INTRODUCTION

Basic education in Ghana, consisting of six years of primary school and three years of junior high school (JHS) education, is faced with many problems. Subjects such as science and mathematics are associated with low learning results (Martin, Mullis & Foy, 2008; Postlethwaite & Wiley, 1992). The poor learning achievements are attributed to poor quality of teaching (GES, 2004). Science teaching is mainly typified by teacher-centered approach (Ottevanger, Akker & Feiter, 2007), rote learning and memorization of facts (Odhiambo, 1972), and teacher presentation of factual knowledge (Quartey, 2007). This reduces the ability of students to engage in verbal interaction which plays an important role in meaning-making. Therefore, this study investigated science teaching, classroom discussion and contexts. It is underpinned by the conception of instruction as a relationship between an individual learner, the instruction, something to be learned, the learning outcome (Bloom, 1976), and the teacher.

METHODOLOGY

This study used Third International Mathematics and Science Study (TIMSS) 1999 video study methodology, Matsubara (2009) lesson analysis method, Anderson et al. (2001) taxonomy table (adapted), Teacher Intentions (TI) lesson analysis framework and Teacher Response Behavior (TRB) lesson analysis method developed by the study.

The mixed methods research design (quantitative and qualitative) was used. However, this study relied primarily on qualitative measures like interviews, video captured data, and direct observations. The data was collected in 2008 and 2009 by video cameras, TIMSS 1999 video study science teachers’ questionnaire, and semi-structured interview guides developed by the study.

Descriptive statistics were carried out on the TIMSS questionnaire, and the interview and the video captured data were analyzed using TIMSS 1999 video study analysis method for science, Matsubara (2009) lesson analysis method, Anderson et al. (2001) taxonomy table, TI lesson analysis framework and TRB lesson analysis method.
The TIMSS 1999 video study analysis method covered 11 dimensions such as science content development, classroom talk, and activity structures. The main features of Matsubara (2009) lesson analysis method were a move (a set of a teacher’s question and a student’s response) and category system which consists of No student response, Teacher-led response, and Non-led response. Anderson et al. (2001) taxonomy table was used to determine the cognitive and knowledge dimensions of teacher questions and students’ answers, and Teacher Intentions lesson analysis method was used to classify teacher intentions behind questions. TRB lesson analysis method was used to analyze how science teachers respond to students’ answers and no responses. The analysis of the video captured and interview data were informed by the work of Miles and Huberman (1994).

Twenty-three JHS science teachers (19 males and four females) in 20 schools were selected, and each teacher taught a science lesson that was observed in camera. The average age of the teachers was 29 years. In addition, 10 head teachers in the JHS (seven females and three males) with an average age of 49 years took part in the study. Furthermore, 12 of the science teachers and 34 students were later interviewed.

RESULTS AND DISCUSSION

**Instructional practices of science teachers**
The science teachers seldom used teaching and learning materials (TLMs), and the pupils do not have opportunities interact evenly with the available ones. Science teachers are encouraged to use TLMs to concretize student learning.

**Factors that influence the selection of lesson content by science teachers**
Science teachers’ decision to select lesson content was greatly informed by curriculum guidelines, mandated textbooks, and external examination and standardized tests. This is because science teachers mainly use curriculum materials like science syllabuses, mandated textbooks and Basic Education Certificate Examination past questions.

**Organization of lesson time**
Science teachers spent most of their time on science instruction, whole class work, seatwork activities, and teacher presentation sessions but very little time was spent on independent work, practical activities and discussion. Science teachers need to organize lesson time effectively on science various classroom activities and actively involve students in lessons.

**Level of Student Cognitive Involvement in lessons**
Students’ answers were usually a demonstration of knowledge, Yes or No responses that are teacher-led, and nonverbal nonphysical responses. Teachers need to use questions to elicit student thinking, regularly invite questions from students, and encourage responses from students.

**Classroom discussion and contexts**
Types of knowledge and cognitive processes in teacher questions and students’ answers
Science teachers placed greater emphasis on eliciting factual knowledge rather than other knowledge dimensions. Besides, they stressed recall and played down high order cognitive processes. Furthermore, most of the students’ answers were a recall of factual knowledge. Teacher questions need to stress remember, understand, apply, analyze, evaluate, and create cognitive processes as well as factual, conceptual, procedural information, and meta-cognitive knowledge dimensions.
Teacher intentions
The intentions of the science teachers in this study were mainly to check students’ knowledge and focus in the lesson. This limits students’ ability during discussions so teacher intentions need to target eliciting student thinking and nurturing student understanding.

Teacher response behaviors to students’ answers or no responses and students’ feeling
TRB to students’ correct or incorrect answers and no responses have been reported. These are encouraging, using, judging, finding out, rejecting, ignoring, and discomforting behaviors.

The students, generally, felt happy and motivated after a teacher’s response to their correct answers, but mainly discouraged and shy after TRB to their incorrect answers and no responses.

Factors that influence classroom discussion
Self-confidence, self-learning and shy-timidity influence classroom discussion. Self-confidence in students is a result of teacher actions like recognizing students’ effort at attempting to answer questions and using positive reinforcement. Using incorrect responses, finding out about responses and using students to judge answers lead to self-learning. Finally, teacher responses like ignoring and rejecting students’ answers and those that cause discomfort to students were put under shy-timidity.

Appropriate teacher response behaviors
Appropriate teacher response behaviors include encouraging, judging, finding out, and using teacher response behaviors. These positively reinforce students’ response behavior. Encouraging and using TRB strengthen students’ self-confidence, and judging and finding out TRB promote self-learning in students.

A Teacher Response Model (TRM) for managing students’ answers to teacher questions, informed by teacher response behaviors that promote self-confidence and self-learning in students, is recommended as appropriate for classroom teachers. This model is guided by the conception that every answer (correct or incorrect) is a useful tool for developing lesson content. TRM has five levels. Levels 1, 2 and 3 require that teachers recognize, commend, and use students’ correct and incorrect answers as valuable contributions in developing lesson content. Level 4 allows teachers to strategically probe students’ answers, and level 5 calls for teachers to modify teacher response behaviors or be flexible in responding to students’ incorrect answers and no responses.

CONCLUSION
Summary, conclusion and recommendations
Science teachers in Ghana do not organize lesson time for effective classroom practices, and curriculum factors mainly affect their decision to select lesson content. The government needs to manage science education, and capacitate science teachers by either supporting programs or acquiring resources aimed at improving the quality of science teaching.

Science teachers stressed recall of factual knowledge rather than eliciting high order cognitive processes and conceptual, procedural and meta-cognitive knowledge dimensions. The quality of students’ answers and thinking is a reflection of teacher questions, so cognitive processes and knowledge dimensions need to be appropriately stressed.

In this study, teacher response behavior to students’ answers and responses are encouraging, using, judging, finding out, rejecting, ignoring, and discomforting response behaviors. The students generally felt discouraged after teachers respond to their incorrect answers and no responses.

Self-confidence, self-learning and shy-timidity were identified as factors that influence classroom
discussion. TRB to students’ incorrect answers that lead to shy-timidity among students are mainly practiced by the science teachers in this study in Ghana, and this leads to low involvement of students in classroom discussion. Self-confidence and self-learning traits in students enhances classroom discussion so science teachers need to engage in response behaviors that promote self-confidence and self-learning in students, and avoid those that breed shy-timidity. Therefore, TRM is recommended for managing students’ answers.

References

備考 論文の要旨はA4判用紙を使用し，4,000字以内とする。ただし，英文の場合は1,500語以内とする。

Remark: The summary of the dissertation should be written on A4-size pages and should not exceed 4,000 Japanese characters. When written in English, it should not exceed 1,500 words.