Implementation of dialogic approach of teaching Science in Ghanaian Grade 7 Science classroom

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ABSTRACT

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The aim of this study was to implement dialogic approach of teaching science in Ghanaian classrooms and how students response to this approach. Despite the moves to change curricula to be more student-centered, the approach of teaching science in Ghana remains authoritative and monologic. To achieve the aim of this research, this thesis carried out action research in grade 7 classrooms in Opoku Ware Junior High School, Ghana. During the action research, lessons were video recorded and students were randomly selected and interviewed. This study analysed the interview data using qualitative content analysis to answer the research questions. The responses from the students indicated that the dialogic approach of teaching science supported their understanding of the lessons and encouraged students' active participation in the lessons.

Major challenge confronted during the implementation of the dialogic approach of teaching science in the Ghanaian classroom was large class sizes. Though the introduction of the group activities helped the students to participate in the lesson, it would have been more effective if the class sizes were smaller.

Keywords: Dialogic Teaching, Action Research, Ghana, Communicative Approach

LIST OF ABBREVIATIONS

Abbreviation	Explanation
GDP	Gross Domestic Product
FCUBE	Free Compulsory Universal Basic Education
BECE	Basic Education Certificate Examination
WAEC	West African Examination Council
WASSCE	West African Secondary School Certificate Examination
BDT	Basic Design and Technology
ICT	Information and Communication Technology
ESP	Education Strategic Plan
TVET	Technical and Vocational education and Training
GER	Gross Enrolment Ratio
NER	Net Enrolment Ratio
SHS	Senior High School
JHS	Junior High School
PTR	Pupil Teacher Ratio
CA	Communication Approach
IRF	Initiation, Response and Feedback
IRE	Initiation, Response and Evaluation
IRFRF	Initiation, Response, Feedback, Response and Feedback
RDD	Research-Development-Dissemination

Contents

1.0   INTRODUCTION

The general aim of this study was to find out how students in Ghana perceive the introduction and implementation of dialogic approach of teaching science in the classroom. In addition, the study found out how the dialogic approach of teaching science supported students understanding of the lessons. This research was conducted using a socio-cultural framework, which emphasize communication as a means to develop students understanding of content taught in the classroom. Though Ghana is considered as a country of multilingual society, English language is regarded as the official language of the country. As pointed out by Ouadraogo, (2000) "Education and language issues are very complex in Africa because of the Multi-ethnic, multi-lingual situation". The situation is more challenging when the selected official language of the nation is different from the indigenous languages. English language is selected as the official language used as the medium of instruction in all schools in Ghana. Vygotsky (1978) emphasized the importance of language use and social interaction within communities for the development of educated ways of making sense of the world, such as those associated with science. Linking the view of Vygotsky to the situation of Ghana, it could be suggested that students face challenges in their academic life since the L1 is commonly used in the communities while English is used as the medium of instruction in schools. Sociocultural researchers have claimed that students are able to reason and make meaning of what is being taught and learned in their local language compared to a second language (in this case English language). Both teachers and the students are not native speakers of the language used as the medium of instructions. Language plays important role in learning. Language and content are linked by the fact that all contents are taught through language. There is a consensus in education that classroom talk during lessons is the chief locus of knowledge construction (Mercer, 2002). Language is used to create thought and in the same way, it is used to transform thought thereby making language a source of learning.

Science can be a challenging subject to learn and of course, to teach. From my experience as a science teacher in Ghana in both the Junior High School and the Senior High School, it was clearly seen that students had challenges in understanding certain scientific principles and concept and had no option than to resort to rote learning. Unfortunately, students who are unable to memorize concept in science are however, seen as academically weak.

Mercer and Littleton, (2007) through their research have confirmed that children learn more effectively and attain higher intellectual achievements, when they are actively involve themselves in pedagogic activity, discussions, dialogue and argumentation. The insight of this influenced and inspired me to carry out a research in the Ghanaian context in the introduction and implementation of dialogic approach of teaching and learning of science. The implementation was based on the concepts of communication approaches (Mortimer and Scott, 2003) and dialogic teaching approaches introduced by Alexander (2006). This action research was conducted in Grade 7 classrooms at Opoku Ware Basic School in Kumasi, Ghana. There were three classes (A, B and C) for grade 7 and each class had 75, 76 and 78 students respectively.

The first section of this research gives detailed description of the background for the study, description of the country and the educational system. The second section talks about the theoretical framework and literature review while section three outlines the research problems. The fourth section gives a brief description of action research and the methodology applied in this study, followed by section 5, which explains the data analysis. The results of the study is in section 6, discussion of the results in section 7 and the conclusion in section 8.

2.0   Background

2.1.   Ghana and Kumasi

The republic of Ghana is located along the Gulf of Guinea and Atlantic Ocean in the sub region of West Africa. The country covers a landmass of 238,535 km2. Ghana shares border with three French-speaking countries: Ivory Coast in the West, Togo in the East, Burkina Faso in the North and the Gulf of Guinea and Atlantic Ocean in the south. Ghana is a multicultural country and has a population of 28.30 million people in 2016 (Ghana Statistical Service, 2016). Ghana is a democratic country and one of the fastest growing economies in Africa. The real Gross Domestic Product (GDP) for the third quarter of 2017 grew by 9.3% (year-on-year) compared to 4.6% recorded for the third quarter of 2016 (Ghana statistical service, 2017).There are ten regions in Ghana which constitute the first level of subnational government administration and they are further divided into local districts for administrative purposes. English is the official language for

the central government and business affairs. It is also the standard language used as a medium of educational institution.

Figure 1. Map of Ghana with neighbouring countries (2018). Reprinted from Google. Retrieved on 5th April, 2018, from https://www.ezilon.com/maps/africa/ghana-physical-maps.html

Kumasi is the capital city of the Ashanti region of Ghana which is the most populous region of the country with a population of 5.4 million (Ghana statistical Service, 2016). Kumasi is popularly referred to as the "Garden city" due to the beautiful species of plants and flowers. It is also the cultural capital of the Ashanti kingdom. The city attracts a lot of tourist because of the rich cultural reserves and many other tourist sites including the Lake Bosomtwe. The people of the Ashanti

region speak the Akan language, which is one of the most popular native languages spoken across the country. Kumasi is among the largest metropolitan areas in Ghana and considered as a business city. This has attracted many people from the rural areas and other cities/towns to settle in Kumasi and thereby making it a multicultural city.

2.2.   The education system in Ghana

Before the arrival of the European settlers in Ghana, education was mainly informal and based on apprenticeship. The European settlers built a formal education system in Ghana and when Ghana became independent in 1957 it had one of the most developed educational systems in the sub-Saharan Africa. However, the delivery of education did no stretch to cover all the children in the country. Educational reforms were made to expand and extend education to reach out to every growing child in the country. The reform targeted basic education and therefore made it compulsory when the country institutionalize the "Free Compulsory Universal Basic Education (FCUBE)" in 1995 to promise universal education by 2005 (Acheampong, 2009). This reform has since been sustained and currently, basic education is free in Ghana for children from ages 6-15. The educational system in Ghana is divided in three parts: basic education (primary 1-6 with children of ages 6-11 and 3 years of Junior High School for children of ages 12-15). In other to complete basic education, students are required to write a final examination (Basic Education Certificate Examination (BECE) Organised by the West African Examination Council (WAEC). After passing this examination, students can therefore continue to the Senior High School or Vocational education for three (3) years. The Senior High School also ends on the West African Secondary School Certificate Examination (WASSCE) organised by the West African Examination Council (WAEC) and other certificates and diplomas for the vocational and technical educational. These certificates are required to enter the tertiary level. A bachelor's degree takes 4 years after which a Master's degree takes 1-2 years. The training colleges and the polytechnic education last 3 years.

The figure below provides an overview of the educational system in Ghana.
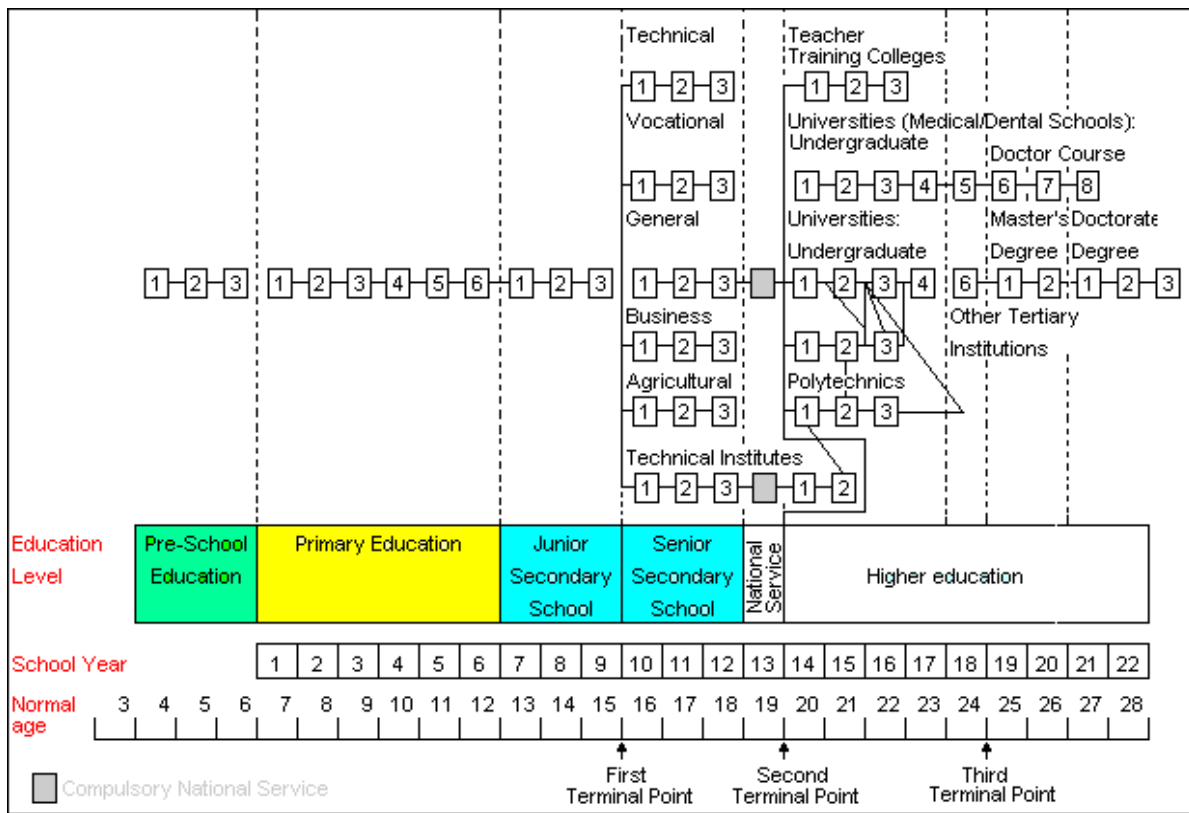
FIGURE 2: Education system from pre-school to Higher education. Reprinted from International Bureau of Education, UNESCO. Retrieved on 5th April, 2018 from
http://www.ibe.unesco.org/fileadmin/user_upload/archive/Countries/WDE/2006/SUB-SAHARAN_AFRICA/Ghana/Ghana.htm

2.2.1   Role of English in the education system

Ghana is a multilingual society and has not less than 44 local languages and a number of cross border languages (Hall, 1983 as cited in Opoku-Amankwa, 2009 p. 122. After Ghana's independence in 1957, nine of these local languages were officially approved by the state for use in education and in the media: "Akan (in three varieties of Asante Twi, Akuapem Twi, and Fanti), Dagaare-Waala, Dagbani, Dangme, Ewe, Ga, Gonja, Kasem, and Nzema " (Opoku-Amankwa, 2009). The state strategically selected those languages because they have larger population and they are very well distributed in the country. However, these selected languages are not the

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medium of instruction in education. The language - in - education policy in Ghana until 2002 had it that the main Ghanaian languages provided for in the curricula of basic schools should be used in the lower primary schools (class 1-3) as the medium of instructions if possible, and in the upper classes English should be the main medium of instruction while the local languages should be taught as a subject. (Ministry of Education, 2002 cited in Opoku-Amankwa, 2009). This policy was not fully implement. However, the government in 2002 clearly stated that English language should be the main medium of instruction in all schools in Ghana (both public and private) and one of the selected local languages should be taught as a subject based on the curricular of the school. The government justified this decision on the fact that schools in the urban areas have students from different backgrounds, hence, classrooms are considered multilingual and thereby bring a lot of challenges to majority of the students who do not necessarily speak or understand the selected local language used as the medium of instruction. Another reason was that, students who are transferred to other areas should start learning new local languages before they can continue with their studies. The government also argues that English has become a global language and the early exposure of the children to the English language will help them to learn the language effectively and they will acquired the desired level of competence (Government of Ghana, 2002; Ministry of Education, 2002 as cited in Opoku-Amankwa, 2009).

2.2.2   Ghanaian classroom

For the purpose of this thesis, I will focus on classrooms in Kumasi, the capital city of the Ashanti region in Ghana. Generally, classrooms in Ghana are quite traditional. In both government and private schools, students sit on wooden benches. In the classrooms, these wooden benches are arranged in rows and columns and students therefore sit in this order (see figure 3). Classrooms do not have enough space due to the large class sizes. Students have to wear school uniforms to school and they often carry backups, which contains their textbooks, notebooks, mathematical sets, and other required materials for the day. There is a general curriculum set by the Ghana Education Service which all schools must follow. However, the head teacher and sometimes in collaboration with the teaching staff plan the timetable and the time allocated to each lesson ranges from 30-40 minutes.

Fig 3. Picture showing common clasroom setting in Ghana. Retrieved from
https://aboundlessyear.wordpress.com/2016/02/10/a-1-day-adventure-to-northern-ghana/
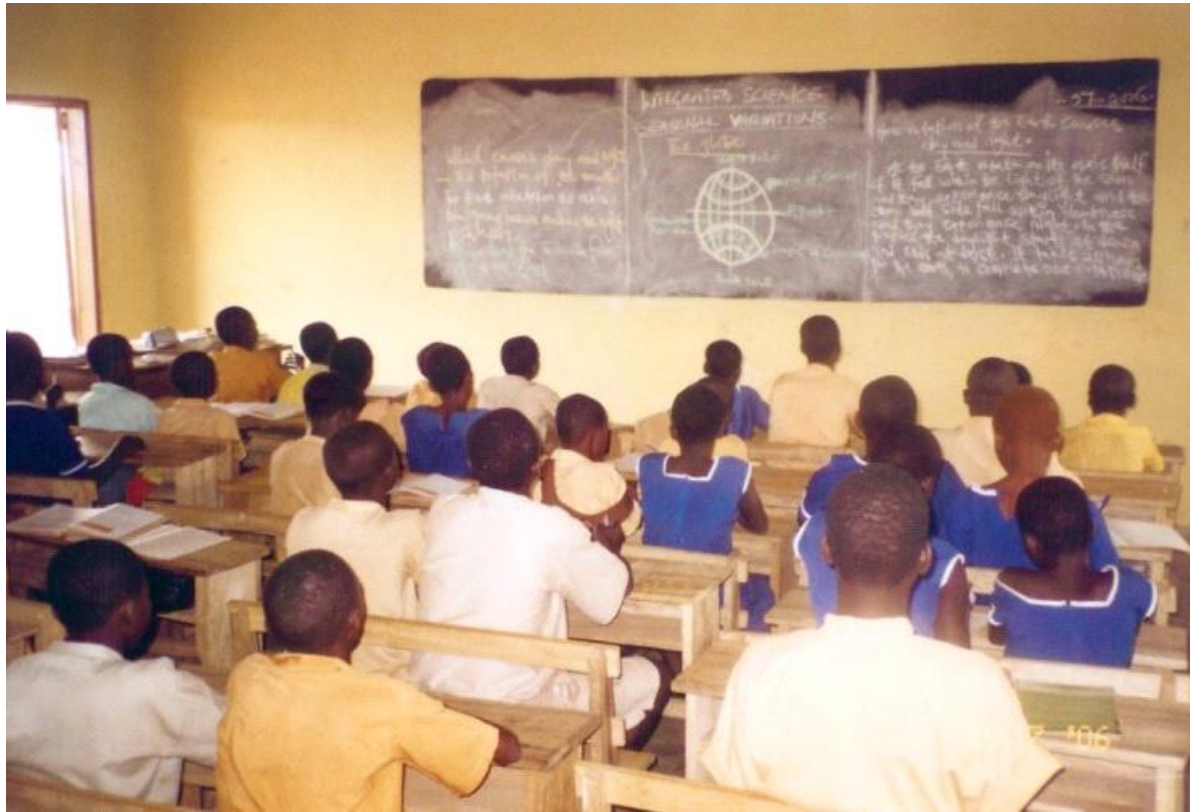
Periodic tests are conducted by the subject teachers on the topics covered from the textbook. Sometimes after every lesson, an assignment is given to the students. These assignments are marked and recorded. Aside the class assignments and homework on each lesson conducted, a general class test is also conducted during the middle of the term to cover all the topics treated. This is to evaluate the students' progress throughout a course of study, as distinct from terminal examination. Mostly, all class assignments and tests are combined and converted to 40% and the final examination for the term also converted to 60%. The combined mark attained by the student in both assessments gives the students final grade. A summative assessment in terms of the end-of-term examination is conducted at the end of every term (three terms in every academic year). Subjects taught in the Junior High Schools include: English, Mathematics, Integrated Science, Social studies, B.D.T (Pre-Technical skills, Home Economics, Visual Arts), Religious and Moral

Education, Ghanaian Language and culture, I.C.T and French (not all schools). Traditionally teaching in the Ghanaian classrooms are teacher centered (Ampadu, 2012). Teachers stand in front of the class and lecture students whiles students sit down quietly and listen to the teacher. Students have to raise the right hand to be called by the teacher if he/she has a question or to give an answer to a question. Discipline and moral uprightness are what teachers always expect from students. Teachers attach more value to a quiet class whiles stubborn classes are always punished (Salifu & Agbenyega, 2016). This could be as a result of large classroom sizes typically more than 25 (Alexander, 2001). It is however common to find 60-90 students in a single classroom in the capital city, Kumasi.

In a typical classroom, teachers use textbooks and other pamphlets, summarize the information and then discuss the questions and answers with students. The summarized notes from the teacher are either written on the chalkboard/marker board or dictated for students to copy into their notebooks. In science classroom, diagrams are drawn on the board and students copy from it. Schools that are privileged to have some textbooks, students are put into groups to copy diagrams since the books are always not enough for each student to get one. Teachers solve questions involving calculations on the board and students copy. At the Junior High School, students are always required to have different notebooks for different subjects. Definitely, expectations could be raised on the method of teaching mentioned above; however, based on my many years of experience in teaching in both the Junior High School, the Senior High School and the anecdotal experience of others, most teachers appear to face a similar situation as that discussed above.

2.2.3 Challenges in Ghana Education System

Education is one of the major tools to eradicate poverty and prevent ignorance among citizens. To achieve the set Millennium Development Goals, Ghana initiated a lot of reforms to ensure massive enrolment at the basic level of education. The Education Strategic Plan (ESP) 2003-2015 was underpinned by ten broad policy goals. These goals were grouped under four focal areas which is seen as thematic:

- Access to Education

- Quality of Education

- Education Management

- Science, Technology and Technical and Vocational Education and Training (TVET), (Ministry of Education, 2012).

The Gross Enrolment Ratio (GER) for JHS increased from 62% in 2002, 73% in 2005 and 79% in 2008 whiles the Net Enrolment Ratio (NER) for the Junior High Schools decreased from 70% in 2005 to 53% in 2008.

Completion rate also reduced from 75% in 2002 to 68% 2008. "Although GER rates shows growth in enrolment, the low NER and completion rates indicate that pupils are dropping out, perhaps to the world of work (Ministry of Education, 2012 p. 7). Many children drop out of school after the 9th grade. Despite the substantial progress made by the Government of Ghana towards achieving the Millennium Development Goals 2015, many problems still remain unsolved. However, the new government which took over in 2017 has initiated a lot of strategies to ensure that children have access to quality education. The new government in 2017 has introduced a free Senior High School education to all students who completed Junior High School. This policy was effected during the 2017/2018 academic year. (Government of Ghana, 2017). This initiative seeks to address some of the challenges listed by the Ministry of Education report in 2012 as:

- Retention of pupils in Junior High School needs to be improved in the next decade.

- In terms of examination, success and skills development, the rate of returns at second cycle level, particularly in SHS is poor.

- Enrolment growth in the 1st cycle has placed a strain on the provision of trained teachers for kindergarten, primary and Junior High Schools, leading in turn to reduced capacity for delivering quality education.

- Pupil Teacher Ratio (PTR) and time-on-task in JHS and SHS are very low, leading to inefficient teaching and high cost - staff rationalization and deployment of these sub - sectors need to be addressed.

- This issue of boarding and student accommodation at 2nd and 3rd cycle levels, with their high levels of public expenditure and corresponding inequalities, need to be addressed". (Ministry of education, 2012 p. 12-13).

According to Lewin, (2009), there are many challenges to access education in Sub-Saharan Africa of which Ghana is no exemption. Schools in Ghana still use wooden benches in the classrooms and poor classroom set up. Most schools still use chalkboard for teaching and most basic schools do not have access to even a single computer, internet nor electricity. Meanwhile, is compulsory for basic school levers to sit ICT exams organized by WAEC. There is lack of teaching/learning materials and teachers always have to improvise. This really affect teaching and learning (Acheampong, 2007). Poor teaching learning methods contribute to school dropouts in extreme cases. This compels most parents to spend more on child education by opting for private tutors. "It is clear through multiple studies conducted by government and international agencies that the economic background of parents determines whether and to what extent a child will succeed in the education system" (Roy & Khan, 2003 as cited in Rangarajan, 2017 p. 21).

2.3. My background

I am a professional teacher under the Ghana education service. I started my professional career in 2005 when I completed the teacher training college. Until I came to Finland in 2016 to study a Master's programme in Educational Leadership at the University of Jyvaskyla, I was still serving under the Ghana Education Service as an integrated Science teacher at a Senior High School (Opoku Ware School, Kumasi). After my professional studies to become a teacher in 2015, I have experience in teaching integrated Science in both Junior High School and Senior High School. Whiles teaching at the Senior High School, I was also employed as an assistant examiner for the West African Examination Council from 2011 to 2015 when I left Ghana. I was marking the integrated Science final examination organized by WAEC for both Junior High Schools (BECE) and Senior High School (WASSCE). The West African Examination Council (WAEC) is an examination board that conducts examination for Junior High School levers (BECE) which enables

students to further their education to the Senior High School and also conducts examination for Senior High School levers (WASSCE) to enter the University or any tertiary level.

As a teacher, I firmly believe in the potential of education to be an equalizer and an important tool for developing a country. Throughout my teaching experience, one major issue I realize was students' fluency in the English language and the predominant rote learning. Most students memories some concepts and definitions in Science but they are unable to explain in their own words. During my studies in the University of Jyvaskyla in Finland, I realized that most science teachers in Ghana including myself were not using a dialogic approach in teaching science. I signed up for several research seminar courses of which most of them were on dialogic teaching of science and this developed my interest to read more and apply them to the Ghanaian context. After more studies into the dialogic teaching strategy I felt that this could work in Ghanaian classroom context.

3.0   Theoretical Framework

Any discussion on the role of language in education as far as dialogic approaches to teaching and learning are concerned, it worth considering the great works of Russian Psychologist Lev Vygotsky who recognized language as a major driving force behind cognitive development and low social and cultural influences affect child development. Vygotsky emphasized in his research that "all learning is located in a social, cultural and historical context" (Vygotsky, 1978 as cited in Lyle, 2008 p. 223).One important interest of Vygotsky research was the relationship between children and their parents, peers and teachers with much emphasis on how children relate language and thought. He believed that one of the highest impact to achieve higher psychological processes was language development (Driscoll, 2013). Vygotsky research has brought a paradigm shift within the educational research, with much dependence on naturalistic observation and reflection to perceive the intended meaning of ongoing situations. Based on his research, educators have come to realize the central role that language plays in children development and this on the other hand has encouraged more research into how language affects learning. The research of Bruner (1986 p. 127) supports Vygotsky idea that all learning takes place in a social, cultural and historical context by sharing the view that "most learning in most settings is a communal activity, a sharing

of culture" (Brunner 1986 p. 127 cited in Lyle, 2008 p. 224). Bruner in support of Vygotsky's idea challenged the tendency of psychological research and therefore argues that the mental functioning of humans does not exist in a cultural vacuum. However, based on this argument and in support of other researchers Bruner created a cultural psychology which he refers to as the psychology that puts human culture at the center of children's development since "cultural psychology is an interdisciplinary hybrid with multi - disciplinary goals (Lyle, 2008).

The works of Bakhtin brought to light the dialogic engagement as a concept. Bakhtin is highly recognized in the field of literary theory. Though the term "dialogic" does not just relate to literature, Bakhtin in the *Dialogic Imagination*, finds the contradistinctions of "dialogic" and the "monologic" work of literature. Bakhtin shares Vygotsky's idea of language as a social practice by viewing all language as well as all thought of dialogic (Lyle, 2008). Bakhtin's concept of "dialogical meaning - making" enables the learner to actively develop a deep personally constructed understanding of the course of study through the means of dialogic interchange. Dialogism highlights the language and thoughts occurring between separate conscious minds in a social context and therefore sees knowledge as gained from collaboration between two people rather than an individual possession. This viewpoint allows Bakhtin to posit that "our words and meanings are filled with other's words, varying degrees of our - own - ness, varying degrees of awareness and detachment" (Bakhtin, 1986, p. 89 cited in Wolfe and Alexander, 2008 p. 9).

In line with Bakhtin`s idea, there are a lot of researchers who have shed more light on benefits and challenges which dialogic teaching brings with it. Lehesvouri, Viira and Rasku-Puttonen (2011) in their research analyze the results of implementation of the Communicative Approach based on dialogic teacher-talk in addition to authoritative teacher-talk to science education.

3.1 *Concept of communicative approach* (CA)

The Communicative Approach particularly relevant to science education was developed as a concept by Mortimer and Scott (2003). It consists of four classes which originate from two dimensions, namely interactive/non-interactive and authoritative/dialogic. *Interactive* talk provides a conducive atmosphere for students to participate in the lesson, where as *non-interactive* talk is more of a lecture type. The second dimension explains that dialogic approach considers

diverging ideas while *authoritative approach* emphasizes on introducing a scientific viewpoint controlled by the teacher.

- *Authoritative/interactive (A/I)* approach: During the question-answer routine in the classroom, which suggests student/teacher interaction, teachers reject diverging ideas by quickly evaluating students' responses. The authoritative approach rather emphasizes on scientific viewpoint.

- *Dialogic/interactive (D/A)* approach: On the contrary, this approach goes extra step to explore and exploit students' ideas and their everyday experience without evaluating the students' responses. During dialogic approach the teacher does not focus on achieving a specific point of view, rather, elicit diverging points of views from students to work with the contracting views.

- *Authoritative/Non-interactive (A/NI)* approach: The teacher uses lecture method to present the scientific point of view and does not consider contracting points of view from the students.

- *Dialogic/Non-interactive (D/NI)* approach: The teacher elicit students contracting points of view and their everyday experiences and further presents the scientific point of view. The teacher talk could still be dialogic in nature when students diverging viewpoints are upheld and discussed although the teacher's approach of teaching is lecturing.

Though dialogic approach of teaching is good, teaching should not always be dialogic. According to Scott and Ametller (2007), teaching of science is more meaningful when aspects of dialogic and authoritative approaches are combined. For instance, during lessons, dialogic approach is applied to *open-up* discussions thereby giving opportunity for students to share diverging ideas and their everyday experience. This should *close-down* with an authoritative approach. *Close-down* approach is worthwhile for the teacher to clarify the diverging ideas and everyday experiences from the students with the accepted scientific explanation to bridge the gap (Mortimer & Machado, 2002). In addition, these two approaches (*open-up* and *close-down*) form cumulative structure for classroom communication. According to Scott, Mortimer, & Aguiar (2006), a fundamental tension exists between dialogic and authoritative approaches. These communicative approaches complements each other. This is represented by the thick dash lines in the figure below showing communicative approaches with teacher interventions and the common pattern of talk (Mortimer & Scott, 2003)

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	Interactive	**Non-interactive**
Authoritative Focus on the Science view	Presentation Question & Answer routine IRF	Presentation Lecture
Dialogic Different points of view are considered	Probing Elaborating Supporting I-R-F-R-F	Review

Fig. 4   Communicative approaches with teacher interventions and the common partners of talk (Figure adapted from Mortimer & Scott, 2003)

An important point to note is that communicative approach is not just a teacher-student exchange, however, it is a series of conversation between the teacher and students that is targeted on a specific lesson objective. To analyze a communicative approach in the classroom , a careful consideration should be given to the series of teacher-student exchanges.

The communicative approaches discussed in fig. 4 were developed from the works of Lemke, 1990 on discourse in science. The researcher explains that the essence of learning science is basically learning how to "talk science" which means doing science through the medium of language. Lemke further explains science teaching as a triadic dialogue where the teacher initiates talk, then followed by students response which is further followed by the teacher's feedback. This approach of communication is referred to as IRF, where *I* stands for *Initiation* of the teacher (such as question), *R* for the *Response* of the student and *F* for the *feedback* (*or follow-up*) of the teacher (Sinclair & Coulthard 1975 cited in Lehesvuori 2013. p.28). When there is a change in the pattern whereby teachers feedback is evaluative, the pattern changes from IRF to IRE, where *E* stands for *Evaluation* (Mehen, 1979 cited in Lehesvuori, 2013). If the features of the teacher's *feedback* goes beyond *Evaluation,* it is essential to activate students' ability to reason (Nassaji & Wells, 2000). Predominant usage of IRF during lessons limits the students' opportunity to share diverging views and their everyday experiences. Despite the limitation of this approach of teaching it is currently

used excessively in the classrooms (Lemke, 1990). Most researchers have also condemned this teaching approach and suggested that teachers should engage students in a dialogue that will encourage students reasoning ability instead of making them to basically reproduce the knowledge (Rojas-Drummond and Mercer, 2003; Chin, 2006, 2007).

Recently distinct talk pattern identified is the IRFRF whereby students' responses are followed by teacher's redirecting students responses back to students without evaluation. For example, teacher asks question to elicit responses from students without evaluating students' point of view, rather the teacher's feedback prompt students to further think (Scott, Mortimer and Aguiar, 2006). This pattern of talk encourages more interactive, collaborative and supportive learning (Sharpe, 2008).

3.1.2 *Dialogic teaching*

Dialogic as a term can be explained by linking with numerous classroom talk including argumentation, exploratory talk and inquiry. As dialogic pedagogy is directly associated with empirical context, dialogic teaching is associated with theoretical descriptions. This study aimed to merge both the empirical context and theoretical descriptions when implementing theory-based descriptions into practice in the classroom. Alexander (2006) introduced principles of dialogic teaching which also helps to classify dialogic pedagogy. According to Alexander, conversation differs from dialogue depending on what follows students' answer. The dialogic teaching introduced by Alexander includes five principles:

- *Collective:* teachers and children address learning tasks together, whether as a group or as a class;
- *Reciprocal:* teachers and students pay close attention to hear each one out during lessons, share various ideas and consider different viewpoints;
- *Supportive:* children articulate their ideas freely, without fear of embarrassment over "wrong" answers; and they help each other to reach common understandings;
- *Cumulative:* teachers and children build on their own and each other's knowledge and experiences;
- *Purposeful:* specific educational goals in view help teachers to plan and facilitate dialogic teaching (Alexander 2006, p.28).

During dialogic teaching, there exists dialogic interaction which refers to the interaction where students are given the opportunity to ask questions, share diverging ideas and experiences and given more time to reason. For dialogic teaching to be successful, the teacher must be able to tolerate students diverging views and initiatives and as well use interactions that will ensure continuity and reciprocity. According to Alexander, dialogic teaching can be applied in a whole classroom teaching process whereby students give different responses and contributions and these diverging points of view are targeted in a specific direction to achieve the lesson goals.

3.1.3   Benefits and Challenges of Dialogic teaching

As for the benefits, Wolfe and Alexander (2008) claim that certain patterns of communication in the classroom such as exploratory talk, argumentation and dialogue provide complex reasoning and development of in-depth knowledge through actions of meaning-making and knowledge construction between students and teachers. The researchers state that dialogic teaching helps to develop students' argumentation skills and to teach students with an account of their individual features. An interesting recommendation emerged from the findings of the study is that teachers should reconsider their roles as the guides rather than controllers of the process of knowledge production. Rangarajan (2017) in her research on the implementation of 4C model (content, cognition, communication, culture) in the classroom work finds out that it has positive impact on students´ oral expressions and content knowledge. Nonetheless, the teacher faced some challenges such as time, noise, classroom space and team structures towards implementing the group work. To add more to the importance of the dialogic teaching, Barnes (1976) outlines that learning has a 'constructivist' nature and researches implications of this approach for teaching involving the idea that getting new knowledge full of terms requires 'working on understanding' which can be most successfully achieved through talk. Furthermore, Barnes points out that two different kinds of talk exist : 'exploratory' and 'presentational', - which are both important in the process of teaching, however each has its own function in the sequence of lessons. While exploratory talk is especially important when working on understanding, presentational talk performs as a final point in evaluation of understanding the topic. Here the author undermines that it is important for teachers to introduce presentational talk only after pupils have completed the stage of digesting new ideas.

As for the dialogic teaching in science, Scott (2008) begins his research with the statement that 'Science can be a challenging subject both to learn and, of course, to teach!'. According to Scott, the science teacher's main objective is to change students' day-to-day view of a physical phenomenon to a scientific one. Analyzing the series of lessons based on communicative approach which is explained by characterizing students-teacher talk along the two dimensions such as interactive-non-interactive and dialogic-authoritative, the author comes to the conclusion that the teacher's success depends not only on their skill in managing different modes of talk but also on domain-specific scientific knowledge as how each student in this class perceive this problem at the moment.

Pierce and Gilles (2008) in their research move from exploratory talk to critical conversations as another way of dialogic teaching. The authors' key idea is that a teacher's main task is to set up 'a culture of talk', and to complete the analysis relating to the different types of talk that should be valued by teachers. Mercer and Dawes (2008) also outlined the value of exploratory talk and raised an argument that teachers clearly need to understand the impact of talk in the classroom so that the quality of classroom talk and educational process in general can be upgraded.

Another article devoted to dialogic teaching in science with the focus on mathematics education is written by Solomon and Black (2008). The researchers clarify how students can master various 'learner identities' and different ways of participating in classroom dialogue and argue that such different ways of interaction can positively influence students' learning of mathematics. Based on observation of students studying in primary school and those studying in secondary/high school, the authors' state that the talk should enable students to self-study the mathematics. The researchers conclude that the most effective mathematics education requires both an appropriate pedagogy encouraging students to take active part in dialogue and mathematics teachers to change current practices for more dialogic-oriented.

To add more about benefits of dialogic teaching, Hardman (2008) asserts that it is crucial that teachers introduce dialogic teaching approach in their classroom work because it helps to encourage students active participation during lessons and to provide students with an informative feedback. Effective application of this educational approach requires teachers to use a range of strategies for interacting with their students and especially for questioning. However, based on the

observational research outcome, the author highlights that the existing teachers' practice does not reflect this importance because the questions asked by teachers are formed to expect only short 'correct responses' and because teachers provide only brief evaluations of students' answers in the way of formative assessment. Hardman emphasizes the immediate need for teachers to be trained on how to use questions and a greater understanding of how feedback on students' answers can boost the development of students' mental thinking.

Cazden (2008) in her research explores the implementation of a classroom talk to teaching science and literacy in the USA. The most interesting aspect of this article is the methodology the author applies to the research:

- Firstly, classroom discussions were recorded in middle schools.
- Secondly, two interviews were held with students some years later as these students reflected on their implication with the approach and its influence on their lives.

Discussing the beneficial outcomes of the application of this approach, the researcher highlights that it gave the teachers and pupils opportunities to work together intellectually in various ways and discusses the positive impact of these on students' educational experience. Apart from those advantages, Cazden argues that this kind of approach usefully enables students' critical reflection on educational process.

To continue with the positive impact that dialogic teaching can have on science learning, Forman, Ramirez-DelToro, Brown and Passmore (2017) described in their research how an experienced teacher managed to direct students' towards appropriation of scientific argumentation by implementation of discursive moves. Since the way how she prompted students' critiques altered, her role as a mentor changed rather for a partner. The researchers conclude that the new classroom community created was different from the scientific community in several aspects:

- Sharing of authority
- Evaluation of epistemic goals
- Investigation of authentic issues

Similarly, Ford and Wargo (2012) consider dialogism in the context of understanding a scientific idea. The authors assert that understanding of a scientific idea means using this idea to explain natural phenomena, with the awareness that the idea is just one out of many alternatives. The scientific idea is prior to other scientific-evaluated disjunctives based on evidence relation. The

authors claim that understanding scientific ideas and using them to explain and argue is an outcome of a dialogic learning.

To add to the benefits of dialogic teaching approach, Kumpulainen and Rajala (2017) described how students' discursive identities were set through dialogic teaching during which moment the interactions, arguments and identity negotiations supported students learning. However, some tensions in introducing dialogic teaching as well as students' identity negotiation as learners of science were identified:

- Tensions within the students' personal alternatives for involvement in classroom discussion and group involvement managed by classroom norms
- A variety of discourses created tensions for collective meaning-making
- Issues with the teacher's management: imbalance between dialogue and teaching

Through this means, the findings of the research show the complication of creating impartial science learning opportunities through dialogic teaching.

Nowadays a lot of researchers state that the implementation of dialogic approach into classroom activities can have controversial consequences. Van der Veen, de Mey, van Kruistum and Van Oers (2017) investigate the influence of effective classroom talk on the development of pupils' oral communicative skills and subject knowledge. Having conducted the multilevel analyses of pupils' oral communicative competence, the authors state that the intervention of effective dialogue during lessons had a significant effect on the progress of pupils' oral communicative skills. However, the researchers outline that there was no significant influence of productive classroom dialogue on pupils' subject knowledge. The authors of the article conclude that dialogical classroom talk is more advantageous compared to non-dialogical classroom talk for the extension of pupils' competence oral expressions.

Another interesting article on the topic of the impact of dialogic teaching in science on students' subject knowledge is written by O'Connor, Michaels, Chapin and Harbaugh (2017). The authors explore vocal compared to silent pupil participation in collective mathematics discussion relatively to learning results. The researchers find that there is no relationship between the degree of vocal student participation in classroom discussion and students' scores as the results measure in any condition. The authors highlight that this finding may be an indicator of numerous restrictions faced by teachers when they try to introduce whole-class discussions.

To shed more light on effective dialogic teaching, Well and Balls (2008) in the *Exploratory Talk and Dialogic Inquiry* studies an inquiry approach to teaching and learning as the generator for more fruitful dialogue and exploratory talk during lessons. The authors emphasize the role of the teacher in making inquiry and associated discussion meaningful and interesting for students. In conclusion, the authors summarize conditions which their research indicates can help exploratory talk to become most effective since students follow their curriculum-related inquiries:

- Students have opportunities to share opinions, suggestions and experiences.
- Other students wish to listen carefully and critically.
- There is a collective discussion on what ways various contributions are relevant.
- Teachers share control and have a right to estimate with novices.
- The interest in the topic under discussion is mostly generated due to the connection of the discussion with a future action to be carried out or with an 'object' which students are working on to improve like model or text.

In recent times, more studies continue to regard the issue of teaching science in mother tongue as the best way for a learner to adopt knowledge. Various data and methods have been used to analyze this problem and a burgeon of works has been written to explore this issue in the context of African educational systems. Okebukola, Owolabi and Okebukola (2013) explore urban-rural differences in teaching science in the mother tongue language L1. The data was obtained from 36 teachers in 12 different primary schools in both urban and rural localities of Lagos State, Nigeria. The authors conclude that science lessons in rural settings are more in the mother tongue than those in urban settings because of several factors including:

- Presence of multiple mother tongues in one science class

- Teachers who are mismatched for L1

Moreover, the researchers claim that English served as an intercommunication language for the geo-spatial interaction between and among students in both urban and rural science classes. Another interesting finding made by the researchers is that the level of mother tongue use during the science class decreases in the higher primary compared to 93.6 % mother tongue in primary 1 and 84.6 % in primary 3 in rural settings.

Abd-Kadir and Hardman (2007) analyzed twenty lessons using discourse analysis approach based on the teacher-led communicative approach of Initiation-Response-Feedback (IRF). The core of the study is the first and third parts of IRF sequence since the research assumes that teachers can boost student learning through questions which help students to extend their thinking, explain their opinions and make links to their own experiences. The results of the study suggest that the teacher's questions were designed to expect only a brief or a short answer and if a teacher follow-up took place, a pupil response was lowly evaluated by those restricting chances for student to fully participate in the classroom discussions and higher-level mental reasoning. In conclusion, the researchers stated that implementation of dialogic teaching in classrooms in Kenya and Nigeria introduces substantial difficulties due to the following issues, which require priority in consideration:

- Poor working conditions for teachers: lack of electricity and other learning resources; overcrowded classrooms.
- The disparity between the teacher and students in English proficiency causes the students to switch to other African languages during the classroom talk.

Alexander (2008) mentions some of the challenges of introducing the dialogic teaching approach:

- The most usually observed teacher-student talk is more related to recitation than dialogue: the feedback to the extended students' answers is minimal and judgmental in most cases rather than informative.
- While teachers try to outstretch their repertoire of teaching talk, the attention to outstretch the repertoire of the learning talk which includes abilities to narrate, explain, instruct, discuss, analyze, solve problems etc is minimized. Therefore, the benefit which dialogic teaching offers in terms of intellectual and social empowerment are still inadequate.
- Recitation has been found out to remain the default-teaching mode: this does not take much for children's participation to regress from repertoire-based to monolithic models, for 'test' question to get their historic power again, for feedback to become uninformative.
- The complexity of achieving cumulation as this requires the pedagogical skills of a teacher, content knowledge and understanding of each of his/her students. To add to the complexity to the following principle, cumulation evaluates the capability of

the teacher to review students' responses and judge what to offer that will take students' thoughts forward – hundreds of times each day.

- As the UK, government insists on a culture of high stakes testing, competition replaces collaboration and that can affect the recent British espousal of the idea of classrooms as learning communities through the emphasis of the personalization and choice (Alexander 2008).

In summary, Lyle, 2008 contradicts the challenges of dialogic teaching discussed above and outlines the benefits of using dialogic approach of teaching in range of situations. The role played by dialogue in pupils learning goes beyond stimulating their thinking and thereby raising their standards and the potential for students voices to be heard and considered (Lyle, 2008, p.233). Despite the evidence of positive impact of the dialogic approach of teaching science, other researches have established the difficulties to implement dialogic approaches in lessons

4.0   RESEARCH PROBLEMS

The research problem for this study, thus, implementing the concept of dialogic teaching of science in Ghanaian classroom in which the content is taught in English. By using the communicative approach suggested by Mortimer and Scott, (2003) and the principles of dialogic teaching by Alexander, (2006), I was trying to understand how the intervention of dialogic teaching of science support students understanding of science and language development. According to Wells (2007) learning becomes more effective when student are given the opportunity to cognitively reconstruct their own knowledge and thoughts. However, authoritative approaches of teaching science (Mortimer and Scott, 2003) are commonly found in the Ghanaian science classrooms. This study therefore aims to find out how the implementation of the dialogic approach of teaching science responds to the challenges acknowledged in Ghanaian science education. In response to this, the study therefore seeks to find answers to this research question:

- How do pupils in Ghana respond to dialogic teaching intervention?
- How does a dialogic teaching approach support pupils understanding of science?

In order to find appropriate answers to the research question, this study adapted action research approach to facilitate the implementation of dialogic teaching approach of science in Ghana. The adapted action research approach in this study has been described in details in the section below.

5.0   IMPLEMENTATION OF THE STUDY

5.1   Action research

5.1.1   What is action research?

"Action research is a systematic approach to investigation that enables people to find effective solutions to problems they confront in their everyday lives" (Stringer, 2013, p.1). Elliot (1991) also defines action research as the "study of social situations with a view to improving the quality of action within it" (p.69). While quantitative research or experimental research bases on a small number of variables and generalize it to explain related issues, action research uses complex dynamics in social context to investigate and bring out effective solutions to challenges or issues that are encountered in a specific situation or location. As explained by Carr, (2006),

> action research would be a form of inquiry that recognized that practical knowledge and understanding can only be developed and advanced by practitioners engaging in the kind of dialogue and conversation through which the tradition-embedded nature of the assumptions implicit in their practice can be made explicit and their collective understanding of their praxis can be transformed (Carr, 2006, p.433 cite in Rangarajan, 2017, p.55).

Action research does not apply a standardized set of procedures to researchers nor a set of fixed prescriptions to be strictly followed in any context. However, action research "provides a flexible and practical set of procedures that are systematic, cyclical, solution oriented, and participatory, providing the means to device sustainable improvements in practice that enhance the lives and well-being of all participants" (stringer, 2013, p.5). Action research is carried out by people who have the passion and are directly concerned with the problems or issues under research. The

research can begin with a specific problem in most fields of human activity or work area. After establishing and clarifying such situations, the researchers base on resources that are available as well as existing research to come up with a new strategy and way to its implementation. There is always the need to double check the situation by making a second observation and better clarifying with more data. If the strategy employed for the action is successful, the researcher can publish the outcomes for other researchers to benefit from it. The outcomes can also be used as basis for other researches. According to Mertler, (2008), action research and its implementation go a long way to develop the practical situation as well as enhancing the practitioner's practice.

5.1.2   Why use action research?

Elliot, (2009) views educational action research as a form of practical philosophy that unifies the process of developing theory and practice. According to Elliot, "research on education" differ from "educational research" with regard to the researchers' role in the classroom. He argues that educational research is undertaken with the practical intention to change a situation to make it more "educationally worthwhile". From the ordinary person's point of view, a researcher is someone who gives report after a careful observation – without attaching any personal opinions or values but rather reports exactly what he/she observed. This best reflects on "research on education". Elliot (2009) therefore construed "educational research as a form of *commonsense theorizing* in contrast to the kind of *scientific theorizing* that stemmed from research on education" (Elliot, 2009, p.28-29).

Research on education commonly follows the Research-Development-Dissemination Model (RDD). Altrichter et al (1993) explained this model, which is commonly used in the physical sciences. According to them, at the initial stage, researchers through their research gather new knowledge based on science (Research), after which they are tested (Development). At the developmental stage, careful examination is done on the materials gathered and when they are considered ready (Matured) they are then transferred to the practitioners (Dissemination). The practitioners receive the materials with specified directions from the researchers on how to use them. However, researchers consider practitioners uncooperative in the sense that practitioners fail

to adopt the findings and specified directions from the researchers more especially the practitioners in the practical fields including education.

According to Carr, (2006), teachers' action research are considered as "educational research" and this was highly recognized in United Kingdom (UK) by the significant works of Professor Lawrence Stenhouse, (1975) who through his research outlined the importance of teachers action research and recommended teachers be part of the process. As explained by Pike, (2000), teachers face many challenges in conducting action research due to the bureaucratic demands of assessment, monitoring, curriculum mapping, etc. However, "it is refreshing to hear that teachers action research is flourishing in places and generating ideas that provide theoretical models and practical strategies that can help us all" (Kirtley, 2000, p. 2 cited in Pike, 2000, p. 28-29).

5.1.3   Action research in this study

Despite the arguments raised by Carr (2006) on the need to explain clearly whether or not the importance of action research in a study, this section seeks to justify need the need of action research in this study.

Action research is considered more appropriate for this study since dialogic teaching of science is a totally new concept in the educational practice in Ghana. More so, there is no research on dialogic teaching of science in Ghana and not much done on Africa as a whole. If there is the need to introduce and implement this concept of teaching science in vastly different context, it is not enough to create artificial conditions for the implementation in a pilot bases. It is more important if the implementation is done by a qualified science teacher who has teaching experience in the Ghanaian educational context and above all has knowledge through further studies and research as well as the exposure to this approach of teaching science in an advanced European country (Finland).

In this study, I carried out the implementation process of dialogic teaching of science myself. As a former science teacher under the Ghana Education Service for ten years and currently studying with a study leave, I still belong to the community of teachers although I am presently not teaching. The questions I seek to find answers to are the same questions my colleague teachers keep asking.

The implementation of this study was not done with any intention of addressing the situation with any ready-made solutions. The study keenly observed and followed the cycles of action and reflection throughout the process and the initial outcomes focusing on the student perspective are being published as part of this Master's thesis. From the start of this study the greatest intention and motivation have been to do and to learn by doing.

5.2   The research Partners

5.2.1   The school and classroom

The school (Opoku Ware Basic) is a public basic school located in the Ashanti region of Ghana (Kumasi). It is rated as one of the best public Junior High schools in the region. The school was established in 1992 and it follows the curriculum of the Ghana Education service. Due to the large population of the school, the school has two head teachers: one head teacher in charge of the primary school (Kindergarten to grade 6) and another head teacher in charge of the Junior High School (Grade 7-9). The school in total has a student population of 1800 however; the Junior High School which was the main partner in this study has a student population of 590. The School has divided each grade into three classrooms (Classes: A,B and C). the school is run on capitation grant from the government and students therefore have free education. Though the government provides textbooks they are always not enough due to the large student population. Students therefore purchase other pamphlets or textbooks recommended by their teachers for various subjects. Most of the students also have extra classes (lessons) either in the morning before school starts or after school in the afternoon.

The research was conducted in Grade 7 classrooms. There are three classes (A,B and C) for grade 7 and each class has 75, 76 and 78 students respectively. The students are between the ages of 11–16 and most of them live nearby. Majority of the parents are engaged in petty trading or low skilled jobs including carpenters, painters, drivers, masons, etc. All students are fluent in the Akan language (Twi) which is the common spoken language in the Ashanti region. Students usually communicate among themselves using the Twi language though the teachers always mandate them to speak English on campus.

5.2.2 My role

My major interest is to implement the dialogic approach of teaching science in Ghana. With regard to the principles of action research, this study aims to respond to the challenges acknowledged in science education in Ghana and how the students in Ghana perceive the intervention of dialogic teaching of science.

I took the role as a teacher for the implementation of dialogic approach in teaching science in this research. I worked with the science teacher in charge of grade 7 at the partner school and I shared the dialogic approach of teaching science with her. My role in this study is explained in detail below and the video recording of all the lessons, recorded conversations between students and the class teacher provide an important set of useful data for this study.

5.3   Research Methods

5.3.1   The beginning

I began this study by first meeting with the science teacher in charge of grade 7 of the partner school to discuss the challenges of teaching science in her school and to better understand her views on the classroom. Through our discussions we went through her previous lesson notes and how she prepares for lessons and her approach to the teaching of science. She outlined some of the challenges she faced including large class size, inadequate teaching/learning materials, too many topics to be covered in the syllabus within limited time, etc. I understood her perfectly because I have experienced similar situation when I was teaching at a basic school in Ghana. Based on this, one of the major factors I considered in carrying out this action research was to make sure that my research neither compounds the challenges the teachers are already facing nor add to the complexity of the teacher's role (Altrichter et al, 1993; Baumfeild, Hall, & Wall, 2008). I used the "multi-methods" approach to collect data to ensure that I capture many aspects of the approach of dialogic teaching of science implementation (Baumfeild et al, 2008). All lessons were video recorded with two cameras: one camera focused on the teacher and the other one focused on the students and capturing various activities in the classroom. In addition to the video recordings of

all the lessons, three students from each class were interviewed. In all, nine (9) students and one science teacher (the science teacher in charge of grade 7) were interviewed. Another data gathered was through the lesson notes for all the topics as well as diary of the day's activities.

5.3.2   Classroom observation

Before carrying out the lessons, I first visited the classrooms to observe lessons of the class teacher in order to confirm the issues raised by the teacher during our initial meeting. School had already reopened and in full section when I visited. It was a great opportunity to obtain actual experience of the classroom situation in this school. I observed various lessons taught by the science teacher in different classes for the first one week. I focused on the method the teacher used in delivering her lessons, her response to students' questions and answers, her lesson plans, as well as familiarizing myself with the students and the way they interact in the classroom. This gave me insight on how to organize the class to make my lessons more interactive and dialogic and the seating of the students to aid group work considering the large class size.

The aim for this observation was to familiarize myself with the procedures and the class routines and to create a friendly relationship between the students and myself so that they would not see me as a mere stranger but rather feel free to communicate in my lessons.

5.3.3   Implementation stages

After my observation, I discussed with the teacher the next topics to be treated based on the scheme of work she had already prepared for the term. I did this because I did not want to change the plans she had already made for the term based on the school's curriculum and syllabus. I made sample lesson plans on the topics she gave using the dialogic teaching approach (Alexander, 2006). I shared with the teacher these lesson plans and discussed with her the dialogic approach to be used in teaching those topics. In total, I taught six lessons on two topics (Respiratory system, Hazards) with three different classes. I introduced group work activities in each class to give students the opportunity to work with each other and to share ideas. Students in each group were given the

opportunity to come up with their own group name and explained to the whole class why they chose that name. I gathered and printed all the needed teaching/learning materials as specified in the lesson plan in order to make the lessons more interactive and to aid understanding.

5.3.4 Data in this thesis

Different kinds of data were gathered within the study period. The data were gathered both inside and outside the classroom. All lessons were video recorded with two cameras: one camera focused on the teacher and the other one focused on the students and capturing various activities in the classroom. In addition to the video recordings of all the lessons, three students from each class were interviewed. In all, nine (9) randomly selected students and one science teacher (the science teacher in charge of grade 7) were interviewed. I also took pictures in the classroom which captured students' group activities. Another data gathered was through the lesson plans for all the topics as well as diary of the day's activities.

The entire list of the data obtained is outlined in the table below. Though this data set appears complex, it enabled me to triangulate information and additionally provided supplementary information to ascertain a broader view of the whole situation. Some of this data could be more useful to support other researches. I saved all the data and backup copies in different location.

TABLE 2 Summary of data obtained for the thesis

Type of data	Quantity	Remarks
Lesson plan	2	I designed it
Video of the classroom	6	Videos covering the lessons and group-work activities
Audio recordings of interviews	9 + 1	9 audio recordings of interviews with students and 1 with teacher.
Pictures of the classroom	8	Pictures of students class and group-work activities
Printed teaching/Learning materials	15	Printed teaching-learning materials distributed in class for group activities

5.4   Data Analysis

Determining the type of data suitable for the analysis was a major consideration. After discussions with an expert in the development of and research into the dialogic approach of teaching science, I reached a conclusion to focus on the audio interviews for the analysis of this study. In order to better understand how Ghanaian students respond to this initial encounter with a dialogic approach to science education and how a dialogic approach can contribute to the development of their scientific understanding. I therefore chose the audio interviews to be the main data for the analysis and used the rest of the data as supporting data in a general way to better explain the findings. I transcribed all the audio interviews, printed and read through them multiple times. I set out some values to consider when coding. I selected the unit of analysis based on instances such as words, phrases and sentences, which are completely described by specific values of the selected value for coding. In situations where a quotation had different examples, they were coded separately. I began the coding by highlighting the instances of the selected values as mentioned by the students. I noticed and coded instances where students appreciate group work and the dialogic approach of teaching. I also noticed common important themes that the students mentioned. They played an essential role in the lesson though not directly related to dialogic approach of teaching.

I paused for some days after the initial round of coding in order to have a second look at the data. During the second look at the data, I redefined codes, merged similar codes to form broader themes (Braun and Clarke, 2006) and commented on the changes I made. I had a discussion with two of my colleagues in different departments at the University who were not part of my research process to seek their opinions on the codes. I did this to ensure there is trustworthiness of the data as recommended by Elo et al.,(2014). To further ensure trustworthiness of my data, I coded everything the students said during the interview rather than narrowing to choose only related codes (Tracy, 2012). I believed that all these instances though not related to the specified values set for coding would still give me insight into how the students perceived the dialogic teaching approach. I carried out the second round of coding and development of themes using the literature and the research questions as a guide. I read through the literature as well as the themes the second time with much regard to my research questions I chose related themes to focus on my results. The themes are illustrated in table 3 below

TABLE 3 Selected Themes

Selected codes
• Students perception of the lesson • Value of understanding content • Value of using one's own mind • Value of working with peers

5.5 Trustworthiness, Reliability and Validity

The terms reliability and validity are commonly used in the quantitative research, however there is much debate on their reconsideration in the qualitative research paradigm (Elo et al., 2014; Golafshani, 2003; Zhang & Wildemuth, 2016). The debate basically centers on the epistemological differences that exist between the two methodologies. Many researchers recommend that since reliability and validity are rooted in positivist perspective then it is worthwhile to redefine their use in a naturalistic approach (Elo et al., 2014; Golafshani, 2003; Zhang & Wildemuth, 2016). The two terms: reliability and validity can be considered in qualitative research to be an aspect of trustworthiness. The trustworthiness in qualitative research embraces five principles: dependability, confirmability, credibility, transferability and authenticity (Elo et al., 2014; Zhang & Wildemuth, 2016). These criteria are applicable throughout the research stages.

Though I have more data for this research, I strategized to choose an appropriate approach to respond to the research questions. The research questions center on the viewpoint of students, therefore the students interview triangulated with the class activities, observations and their perception on the lessons. This was set as the main fundamentals of the analysis. This step taken in the study satisfy the qualities of credibility (Elo et al., 2014; Zhang & Wildemuth, 2016). Furthermore, the triangulation of the data goes a long to ensure that the research findings become more credible. The long time taken to gather the data as well as interviewing different students on various lessons also add to the credibility of the data (Elo et al., 2014; Zhang & Wildemuth, 2016). In reporting the students' interviews, all efforts were taken so that the students' voices are

transcribed and reported by directly quoting the students so that the findings and interpretation will not differ.

To further ensure trustworthiness of the data in the analysis process, I have provided a detailed description of the coding process. Everything the students said were transcribed, coded and interpreted in order to ensure trustworthiness. All comments from the students, being it positive or negative have been reported and discussed. I shared and discussed the codes with my classmates and other students in different departments to have their opinions in order to avoid bias interpretation of the data. The codes were also shared and discussed with my research supervisor.

Generally, close examination was carried out to ensure that all the processes in this research: data collection, analysis and interpretations are reported with much possible details. This positions the reader in a better place to make fair assessment of the transferability of the results of this research (Elo et al., 2014; Zhang & Wildemuth, 2016). All the challenges and the short comings of this study are being outlined in the conclusion section of this research. This would also assist the reader to make assessment of the dependability of the study (Elo et al., 2014).

5.6   Research Ethics

I took steps to make sure that the values of the research are maintained. I considered the three set criteria: informed beneficence, respect and justice as described by Fisher & Anushko, (2008) to make this research more ethical. To ensure informed beneficence, I did not want to extort the teacher and the students to maximize benefit for my research. However, throughout the research process I made sure not to add extra work to either the teacher or the students. I followed the scheme of work set by the teacher for the term and continued the topics to be taught. I made sure I did not add extra tests or assignments that could lead to additional stress to the teacher and the students. Though I did not add extra stress to the teacher and the students, it did not have any effect of changing the results of the research.

Fisher & Anushko, (2008) identify the second criteria of ethics as respect. This criteria demands that all the research processes are well explained to all the participants and the participants have the right to give their consent or withdraw from the research process. I first met the head teacher

of the school to ask permission to undertake the research in the school. I explained the whole research process to the Head teacher and further explained that the school could withdraw from the research process. After the approval from the head teacher, I met the science teacher in charge of the seventh grade. I also explained the whole research process to her and made it clear to her that she could give her consent to either take part in the research or withdraw from the research process. I together went with the teacher to all the participating classes to explain the whole research process to the students and ask their consent or withdraw from the research process. I made the head teacher and science teacher aware that the findings would be shared with the school.

To ensure confidentiality, I made the participants aware and they agreed to the strategies put in place to protect their identity. I made sure that all students who participated are not identified and every information of the teacher or the students were removed.

The final general principle of research ethics is to ensure justice. I upheld this principle as very important in this research. I made all the research processes very clear to all the participants to ensure transparency with all the participants. When this research is finally accepted and published, I will share the final report with the participating school and the teacher involved in this research.

6.0   RESULT

This section reviews the results of the interviews with students, which correspond with the main research questions. Four major points were considered during the coding and these selected codes correspond to the research questions (see tab. 3).

6.1   Students' perception of dialogic teaching approach

This section discusses how the students in Ghana perceive the dialogic teaching approach when applied in the science classroom. Though this method of teaching has been introduced in some European countries (e.g. Alexander, 2006; Sedova, 2017; Lehesvuori, 2013) and South Africa (Lehesvuori, Ramnarian and Viiri, 2018), it is new to most African countries especially Ghana. It

is therefore necessary to analyse how the students respond to this new approach of teaching science in Ghana so that the necessary implementation can be effected. This section also analyses the value the students place on the implementation of the dialogic teaching approach of science.

"I think it was very interesting and I also felt that this lesson was special"(Std_2)
"It was smooth" (Std_4)
"Exciting, great : what was different is, it was special I could understand whatever they were saying" (std_5)

From the above instance, the students express their views on how they experienced the lessons. These extracts highlight the interest of the students concerning different lessons. Std_5 expresses excitement about the lesson with the viewpoint that students were accorded the chance to freely express themselves in the lesson and this supported the student to understand the lesson.

"The lesson was great, many people took part in it so it was interesting: like the teacher asked us that when you get to the lab and chemical pour into someone's dress and the dress started burning what will you do? Some said they will use fire extinguisher, some said they will pour water and some others said they would use sand and someone also said he would remove the dress" (Std_1)
"When I compare it I think this system is very good because in this system no one will laugh at you when you say your ideas and is not specifically from the book and you can also share your ideas in whatever you think that you should add to the lesson you can add to it without anyone saying that you are wrong or right" (Std_2)

The extracts above highlight how the students experienced the introduction of the dialogic teaching approach. This lesson described by std_1 was a discussion about safety precautions at the science laboratory under the main topic: Hazards. A practical question was given to the students to discuss and come up with solutions. The perception of student_1 is clear that the lesson was great and because most people took part, the lesson was interesting. Student 2 also shares her view when she was asked her perception about the dialogic approach of teaching science. From the above instance

student 2 shares her perception that there is flexibility in the classroom and students can freely express their ideas (Std_2).

"It was interesting and opinions of other colleagues were accepted and used". (Std_3)

"Great: because you gave us the opportunity to think about every question the teacher ask us" (Std_5)

From the extracts above, the time allocated to students to think and discuss their opinions in class was very helpful (Std_5). It developed their interest in the lessons.

6.2   Value of understanding content

This section examines how the students understood the content of the lessons. It is also important to discuss the point at which students came to understand the lesson to give insight whether the dialogic approach of teaching is helpful. This section also analyses the value the students place on this teaching approach that went a long way to support their understanding of the contents of the lessons.

"I came to understand the topic very well when we were talking about some of the safety precautions we could take to prevent hazards" (Std_2)

"Because this lesson I understood more and knowing more about respiratory system" (Std_7)

During the lesson on hazards, teaching learning materials concerning safety measures were provided to students and they were given the opportunity to discuss. The time allocated for the discussions was very helpful in assisting the students to understand the lesson std_2. Similar process was carried out during the lesson on respiratory system and it also supported students understanding. The highlights below confirm how the lesson changed students' mindset and

enabled them to develop sophisticated understanding of the topic by their ability to define key concepts in the lesson.

"I find the lesson very well and nice because at first I only knew that I breathe in only oxygen and breathe out carbon dioxide but as for today's lesson made me got to know that we breathe in all the components of air but our system picks the oxygen and use it after that release the carbon dioxide".(Std_9)

"They say that respiration is the process by which living organisms obtain energy from food". (Std_8)

6.2.1 *Difficulty in understanding the content*

This discusses the challenges students had in understanding the content of the lesson as well as the moment they came to understand the content of the lesson.

"I wasn't getting anything when they ask when we were talking about things toxic and also explosives because I didn't know which things could explode or some of the things; I knew some of the things that could come into contact but not all of them. Yes, Now I have ideas about those things". (Std_2)

"I understood the topic when we reached the types of hazards: the physical hazards, the environmental hazards and the health hazards and the preventive measures" (Std_4) (Std_5)

Students were given a list of toxic items to classify during the lesson under the sub-topic (classification of toxic substances). According to std_2, it was a difficult moment since he had no idea on the classifications. However, the group discussions and opinions from other students supported his understanding.

Student 4 and 5 also share common experience that they understood the lesson during the discussion about types of hazards and the preventive measures.

> "I find the lesson very well and nice because at first I only knew that I breathe in only oxygen and breathe out carbon dioxide but as for today's lesson made me got to know that we breathe in all the components of air but our system picks the oxygen and use it after that release the carbon dioxide".(Std_9)

> "They say that respiration is the process by which living organisms obtain energy from food". (Std_8)

During the lesson on respiratory system, students were given the chance to discuss and share their opinions on the exchange of gases and the mechanism of breathing. The students shared various opinions and through the conversation with student 9 and with reference to the instance above, he tells me that the discussions in the lesson changed his way of thinking and rather helped him to understand the lesson better.

There was an interesting instance with student 8 during our conversation after the lesson. He was asked how the contributions from his colleagues helped him to understand the lesson. From the above instance he was able to recall the definition of respiration as suggested by some of the students. Discussion with the class teacher reveals that std_8 is considered a slow learner and being able to recall the definition of respiration suggested by his colleagues' means that he greatly benefited from the lesson.

> "It was interesting and I understood the more and experienced more and something about scientific laws things and effects of trying to cause hazards (Std_3)

The above instance highlights the view of the student when he was asked how he compares the dialogic approach of teaching to the normal way of teaching science in Ghana. The response he gave reflects the moment in the lesson when students were given the opportunity to discuss among themselves in their various groups under the subtopics "causes of hazards and effects of hazards"

> "How to save your friend or your colleague when there is an accident" (Std_3)

The student was also asked the period during which he understood the lesson and in the above instance, he tells me he understood the lesson when they were given the opportunity to share their ideas in a scenario about how to save their colleague in an accident.

6.3 Value of working with peers

This section examines how group activities supported the students learning. Throughout the lessons, students were put in groups to work together, discuss the topics among themselves and share their results with other students. This section therefore discusses the value students place on working together in groups. The students were asked their opinion on their participation in group activities during the lessons.

6.3.1 *Support from group work*

This section reports on the analysis of the value students place on working with their colleagues in groups in terms of the support they gain from each other.

"I feel happy, I don't feel lonely because I have many people to support whenever a question comes and if I don't know I can ask my group members and they will tell" (Std_1)

The above extract highlights the view of student_1 concerning her participation in the group activities during the lesson. According to her, she feels that she has many of her colleagues to support during the lesson and in return get similar support from them. She feels happy because she does not feel lonely working with her colleagues. During the lessons, I observed that students find it easy to first share their ideas or ask for support from the person sitting next to them rather than calling the teacher's attention.

"we were given the opportunity to discuss with our friends and tell the answer" (Std_4)

The extract above highlights the opportunity students had to discuss the topic/questions amongst themselves before they come up with their answer. During the lessons, students were given 2-5 minutes to discuss some questions in their groups to come up with their answers and then share with the whole class. This is not a common method of teaching science in Ghana. It was therefore easy for std_4 to notice this change when he was asked how he saw this lesson compared to the normal lessons they always had.

6.3.2 *Accepting different views in group work*

"Some people were giving different answers so I then got up my own answers" (std_6)

This section outlines the report on the analysis of one of the important factors to consider when engaging in dialogic method of teaching. Before the lessons students were briefed about this approach of teaching and learning science and with that diverse opinions from everyone should be seen as valuable.

"it was interesting and opinions of other colleagues were accepted and used" (Std_3)

During the lessons students were given some few minutes to discuss a given question among themselves in the groups to come up with their answers and suggestions. Students were given the opportunity to freely express themselves and ask questions. In the above extract, std_3 sees this teaching approach as interesting because opinions from everyone were accepted in class.

"Because it can help us to share ideas and it makes teaching and learning easier and understanding" (Std_6)

During the interview, std_6 was asked his opinion about the dialogic approach of teaching science and he recommends that this approach should be continued. The above extract highlights his reason as to why he supports this approach of teaching science. According to std_6, this approach to

teaching science makes it easy for the students to understand the content an as well share ideas among themselves.

6.4   Value of using one's own mind

The dialogic approach of teaching science gives students the opportunity to express their everyday experience and how they basically and in their own way understand certain scientific principles and occurrences before they are guided to understand the real scientific meanings and implication. during the lessons students were given the opportunity to freely express themselves and share ideas on how they understand certain scientific principles. This section therefore discusses the value students place on using one's own mind to explain how to understand scientific principles rather than memorizing without understanding them.

"First one the normal lesson we took it from a book but as for this one we use our own mind" (Std_1)

The extract above highlights how the student compares the normal method of teaching and learning science in Ghana to the dialogic approach of teaching science. it is clear that the dialogic teaching approach gives the students the opportunity to use their own mind and express how they understand the topic. This also gives the teacher the opportunity to know the students understanding of the topic and then guides them to the scientific meaning.

"When I compare it I think this system is very good because in this system no one will laugh at you when you say your ideas and is not specifically from the book and you can also share your ideas in whatever you think that you should add to the lesson you can add to it without anyone saying that you are wrong or right" (Std_2)

The above extract also highlights how std_2 compares the dialogic approach of teaching science to the normal teaching method of science in Ghana. the student sees this approach of teaching as very good because students can freely express their views without anyone laughing at them. Most students become discouraged and would not want to contribute in class when they know their colleagues will laugh at them when their answers are wrong. In this perspective the students are

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able to share their ideas without the fear of been wrong or right (Moate, 2011; Wegerif, 2008). The student also shares the experience that students were given the opportunity to say their own ideas and opinions without specifically quoting from the textbook in the sense that the lesson was so flexible to support teaching and learning. The response from the student reveals the contrast of book-based learning and talk-based discussions. This approach of teaching gave the students the opportunity to embrace talk-based discussions.

"Opinions were accepted from everyone and we tolerated everyone's opinion in the group, we cannot even say one's opinion is not right" (Std_3)

From the extract above, std_3 confirms that opinions from everyone in the group were accepted. They tolerated diverse views from their colleagues. before the lesson the students were briefed on how to tolerate different opinions during the lesson. this is not a common practice in normal science classroom in Ghana. When the student was asked how the group tolerated each person's answer, the student replies that they did not have to tell whose answer was right or wrong.

"Some people were giving different answers so I then got up my own answers" (std_6)

The extract above explains how supportive it is when we tolerate each one's opinions in class. Std_6 explains how the various answers given by other students supported him to come up with his answer as well. This suggests that the dialogic approach of teaching which tolerates diverse views and opinions from people also help others in the class to restructure your thinking.

7   DISCUSSION

This research aims to find out how the implementation of the dialogic approach of teaching science responds to the challenges acknowledged in Ghanaian science education. With respect to this, the study therefore sought to answers two research questions:

1. How do pupils in Ghana respond to/perceive a dialogic teaching intervention?
2. How does a dialogic teaching approach support pupils understanding of science?

This section seeks to find out the extent to which these two questions were answered and further summarizes the diverse perceptions of the students, challenges to the implementation of the study and the recommended approach to the implementation of the study.

7.1   Results summary

In answering the first research question, the participants have shown in various ways how they perceived the lessons. During the interview with the students, they mentioned over and over that the lesson was great, nice, good, interesting, etc to show their approval of the dialogic approach of teaching science and they went further to give concrete reasons on why and how they benefitted from the lessons. The students also recommended the continuation of the dialogic approach of teaching science in their school. This suggests their perception of the introduction of the dialogic approach of teaching science. In an interaction with the science teacher after the lessons, she told me that most of the students who were previously not active in class were seen fully participating by working with their colleagues during the group activities as well as contributing in the lessons. Taking a look at the video data, it was seen that students were actively partaking in the lesson activities and interacted with their colleagues in their groups to bring up their final responses.

In response to the second research question the students again expressed how they benefited from the introduction of the dialogic approach of teaching science. The participants clearly stated how they understood the lessons and how the lessons changed their way of thinking and analyzing some content. When the participants were asked the point at which they came to understand the lessons their responses were towards the opportunity given to them to express their opinions without anyone condemning their views and the various group activities which gave them the opportunity to discuss with their colleagues and to share ideas among themselves before arriving at a consensus. From the interview data, some of the students were able to recall and define some important and basic contents of the lessons which basically show some form of understanding the lesson. This explains that the students did not intend to please me with their comments rather they understood the lessons due to the influence of the dialogic approach of teaching.

Table 4: Summary of themes and subthemes

Themes	Subthemes
Students perception of dialogic teaching approach	- The value students place on the implementation of dialogic teaching approach of science - Students experience with dialogic approach of teaching.
Value of understanding content	- Influence of discussions on students understanding of content - How dialogic approach changed students mindset to develop sophisticated understanding. - Difficulty in understanding the content.
Value of working with peers	- Support from group work - Accepting different views in group activities
Value of using one's own mind	- Opportunity to freely express one's ideas and experiences - Tolerance of diverse views from colleagues

Can the above results be attributed to the introduction and implementation of the dialogic approach of teaching science in the school? From the interview data, students tell me that this approach gave them the opportunity to use their own mind compared to the previous practice where they always go strictly to the books and teacher's opinion. The group activities also supported their learning and one important thing the students confirmed was the opportunity to share their ideas without anyone saying it is wrong or right but however, deliberate to reach a consensus.

The lessons were definitely a deviation from the normal approach of teaching science in Ghanaian classrooms. The students actively participated and had the opportunity to work with each other. The communicative approach introduced by (Mortimer and Scott 2003) was adapted in all the lessons to ensure dialogue and full participation of students in the lessons. Hence, the dialogic approach of teaching science brought about the observable change in the classrooms. The classroom culture in Ghana demands that students raise up their right hands when they want to ask or response to a question and wait to be called by the teacher. From the video data, many students raise up their hands to show their readiness to share their views. The students showed appreciation on the opportunity given to them to freely express their views during the group discussions. The increased participation of the students in the lessons are borne out by the interviews with the students.

7.2   Challenges in the implementation

Major challenges were confronted during the implementation of the dialogic approach of teaching science in the Ghanaian classroom. Large class size was one of the major challenges for the implementation of the dialogic approach of teaching science in Ghana. As indicated earlier almost each class had 80 students for this study. Though the introduction of the group activities helped the students to participate in the lesson, it would have been more effective if the class sizes were smaller. Class control also becomes a challenge due to the large class size more especially when lessons start to get interesting and everybody wants to share an opinion. As the lessons got interesting most students wanted to share more opinions however, due to the large class size and with limited time allocated to each lesson, students at some point could not fully express their opinions. From the video data, it is seen how students are so interested to share their opinions.

In Ghanaian classrooms much importance is placed on written work since all the final and the end of year exams are writing based. Teachers inspect notes given to students and mark class assignments and homework. The head teacher as well as the District Education officers come to the school to inspect all the written assignments given to the students, the teacher's lesson notes and the notes given to the students. This is to prove the progress of the topics covered by the teacher. Considering this context, the oral group activities made use of more valuable contact time to the detriment of the written practice, however, there was the need to balance it carefully considering the benefits of group work. Though it was challenging, I had to incorporate writing into the group activities (Alexander, 2001).

7.3   Communicative Approach

Considering the discussion above, which centered on dialogic approach as an entity, the individual components of the communicative approach on the other hand, functioned differently in the classroom than expected. This section focuses on the communicative approach established by Mortimer and Scott (2003), and communication structure (Alexander, 2006) to analyze how the

dialogic approach in the lesson supported students understanding and the perceptions of the students concerning this this approach. This basically answers the aim of this research.

In the process of question and answer approach in the classroom, teacher evaluates students' responses and rejects diverging viewpoints. The authoritative approach centers on the scientific viewpoint. Before the lessons the student were briefed on the authoritative/interactive approach so that they would not reject diverging ideas from their colleagues. This approach was successfully implemented and from the interview data and as discussed above under the theme *"The value of using one's own mind"*, students shared their experience on how this approach helped them to share their opinions without anyone saying they are wrong or right.

This approach goes beyond students initial responses to explore and exploit student ideas without an aspect of evaluating student comments. This approach as explained by Mortimer and Scott (2003) I did not target on getting specific point of view from students rather solicited different viewpoints either in line with the scientific view or contracting to help student to better understand the lesson. From the video data, students were seen sharing different opinions in their group activities until they come to a consensus. An example can also be cited from the interview data as discussed above when students' reflected on different exploited ideas from their colleagues which supported their understanding of the lesson.

7.4   Communicative Structure

Cumulativity embraces how the teacher and students together build on each other's knowledge and experience (Alexander, 2006). Cumulativity acknowledges and takes advantage of contributions made by students during lessons to make meaning out of it. The cumulative communication structure (*Opening-up and Closing-down)* introduced by Scott and Ametller, 2007 plays a major role in analysing the classroom discussions in this study. In order to resolve students' contributing ideas and opinions when shifting focus towards scientific explanation in a lesson, the teacher should open up room for dialogic discussion to explore students' viewpoints or experiences. During the lessons as seen in video data, I set the ground and gave opportunity for the forthcoming discussions (*Opening-up*) and developed concepts to demonstrate awareness of

the earlier contributions made by students before introducing the scientific point of view (*Closing-down*). This step taken deepened the dialogic approach between the opening-up and closing-down phases hence, exploited students' views and experiences to ensure cumulativity (Scott & Ametller, 2007, p. 82).

As introduced by Alexander (2006) as one of the principles of dialogic teaching, collective participation involves the teacher and students addressing a given tasks in the lesson together. This could be done as a group or involving the whole class. During the implementation of this study in Ghana, students were put in groups and addressed learning tasks together. From the interview data, students shared how they fully participated in the group activities and how they together addressed learning tasks with the teacher to support their understanding of the lessons.

This principle of dialogic teaching as introduced by Alexander (2006) enable students to freely give responses to questions or share their opinions without feeling embarrassed over wrong or right answers and in turn help their colleagues to reach common understanding. From the research data and as discussed above students expressed how this dialogic approach of teaching science gave them the opportunity to freely express their views and ideas without anyone telling them it is right or wrong. From the students' perception as discussed above, this principle was successfully implemented and supported students understanding of the lessons.

This principle of dialogic teaching enables teachers and students to pay close attention to hear each one out during lessons, share various ideas and consider different viewpoints. During the lessons students had the opportunity to listen to the teacher and the teacher intern listened to the students. There were situations in the lessons where students had whole class discussions and they were also put into groups to have group discussions. Some students shared different viewpoints and through the discussions of these ideas, it helped to support students understanding of the lessons. As a teacher, the more you listen to the students it informs you of their ideas and experiences as well as their level of understanding of the topic in order to guide them to fully understand it scientifically.

This principle of dialogic teaching explains how specific educational goals in view help teachers to plan and facilitate dialogic teaching in order to achieve them (Alexander 2006, p.28). As shown in the lesson plans attached to this study, all the lessons had educational goals to be acomplished at the end of each lesson. The lesson plans stated clearly the objectives which students were expected to achieve by the end of the lesson. Though during discussions in the lesson some

responses from the students were not directly related to the main topic, the facilitation of the dialogic teaching approach by the teacher guided the students and supported the classes to achieve the goals of the lessons.

The implementation of dialogic teaching approach seems to make headway in Ghana unlike that of Czech Republic, which faces challenges such as semantic noise and rational argumentation during the lesson delivery (Sedova et, al,. 2014 p. 279-280). According to the researchers, the students highly show willingness to answer teacher's questions and as the teacher calls the students to respond to the questions, the second response typically takes a different twist and do not reach on the initial ones. This suggests that, "such communication lacks uptake and each response returns to starting of the communication sequence, which is the teacher's question. Not only does such a communication lack coherence, but it also does not allow the student to develop her his answer" (Sedova et, al,. 2014 p.279). The authors posit that the absence of rational argumentation orchestrate by the teacher by not encouraging the students to freely express their ideas is a major reason why the implementation of the dialogic approach of teaching faces challenges in the Czech Republic. The implementation of the dialogic approach of teaching science seems to make headway in Ghana due to the lesson I took from the situation in the Czech Republic as indicated. The students in this study were ready to discuss each ones ideas based on the approach I adapted to encourage rational argumentation and on the part of the students (as the schools culture demands), to maintain silence in class to listen when someone speaks in order to be listened when it is their turn to speak.

8   CONCLUSION

8.1   Contribution

This action research was conducted in the classroom with a set goal of implementing dialogic approach of teaching science. The students collaborated and contributed to achieve both the academic and non-academic objectives of the classroom.

After the acceptance and publication of this research, it will be share with partner school. This research could also be shared with department of basic education under the Ghana Education

Service in Kumasi. Since this research is applicable to the Ghanaian classroom, it is perceived that teachers who are interested in the findings of this study can apply them to the classroom. Resources such as the dialogic approach to teaching science and the communication structures introduced by Alexander, 2006 as well as the findings of the study by Lehesvuori, et al., 2013 on the introduction of dialogic approach of teaching science in South Africa can be shared with interested teachers. The information obtained from this study can be beneficial when applying the dialogic approach of teaching science.

Since there are few research papers published on dialogic approach of teaching science, this study can contribute to the wider African context. This research can add to deepen the understanding of the theoretical framework of dialogic approach of teachings science based on the detailed contextual parts. This study can provide support to poised teachers struggling to establish more holistic value based education.

8.2   Limitations of the study

Though I have been a teacher in Ghana for couple of years, I had a strong challenge with the epistemology of the study. My positivist background posed a challenge on the sociocultural nature of action research as well as qualitative research analysis. I found action research appropriate for the implementation of this study in Ghana, however, it was a challenge to stay neutral and not take a positivist stance at the stage of the analysis. The struggle to overcome this challenge is apparent in the report of this study. This study used action research where I taught all the lessons to implement the dialogic approach of teaching science. It is worth questioning how easily other teachers might take on this approach. This research only dwells more on how students respond to this approach of teaching science rather than the implementation because the teachers who have to assist in the implementation were left out of the whole research process.

Another major limitation of this study regards dataset. This study gathered a large dataset but the research report based on a narrow dataset for the analysis. An experienced researcher could have used all the data gathered to provide a real picture of the classroom situation and whether the

implementation was successful or not. I also see a limitation in the area of the analysis since I carried out the action research and did the analysis by myself, there could be some aspects I might overlook. However, a different researcher could be more critical to analyze the same issue from different perspective.

The time allocated for this study was too short to introduce and implement a new approach of teaching which totally deviates from the existing method of teaching science in Ghana. Though the introduction and the implementation were successful, I still believe that more could have been achieved if more time was allocated. I see this as a challenge because only two lessons were made in each class and this could hardly justify the successful implementation of this approach of teaching science. However, the positive response of the pupils and teacher suggest that this is an approach worth working on more in the Ghanaian education.

8.3   Recommendations

This action research and the method applied in attaining the data would go a long way to contribute to further research in same area but in a broader view. However, I would be interested to see the outcome of this same study using different methodology. To have a better view communication structures in the classroom I would recommend a discourse analysis based research to see how the communication structures and the dialogic approach of teaching science supports students understanding.

The education system in Ghana demands that students at the 9th grade write an external exams organized by the West African Examination Council before graduating from the basic school. Students at this grade therefore focus their learning towards passing exams. However, I recommend that this study should be well implemented at the lower levels before the students get to the 9th grade. Since this approach of teaching science facilitates students understanding of the subject matter, students would be well informed and more knowledgeable with the content even before they get to 9th grade to sit their final exams.

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Appendix 1: **Integrated Science Curriculum for Junior High School.** Retrieved from
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on February 18, 2019.

STRUCTURE AND ORGANIZATION OF JUNIOR HIGH SCHOOL INTEGRATED SCIENCE

SECTIONS	JHS1	JHS2	JHS3
DIVERSITY OF MATTER	Unit 1: Introduction to Integrated Science	Unit 1: Elements, Compounds and Mixtures	
	Unit 2: Matter	Unit 2: Metals and Non Metals	Unit 1: Acids, Bases and Salts
	Unit 3: Measurement	Unit 3: Chemical Compounds	Unit 2: Soil and Water Conservation
	Unit 4: Nature of Soil	Unit 4: Water	
	Unit 5: Hazards		
CYCLES	Unit 1: Life Cycle of Flowering Plants	Unit 1: Carbon Cycle	Unit 1: Life Cycle of the Mosquito
	Unit 2: Vegetable Crop Production	Unit 2: Climate	Unit 2: Animal Production
	Unit 3: Fish Culture		
SYSTEMS	Unit 1: Respiratory System of Humans	Unit 1: Reproduction and Growth in Humans	Unit 1: The Solar System
	Unit 2: Farming Systems	Unit 2: Heredity	Unit 2: Dentition in Humans
		Unit 3: Diffusion and Osmosis	Unit 3: Digestion in Animals
		Unit 4: Circulatory System in Humans	
ENERGY	Unit 1: Sources and Forms of Energy	Unit 1: Photosynthesis	Unit 1: Heat Energy
	Unit 2: Conversion of Energy	Unit 2: Food and Nutrition	Unit 2: Basic Electronics
	Unit 3: Basic Electronics	Unit 3: Electrical Energy	
	Unit 4: Light Energy	Unit 4: Basic Electronics	
INTERACTIONS OF MATTER	Unit 1: Ecosystems	Unit 1: Physical and Chemical Changes	Unit 1: Magnetism
		Unit 2: Infections and Diseases	Unit 2: Technology and Development
		Unit 3: Pests and Parasites	Unit 3: Machinery
		Unit 4: Force and Pressure	Unit 4: Entrepreneurship
		Unit 5: Machines	

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Appendix 2: **Junior High School Science Syllabus (Respiratory system of humans).** Retrieved from https://mingycomputersgh.files.wordpress.com/2013/01/integrated-science-syllabus-jhs-1-3.pdf on February 18, 2019.

JUNIOR HIGH SCHOOL 1

SECTION 3: SYSTEMS

General Objectives: The pupil will

1. show an understanding of the role of the respiratory system in the life of an organism.
2. appreciate the basic principles underlying various farming systems.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **RESPIRATORY SYSTEM OF HUMANS**	The pupil will be able to: 3.1.1 draw and label the human respiratory system	Structure of the respiratory system	Let pupils: - explain the meaning of respiration - identify the organs that form the respiratory system using charts. - draw and label the respiratory system using charts NOTE: Structure of individual organs not required	
	3.1.2 distinguish between the two types of respiration.	Types of respiration: o External respiration o Internal respiration	- use digital content for the discussion of types of respiration - observe each other as they breathe in and out - discuss what happens to the chest as they breathe in and out. NOTE: Tissue respiration should be limited to burning of food to release energy, water and carbon dioxide.	Distinguish between external respiration and internal respiration.

Appendix 3: Junior High School Integrated Science Syllabus (Hazards). https://mingycomputersgh.files.wordpress.com/2013/01/integrated-science-syllabus-jhs-1-3.pdf Retrieved on February 18, 2019.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 5 HAZARDS	The pupil will be able to: 1.5.1 explain the term hazard	Meaning of hazard Causes of hazards encountered in teaching and learning science - Toxic, inflammable and corrosive substances - Lack of knowledge or information, etc.	Let pupils: - brainstorm to bring out the meaning of hazard - give examples of hazards encountered in teaching /learning of science - discuss causes of hazards that are encountered in teaching /learning science	Name and discuss three hazards that can occur in teaching and learning science. How do you prevent the hazards?
		Effects of hazards	- discuss the effects of hazards on victims	
	1.5.2 identify and interpret warning and safety signs in science	Warning and safety signs in science	Using charts, teacher to display safety and warning signs on wall for pupils to observe - identify and interpret safety and warning signs	Prepare a table of safety and warning signs and their meaning on a card for a community display.
	1.5.3 safety precautions to prevent hazards	Safety precautions against hazards	- discuss ways to prevent hazards from occurring - identify precautions to adopt to prevent hazards from occurring - role-play hazardous situation in the laboratory and actions taken by pupils to rush the victims to hospital or clinic.	

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Appendix 4: Lesson plan notebook (template) for public schools in Ghana. Pictures taken by me.

Appendix 5: **Lesson plan made by me using the dialogic teaching approach**

Integrated Science lesson plan – Grade 7

Topic: Respiratory System in Humans

Objectives: By the end of the lesson, the pupil will be able to:

- Explain the meaning of respiration
- Identify the organs that form the human respiratory system
- Distinguish between the two types of respiration

Teaching Learning Materials: Chart showing organs that form the respiratory system.

Teaching and Learning activities: (Put students into groups)

Activity 1:   Using the communicative approach, let students

- Explain the meaning of respiration
- (Teacher) Distribute the charts to the groups
- Identify the organs that form the respiratory system
- Draw and label the respiratory system using charts.

Activity 2:   (Students maintain their groups)

- Let students observe each other as they breathe in and out
- Let students discuss in their groups what happens to the chest as they breathe in and out.
- In groups, let students brainstorm to distinguish between external respiration and internal respiration.

Evaluation: Let pupils answer the following questions

- Explain the meaning of respiration
- Distinguish between external respiration and internal respiration

Appendix 6: **Lesson plan made by me using the dialogic teaching approach**

Integrated Science lesson plan – Grade 7

Topic: Hazards

Objectives: By the end of the lesson, the pupil will be able to:

- Explain the term hazards
- Identify and interpret warning and safety signs in science
- Outline safety precautions to prevent hazards

Teaching Learning materials: Pictures showing safety signs.

Activity 1:   Using the dialogic approach. Let pupils

- Brainstorm to bring out the meaning of hazards
- Give examples of hazards encountered in the teaching and learning science
- Discuss in groups causes of hazards encountered in teaching and learning of science
- Share their views on the effects of hazards on victims

Activity 2:   Teacher to distribute safety and warning signs to groups

- Let Pupils identify and interpret safety and warning signs in their groups.
- Let each group give report of different opinions raised in the groups

Activity 3:

- Narrate hazardous situation in the laboratory and ask pupils opinions on how to address the situation.
- Discuss with students ways to prevent hazards from occurring.
- Identify with pupils the precautions to adapt to prevent hazards from occurring.

Evaluation: Let pupils answer the following questions

- Name and discuss three hazards that can occur in teaching and learning science.
- Identify three ways to prevent hazards