitarian dialogue in which learner and teacher collaborate and research with mutual goals in mind. Howarth's submission above is in line with Alexander (2005) who alludes to collectivity and reciprocity in interaction in his description of dialogic teaching and learning. Both scholars seem to emphasize the notion of collaboration and interaction with the other as central in facilitating the spirit to learn and the achievement of understanding and competences. The intricate linkage that exists between (Haworth, 1999)'s investigation and this current study is the focus laid on the power of dialogic communication and its exploitation in the classroom. In Dialogic discourse one might therefore expect interaction to be multi-voiced, versatile and playful. In exploring the merits of dialogic communication in Mathematics and Science pedagogy, this study is significant in that it will determine the efficacy of existing teaching practices and further establish the effectiveness and functionality of dialogic communication in the Mathematics and Science classroom. Furthermore, findings from this research will help teachers apply dialogic learning strategies in the classroom. Teachers will also be able to extend learning theory beyond a single application and coherently explain and design their teaching strategies in accordance with how students learn best both for real life situations and for examination purposes.

It seems that if teachers want learners to develop the competence that they need to use Mathematical and scientific knowledge easily and effectively in the kinds of situations they meet outside the classroom, they need to experience how the same are used as a tool for communicating Mathematical and scientific concepts inside the classroom. Indicators of meaningful learning in Mathematics and Science include competent task performance and this can only result from implementation of effective learning strategies on motivated learners (Ruthven, 2011). Motivating learners would then be mirrored by the teacher's choice of teaching strategy. Learning tasks have to be cognizant of the fact that learning is a socially grounded phenomenon (Koshmann, 1999). Drawing from the Russian philologist (Bakhtin, 1981), the dialogic nature of all texts presents the instructor with innovative possibilities of learning.

The teacher as a skilled dialogic communicator: The Mathematics and Science teachers have an important role to play in the classroom. Mathematical and scientific concepts are generally perceived as complex thereby creating a high-challenge atmosphere. Such an atmosphere calls for high support dialogue from the teacher (Gerard, 1998). A skilled communicator is able to select key pieces of a complex idea to express in words, sounds and images in order to build shared understanding. Teachers who are skilled communicators negotiate positive outcomes with learners through social perceptiveness, persuasion, negotiation, instructing and service orientation.

When a teacher gives students an opportunity to participate in their own learning through active and extended communication with their peers, a sense of novelistic indeterminacy is created within the learner. Self esteem is raised and a multiplicity of possibilities come into existence. The open-endedness inherent in small group interaction gives the student a new authority in the classroom and ultimately in the teaching/learning process itself.

Modern teaching practice is characterized by the pitiless divorce which the education establishment maintains between the provider of instruction (teachers) and the receiver of instruction (learners) due to underutilisation of communication. Traditional maths and science pedagogy is more often a monologue. The tendency and perceived responsibility of the instructor is to deliver content monologically with a voice of authority. This reduces learning to didacticism or a form of official knowledge transfer (McKnight, 2004).

Instructors must begin to think of classroom interaction as a multi-layered phenomenon where many types of interaction for instance learner-content, learner-learner, learner-instructor, happen simultaneously and interconnectedly. If we are to move meaningfully beyond our traditional concepts of interaction, we must also pay more attention to the contextual and discursive factors that mediate the learning and interpretive process

The place of communication in the Mathematics and Science classroom: Communication in its verbal and non verbal forms is a key competence that science-related subjects have to contribute to education. Subject-specific language use and communication do not form a goal in themselves rather they are closely linked to what is being communicated namely the content or subject matter and how a specific concept or insight has been processed and obtained and the cognitive activities involved. Interaction describes collaboration and communication between or joint activity involving two or more people. Classroom dialogue explicitly seeks to make attention and engagement mandatory and to chain exchanges into meaningful sequence (Alexander, 2005a, b, 2008a, b).

Understanding the language dimension in science education is only beginning to develop. Subject-specific communication should be identified explicitly and defined as a competence area of its own. Communication in the Mathematics and Science classroom should be structured to achieve a number of purposes such as overcoming deficiencies and gaps in the technical subject matter. Since, Science learning is context dependent, the teacher has to exploit language, visual or other semiotic forms of representation during delivery of lessons.

On a more empirical level: In Biology the language mediated construction of biological knowledge and the interactive exchange about this knowledge are seen as two relevant components. Communication in the Mathematics and Science classrooms may be understood as a tool for developing and constructing conceptual knowledge. It is also seen as a tool for carrying out cognitive operations as learning activities and as a means of expressing the results by interacting about them with others. Additionally, it is emphasised that science education has to be adequately contextualised, so that, it can be related to the experience and life of the students. This will help learners to apply their new knowledge at home in the community as well as in future careers and prepare them as future citizens who can participate fully and effectively in industry and commerce.

The Zimbabwe Mathematics and Science curriculum, like the first National Curriculum for England, introduced in 1989 is highly prescriptive and bureaucratic with a strong emphasis on competency and testing. Through communication with learners in motivating activities, teachers are expected to demystify scientific phenomena. Although Secondary level Mathematics and Science is taught by specialist teachers who have a degree in science and some science specific teacher training, Lewis argues that even trained teachers need guidance and support owing to the evolution of methodologies and the changes in the client demands as a result of globalisation in the 21st century. When exploited maximally, communication in the classroom has the ability to appeal to multiple intelligences thus meeting individual needs through a range of teaching strategies. Effective communication skills in Mathematics and Science should enable learners to:

- Recall analyse, interpret, apply and question scientific information or ideas
- Use both qualitative and quantitative approaches
- present information, develop an argument and draw conclusions, using scientific, technical and mathematical language, conventions and symbols and ICT tools

Learners from a low socio-economic background generally have a compromised self-esteem that impacts negatively on learning. They therefore need to feel wanted, respected and important through participating in subjects that are deemed challenging. This idea of giving learners voice and allowing them space to explore each other's minds, proving that the teacher is not the sole owner of power in the learning process in important for learners to achieve success.

The dialogic and cognitive pedagogy model: The researchers came up with a model that could be used as a framework in assessing communication and interaction in the classroom. The essence of the Dialogic and Cognitive Pedagogy Model (DCPM) is its insistence on seeking the decentralisation of power from the teacher to the learner so that the classroom assumes the natural, social day to day environment thus enhancing classroom affect.

The DCPM framework marries (Alexander, 2005)'s conception of dialogic talk in the classroom as developed from (Bakhtin, 1981)'s categories of dialogic interaction and (Vygotsky, 1962, 1978)'s concepts of mediation and internalisation in his socio-cultural theory which are closely woven within Bloom's Taxonomy of Learning Domains in 1956 that identifies six levels within the cognitive domain (Fig. 1).

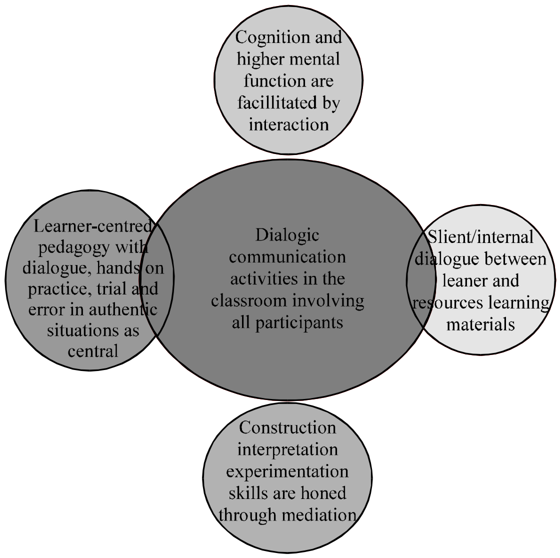

Fig. 1: Constituents and Processes in the Dialogic and Cognitive Pedagogy Model (Created by researchers drawing from the ideas by Vygotsky (1978), Bakhtin (1981) and Alexander (2005) on learning and social interaction)

Bloom's taxonomy levels: The concept of the teacher having effective communication skills is directly linked to the delivery of learning material. Consequently, a teacher who communicates well is better placed to create an interactive environment in the classroom. It is this interactive environment that allows learners to stretch their thinking capacity to accommodate and practice all the levels in the cognitive domain as propounded by Bloom. In 1956, Bloom led a consortium of educational psychologists who developed a classification of levels of intellectual behaviour that are crucial in learning. Bloom found that over 95% of the test questions that students encounter require them to think only at the lowest level where they are merely required to recall information. Bloom identified six levels within the cognitive domain. The first is the simple recall or recognition of facts through increasingly more complex and abstract mental levels to the highest level which is evaluation. This research finds Bloom's taxonomy significantly relevant in that the higher levels of thinking that are required in solving complex mathematical theorems can only be employed where there is extended communication and collaboration between teacher and learner, learner and other learners as well as learner and resource material as proposed in dialogic communication activities.

The six levels of intellectual behaviour can be diagrammatically represented in an up-shooting arrow pointing upward towards the achievement of excellence as illustrated (Fig. 2).

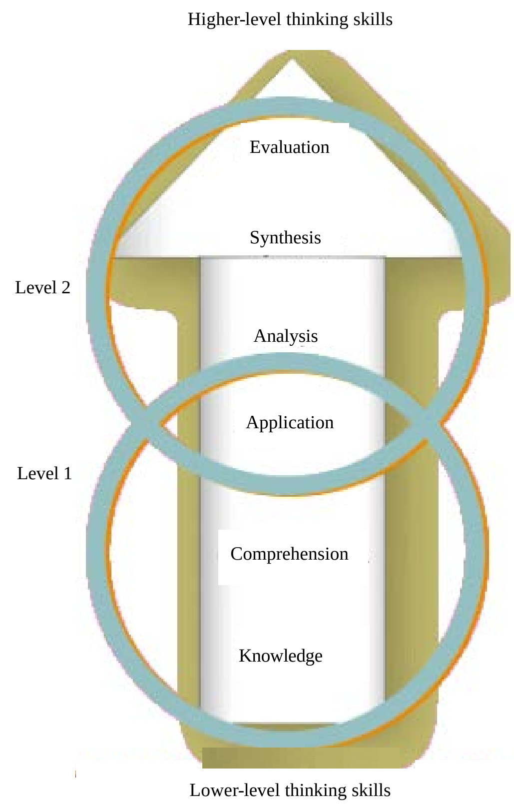

Fig. 2: Bloom's taxonomy of educational objectives

Table 1: Intellectual levels of behaviour (adapted from taxonomy of educational objectives

Cognitive	Affective	Psychomotor
Knowledge	Attitude	Skills
Recall data	Receive	Imitation
Understand	Respond	Manipulation
Apply	Value	Develop precision
Analyse	Organise personal value system	Articulation
Synthesize	Internalize value system	Naturalization
Evaluate	Weigh alternatives	Appraisal

Table 1 is a tabulated summary of the activities involved at each of Bloom's intellectual levels of behaviour illustrated in the diagrammatic representation (Table 1).

MATERIALS AND METHODS

The research adopted a bounded case study design. Using the purposive sampling method, the researchers approached 'O' Level Mathematics, Chemistry and Physics teachers at two high schools in Mashonaland Central Province in Zimbabwe. The total sample included 8 and 4 teachers per school. The researchers requested to see the teacher's scheme-plans. The researchers intended to note the method of lesson delivery and the nature of activities that the teachers and the learners engaged in as documented in the scheme plans. After noting that pupil-pupil and teacher-pupil activities were limited to short question and answer sessions as well as odd group-work discussions, the researchers proposed the dialogic communication approach as an alternative methodology. The researchers encouraged the teachers to try this approach after sufficient explanation on how it research. Handouts on steps involved in the dialogic communication circle and collaboration circle which are some key activities in dialogic teaching and learning were given out. Teachers were given the freedom to drop the dialogic model should they find it not user-friendly, useless or difficult. The preparatory talk emphasized that functional communication skills in Mathematics and Science pedagogy should involve exploitation of the dialogic approach to instruction as opposed to monologic methodologies that are teacher-centred and that did not accommodate Bloom's levels of cognition. It was envisaged that the responses the interview questions would indicate whether teachers and learners perceived dialogic teaching and learning as beneficial and more importantly whether the teaching approach motivated the learner and helped in fostering a sense of progression leading to high attainment levels.

Data collection instruments: The researchers observed two Mathematics lessons on circle theorems and transformations. Two Biology lessons on Transport across the plasma membrane and enzymes were also observed. One Chemistry lesson on Atomic and Molecular Structure was observed. One Physics lesson on velocity was also observed. The researchers interviewed 8 teachers after the participatory observation sessions. A total of 40 learners were asked to complete short questionnaires on their perceptions of dialogic lessons.

Collaboration circles: Collaboration circles provided the opportunity for learners to share their knowledge about mathematical and scientific issues before the teacher leads further into more complex mathematical formulae and scientific phenomena. A teacher needs to be fundamentally competent in communicating subject specific content through planning engaging activities such as dialogic and collaboration circles. Planned collaboration circles can lead to high degrees of critical thinking and of communicative exchange about complex problem solving, synthesis and evaluations. Communicative abilities are key to bridging the gap between seemingly complex scientific ideas and a student's existing ideas of the world around them. Dialogic and collaboration circles allow learners to talk the science into existence (Lewis, 2007). The Figure illustrates the structure of collaboration circles as used to solve problems of a mathematical and scientific nature in the classroom.

Dialogic communication circles: The idea of dialogue in the science classroom imitates a home or community environment that learners are more comfortable in. As a result, learners feel freer, less threatened and enthusiastic to learn in a friendly dialogic and collaborative atmosphere. Figure 3 illustrates an example of a dialogic communication circle.

Learning of mathematical and scientific concepts is a dynamic activity not without complexity. It seems succinct that the substantive nature of learning lies in the manner in which learning is negotiated and how communication is constructed. This seems to be in tandem with the view that explicit knowledge can be verbalised after working out the regularities of ideas and then figuring out concepts and rules which characterise these regularities. If the instruction is confused and the rules are complex, the student may not benefit anything. Even without authoritarian, explicit and teacher-driven instruction a learner might attempt to extract rules to categorise or characterise and make sense of a set of input data. This is where adapting the dialogic circles in the Mathematics and Science classroom comes in as a functional tool where the learner is allowed to interact with the content alone beforehand and then get into a dialogic circle where there is extended discussion and practice of the material with teacher and peers (Fig. 4).

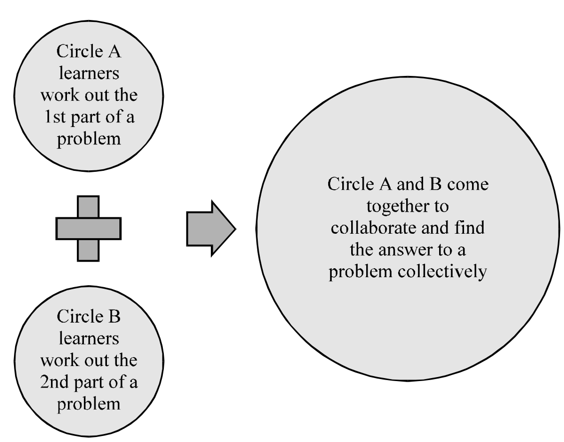

Fig. 3: Example of collaboration circle

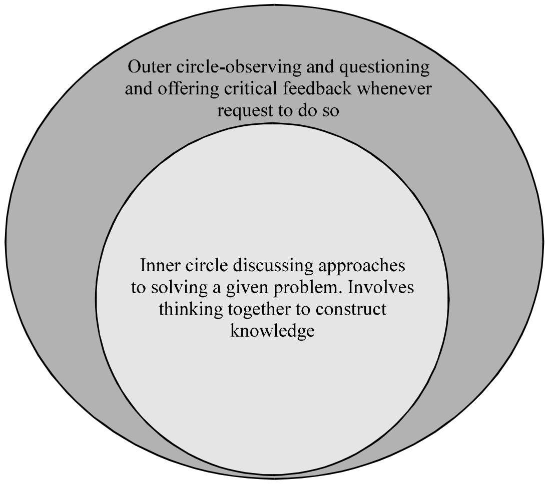

Fig. 4: Dialogic communication circles

RESULTS AND DISCUSSION

Dialogic instruction and positive learning outcomes The findings that evolved from participatory observations, interviews and questionnaires provided a number of important perspectives. It emerged from the data analysis that it is indeed possible to achieve positive learning outcomes from using the dialogic approach in the Mathematics and Science classroom. Classroom lesson observations, interviews and questionnaires indicated a common strand that illustrates that mathematics and science classes are challenging, hence, they need high support for learners from the teacher. Designing lessons inclusive of techniques that centre on dialogue and extended sessions of interaction was proved to research positively for learners in several progressive ways.

Learners indicated better understanding of concepts when given an opportunity to engage in collaboration through dialogic communication and collaboration circles. Even known timid and slow learners were reported to open up during the circles due to the non-threatening atmosphere of the circles. Learners reported feeling energetic, important, respected, bold and free in circles.

While working out equations or planning experiments, doing the preparations in a dialogic circle prior to getting into the laboratory gave learners confidence and armed them with the correct information. Asking questions is a continuous process in the circles as opposed to the once off at the end of the lesson, so, learners are not left behind, the lesson goes on with everyone on the same page. Teachers reported feeling less uptight about time pressure, syllabi completion and content complexity when using dialogic circles. They stated that they felt more compelled to 'help' learners as opposed to just popping into class, introducing a topic, exemplifying and assigning learners with written research. One teacher actually summarised his views by saying more interactive activities made teaching a 'joy' and not a 'duty'.

Dialogic communication circles and collaboration circles were credited with improving the learner's ability to research out Mathematics problems as well as speak the English language proficiently and fluently. Both learners and teachers agreed on the fact that communication created much energy, positive energy that was a prerequisite in solving complex problems. Confidence also soared and learners could participate freely as soon as they perceived their teacher's attitude to be relaxed judging from the tasks assigned to them. Learners reported feeling less afraid of their teacher while in a problem solving circle. As a result, even indifferent learners were aroused into participation, thereby showing that dialogic activities have the power to optimize the realization of individual potential in handling challenging situations.

The major problems raised by teachers with regards to extended communication activities was that they are time consuming and they are demanding when it comes to classroom management. Teachers also commented on the excitement that learners exhibit saying sometimes the excitement caused noise and disturbed the progress of the activities. However, it was clear that this was an issue of classroom management that needed to be dealt with firmly without spoiling the collaborative mood.

Dialogic approaches an emerging pedagogy for the 21st century: The emerging pedagogy of choice for the impartation of Mathematics and Scientific knowledge revolves around interactive and dialogic methodologies as demonstrated in this research. The globalised world that learners live in calls for the teacher to integrate as many interactive activities as possible during class. The power of teacher-pupil talk, small-group talk, pupil resource material talk in the classroom cannot be underestimated as long as the talk is structured and extended to suit the particular needs of the learners. Teachers can even have circles following video clips and other excerpts that take advantage of ICTs in order to keep learners motivated.

The exploitation of dialogic techniques in the Mathematics and Science classroom goes a long and sure way in exciting and maintaining the requisite zeal to learn in a diversity of ways. The freedom of expression and movement does not only emancipate the learner from the rigidity of controlled learning but it benefits both teacher and learner by drawing the learner closer to the teacher thus closing the traditional gap whose barriers keep the two parties distant in a theoretical divide. Bridging this gap through dialogic instruction necessarily prepares the learner psychologically by making it possible to be receptive to the learning material. It also empowers the learner with social skills of interaction for instance, intrapersonal and interpersonal repertoire to engage in negotiation, construction, meta-cognition and communication of meanings.

CONCLUSION

That Mathematics and Science pedagogy in Zimbabwean classrooms is marred by various resource challenges is undeniable but there seems to be uncomfortable allegiance to conventional systems of instruction and minimum exploitation of modernistic and contemporary versions of instruction that have a potential to record positive yields for the learner. While, the former observation is a fact that cannot be reversed overnight given its budgetary implications on the country's overstretched budget, the latter observation remains a consequence of a mindset whose overhaul lies squarely in the hands of the Mathematics and Science teachers as well as school administrators. It may therefore be difficult but not impossible to transform the Mathematics and Science classroom from a place of ritual teacher-centred instruction to a place of dialogic learner-centred instruction that records positive learning outcomes for the learner who is the most critical player and priority in the classroom. As the physicist Garret Lisi observed our reality is continuously branching into countless possibilities, therefore the teacher has the prerogative to transform the classroom into a vibrant dialogic forum where learning is a collaborative.

RECOMMENDATIONS

The researchers make the following recommendations: Mathematics and Science teachers should be trained and workshopped on recent trends in interactive and dialogic instruction. Dialogic and other interactive approaches should be recognized as valid methodologies in curriculum design. In-service training and refresher courses on classroom management techniques that incorporate ICTs or are ICT centred should be planned, financed and implemented. A national strategy on prioritization of Mathematics and Science education should be launched. Allocation of resources to build, develop and equip science laboratories and school libraries should prioritise the schools located in low income suburbs where learners hardly own any Mathematics or Science reading material that they can interact with closely at their own pace as individuals outside the classroom to facilitate implicit learning.

The dominant perception of teachers and school administrators is that upon enrolment in the formal school system learners should aim to excel in the final examination thus leaving an excellent record for the school's reputation. The researchers are not in the least undermining such a goal oriented approach but seek to balance administrator's expectations with learner's needs. The learner is not in school solely for preparation for the final course examination. It is the teacher's role to begin to concentrate on preparing the learner for real life integration in the community and real life research in the corporate world. Dialogic learning serves both the learner's needs and the school's needs as it motivates the learners to develop the necessary enthusiasm and positive energy to learn Mathematics and Sciences while attaining high marks.

REFERENCES

Abbey, N., 2010. Developing 21st Century Teaching and Learning: Dialogic Literacy. New Horizons for Learning (NHFL), Johns Hopkins University, Baltimore, Maryland,.

Alexander, R.J., 2005a. Teaching through dialogue: The first year. Barking and Dagenham London Borough Council, London, England, UK.

Alexander, R.J., 2005b. Culture, dialogue and learning: Notes on an emerging pedagogy. Proceedings of the 10th International Conference on Education, Culture and Cognition: Intervening for Growth, July 10-14, 2005, International Association for Cognitive Education and Psychology (IACEP), Durham University, Durham, England, UK., pp: 1-21.

Alexander, R.J., 2008a. Essays on Pedagogy. Routledge, Abingdon, England, UK., ISBN-13:978-0-415-45482-7, Pages: 212.

Alexander, R.J., 2008b. Towards Dialogic Teaching: Rethinking Classroom Talk. 4th Edn., Dorchester Publishing, New York, USA., ISBN:9780954694364, Pages: 60.

Bakhtin, M., 1981. The Dialogic Imagination. In: Austin, TX, Holquist, M. (Ed.). University of Texas Press, ISBN 978-0-292-71742-8.

Gerard, G., 1998. Dialogue: Rediscover the Transforming Power of Conversation. John Wiley & Sons, Hoboken, New Jersey, USA., ISBN:9780471174660, Pages: 366.

Haworth, A., 1999. Bakhtin in the classroom: What constitutes a dialogic text? Some lessons from small group interaction. Lang. Educ., 13: 99-117.

Koschmann, T., 1999. Toward a dialogic theory of learning: Bakhtin's contribution to understanding learning in settings of collaboration. Proceedings of the 1999 Conference on Computer Support for Collaborative Learning, December 12-15, 1999, International Society of the Learning Sciences, Palo Alto, California, USA., pp: 308-313.

McKnight, D., 2004. Task of the teaching life: Self through Bakhtinian dialogue and ideological engagement. Interchange, 35: 281-302.

Ruthven, K., 2011. Using international study series and meta-analytic research syntheses to scope pedagogical development aimed at improving student attitude and achievement in school mathematics and science. Intl. J. Sci. Math. Educ., 9: 419-458.

Vygotsky, L.S., 1962. Thought and Language. 12th Edn., MIT Press, Cambridge, Massachusetts, USA., Pages: 168.

Vygotsky, L.S., 1978. Mind in Society. Harvard University Press, Cambridge, MA., UK.

Wells, G., 1999. Dialogic Inquiry: Towards a Socio-Cultural Practice and Theory of Education. Cambridge University Press, Cambridge, England, UK., Pages: 371.