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Editorial Comment

The Oguaa Educator is a peer reviewed journal that provides the platform for tutors of Colleges of Education, school teachers, headteachers and teacher education researchers to disseminate their insights into innovative teaching and learning as well as educational leadership practices at the pre-tertiary level. The journal therefore publishes original research on innovative and best practices in teaching and learning in all school subjects as well as school management and leadership. Six (6) well researched topics from seasoned and well experienced academics make up this volume. The articles discuss various issues that are found in the classroom, criterion for selection of students into tertiary education institutions, and analysis of a policy. They provided great insight into the issues raised, whilst the authors bring their rich and varied backgrounds to bear in their respective articles.

Ernest Kofi Davis reports on a study which investigated the nature of classroom interaction and how that affects the way pupils learn mathematical concepts meaningfully. Observations of mathematics lessons of three primary six teachers from one District in Southern Ghana were recorded. Results from the study revealed amongst others that the traditional school mathematics micro-culture constituted the dominant public discourse in the three lessons observed. He discusses the findings, and provides its implication for mathematics curriculum development and delivery.

Eric Magnus Wilmot compares the effects of teaching using the methods of Decomposition and the Base Complement Addition (BCA) on primary 2 school children's ability to solve compound subtraction problems in Ghana. He employed the quasi experimental design to explore the effects of the two teaching approaches. The study revealed that Base Complement Addition method improved the performance of primary school children better and had a higher power for retention than the Decomposition method. Differences were found in the performances between the two groups. Recommendations for teacher professional development, curriculum developers and further studies are made.

Jonathan Osae Kwapong investigates the relationship between students' West Africa Senior School Certificate Examination (WASSCE) grades and their performance in the Diploma in Basic

Education (DBE) programme at the Colleges of Education in Ghana. The results showed a statistically significant positive but low relationship between the two variables. It was also found out that using only the core subjects results will better predict performance at the CoE than using the core and some electives. He, therefore, suggests that for effective selection of students for the DBE programme, Colleges of Education may resort to additional predictors such as entrance examination and/or oral interviews besides the WASSCE results.

Asomah, K. R., Wilmot, E. M., and Ntow, F. D. are concerned about the public outcry about students' poor performance in mathematics in Ghana, and therefore examined how junior high school students perceived their mathematics classroom learning environment. A total of 350 eighth and ninth graders (i.e., junior high school forms two and three students) from four public and two private schools in a metropolitan community in southern Ghana participated in the study. The results revealed that, though in general, the perception of students were positive, that of the public school students were relatively more positive than that of their private school counterparts. Implications of this are discussed and recommendations for classroom teachers and future research are also presented.

Christopher Yaw Kwaah and Joseph Ghartey Ampiah investigate the implementation of the School Performance Improvement Plan (SPIP) through the Capitation Grant (CG) scheme which was introduced by the Government of Ghana in the 2004/2005 academic year for basic schools. The authors used the interpretive qualitative approach to obtain data from 48 teachers and eight head-teachers from eight basic schools in one municipal area in the Central Region of Ghana. The study provides insightful discussions on stakeholders' participation in the implementation of SPIP.

Michael Amakyi used a mixed-method design, adopting a non-experimental survey in a basic interpretive study to analyse the institutional climate of high performing schools with the focus on a senior high school. Data were collected from 43 academic staff and six management members of the school, and from 10 purposefully-selected heads and assistant heads of departments. The study revealed among other things that there is a positive school climate showing respondents having a high level of institutional identity, strong collegiality, favourable supervisory styles, and a good sense of professionalism.

These four elements of the positive climate correlates strongly with institutional effectiveness.

Eric Nyarko-Sampson, PhD
(Editor-in-Chief)

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Mathematics Classroom Discourse in typical Ghanaian Public School: How does it look like?

Ernest Kofi Davis

College of Education Studies, University of Cape Coast, Cape Coast, Ghana

ekdavis@ucc.edu.gh

Abstract

This paper reports on a study which investigated the nature of classroom interaction and how that affects the way pupils learn mathematical concepts meaningfully. Observation of mathematics lessons of three primary six teachers from one District in Southern Ghana were recorded. This was followed by analysis of the rationale, general aims and objectives of teaching mathematics and the general teaching approach suggested in the preamble of the mathematics curriculum. The data collected were analysed qualitatively and presented as narrative description with illustrative examples. The results from the study revealed amongst others that the traditional school mathematics microculture constituted the dominant public discourse in the three lessons observed. Discussion of the findings and implication for mathematics curriculum development and delivery, and future research are provided.

Key words: classroom interaction; public discourse; mathematics; primary school; meaning-making.

Introduction

The government of Ghana recognises the role of Science, Mathematics and Technology in the attainment of the developmental agenda of the nation and has therefore identified the development of Science, Mathematics and Technology as one of the pillars for national development (MOEYS, 2004). Several interventions have therefore been put in place by the Ministry of Education to support the development of mathematics and science education in Ghana. One of such interventions was the designation of initially ten (but now eighteen) out of the then thirty-eight public Colleges of Education as

Mathematics and Science Colleges in 2008 to train teachers to teach Mathematics and Science, especially at the junior high school level. Despite these interventions, pupils' performance in Mathematics and Science in Ghana has not been as good as envisaged. At the primary school level, a study conducted to test pupils' level of numeracy showed that many of the pupils had low attainment levels (MoE, 2014). At the junior high school level the situation is not different. Pupils' performance in Mathematics at the junior high school level both locally and internationally has not been high. Ghanaian pupils' performance has always been rated low among the participating countries in TIMSS (see Mullis, Martin, Foy & Arora, 2012, for example).

Some research studies have investigated why pupils in the sub-Saharan African countries, such as Ghana, struggle with mathematics by looking at the teaching practices of beginning teachers and pre-service teachers in English and Mathematics (see Akyeampong, Lussier, Pryor, & Westbrook, 2013, for example). Some of these studies have often questioned the system of teacher preparation and argued that the system is not preparing teachers well enough to teach subjects such as mathematics to pupils (Akyeampong, Lussier, Pryor & Westbrook, 2013). Akyeampong et al (2013), for example, observed that initial teacher training did not equip both beginning teachers (Newly Qualified Teachers or NQTs) and pre-service teachers in Ghana to conceptualise teaching as problem-solving. It did not also help them to draw on the socio-cultural background of the learners to scaffold their learning to make the teaching of mathematics relevant. Others have questioned the Mathematics curriculum, and have described it as being outmoded (Anamuah-Mensah & Mereku, 2005). However, building on the work started by Akyeampong et al (2013), this study sought to contribute to literature on why mathematics is difficult for pupils. This was achieved by exploring how classroom interactions of experienced teachers help pupils to learn mathematics meaningfully, by drawing on Cobb and Bauersfeld (1985) conceptualisation of types of school classroom microcultures and relationship between social processes and psychological development of the learner. Experienced teachers in this context refers to teachers who have taught for more than ten years. In this study, I conceptualised classroom interaction as involving the social and sociomathematical norms of the classroom; here I am looking at explaining and justifying solutions, rationalising others' explanations, agreeing or disagreeing with others' ideas among others, both in general and specific to mathematical activities (Guven & Dede, 2017).

Explaining and justisfying solutions require a sound mastery of language of instruction. Durkin (1991), for example, argues that "Mathematics education begins and proceeds in language, it advances and stumbles because of language, and its outcomes are often assessed in language"(p.3). This quotation shows that mastery of the language of instruction by both the teacher and pupils is key to the quality of the classroom discourse and hence meaning making in mathematics. In classroom contexts where pupils or their teachers or both have limited mastery of the language of instruction, detailed explanation and justification of concepts by teachers or pupils or both is likely to be limited and this has the tendency to affect meaning making in mathematics.

The nature of the classroom interaction characterizes the public discourse in the classroom and hence the classroom microculture (Cobb & Bauersfeld, 1995) and learning outcomes in mathematics. A growing body of literature has shown that the quality of classroom interaction affects the quality of learning outcomes in mathematics in school (Guven & Dede, 2017; Bruce, 2007; Hiroshi & Heinz, n.d.; Pape, Bell & Yetkin, 2003; Cobb & Bauersfeld, 1995). Cobb and Bauersfeld (1995), for example, argue that "Mathematical meanings are considered to be products of interaction processes and to be specific to the microculture studied." (p. 166). Their argument is that mathematical meaning arises and gets stabilized in the process of classroom interaction. This shows that the process of classroom interaction is key to the development of mathematical meaning.

In this paper, therefore, the nature of classroom interaction is positioned as being a strong predictor of students' learning outcomes in mathematics. Looking at the study from the perspective of the dynamics of classroom interactions that produce mathematical meaning in the classroom of experienced teachers provides the opportunity to understand the nature of classroom interaction of typical experienced Ghanaian mathematics teachers who have taught for over ten years and benefited from some in-service training programmes after their initial teacher training. This provides the opportunity for reflections on how their classroom interactions compare with those of the newly qualified teachers reported in previous studies in the same context (Akyeampong et al, 2013).

Some studies have looked at classroom microcultures, focusing on the social and sociomathematical norms and their effect on sense making in mathematics and justification, at the secondary school level, using qualitative approaches (see Goose, 2004, for example). Others have employed quantitative approaches to look at the effects of inquiry based versus traditional mathematics approaches on students' understanding and comprehension at the secondary school level (see Ferguson, 2010, for example). Some studies have also investigated classroom microcultures, focusing on the social and sociomathematical norms of prospective mathematics teachers, using qualitative approaches (see Guven & Dede, 2017, for example). Other researchers have also looked at the effect of class size on classroom engagement and teacher-pupil interaction (see Blatchford, Bassette & Brown, 2011, for example). Blatchford, et al. (2011), for example, found from their study involving primary and secondary school students that class size had effect on the quality of classroom interaction and individual attention primary school children received from their teachers. Many of these studies were conducted in developed countries. However, not many of the studies have looked at the situation at the primary school level, and also in developing countries that do not perform well in international comparative assessment such as Trends in International Mathematics and Science Studies (TIMSS). Looking at the situation at the primary school level and in developing countries that are not doing well in TIMSS provides understanding of the picture across a spectrum of contexts.

Theoretical Framework

Cobb and Bauersfeld's (1995) analysis of types of school classroom microcultures provided the theoretical support for this study. Specifically, their distinction between two types of public discourse in the classroom and the general theoretical positions on the relationship between social processes and psychological development of the learner, provided the author with a theoretical perspective to study the nature of classroom interaction. These theoretical perspectives were important because the study sought to investigate the nature of classroom interaction and how that contributes to pupils' opportunity to make meaning from mathematics instruction in the classroom.

Regarding the distinction between their two types of public discourse in the classroom, Cobb and Bauersfeld (1995) identified two types of mathematics classroom settings based on the type of public discourse that normally takes place in the classroom. These are traditional school mathematics and inquiry mathematics microcultures. According to Cobb and Bauersfeld (1995), the public discourse in traditional school mathematics positions explanation as involving specifying instructions for manipulating symbols. Thus, in the tradtitonal classroom environment, mathematical knowledge is presented as a pre-packaged system of knowledge in which rules and procedures must be remembered and followed in order to be successful. The public discourse in an inquiry mathematics classroom, on the other hand, entails classroom interaction where "teachers and students appear to act as Platonists who are communicating about a mathematical reality that they experience as objective" (p.3). In the inquiry classroom, therefore, mathematical knowledg is presented as knowledge which can be discovered through social interaction in the classroom. These two types of school classroom microcultures in the author's view have implications for the opportunity of students to learn school mathematics, in the sense that the former is likely to promote acquisition of only procedural knowledge. The latter, however, has the tendency to afford pupils the opportunity to develop conceptual understanding of concepts since communication about mathematical reality will provide them the opportunity to make sense of mathematics.

Related to the school classroom microcultures is the relationship between social processes and psychological development of the learner. Cobb and Bauersfeld (1995) identified two general theoretical positions on the relationship as collectivism and individualism. They argue that "the collectivist position is exemplified by the Vygotskian tradition and in the sociolinguistic tradition" (p. 3). The Vygotskian perspective positions learning as being socially constructed through participation of the learner in the sociocultural practices (Vygotsky, 1978). This highlights the importance of co-participation of the learner in the process of development of conceptual concepts in the classroom. Here co-participation involves active participation of the learner in discovering mathematical truths but not mere response to teachers' questions as and when students are invited to do so. Cobb and Bauersfeld (Op cit) further explain that "the sociolinguistic perspective also characterises mathematics learning as an initiation into the social tradition of doing mathematics in school" (p.3). On the other hand, the individualistic theories "treat mathematical learning almost exclusively as a process of active individual construction" (p.3). Here, classroom interaction is expected to provide the individual learner the opportunity to attain growth in mathematical knowledge and experience, based on his or her ability, through personal and active construction of mathematical knowledge and understandings.

These two theoretical positions also have implications for the kind of classroom interaction and the opportunity for pupils to learn mathematics meaningfully. In the author's view, both attention on the group, that is, collectivism and the individual, that is, individualism are very important in mathematics teaching and learning. Attention could be on a group at one point in the classroom discourse, but may have to shift from the group to the individual at another point if the individual is being left behind or the individual needs to be given the opportunity to move at his/her own pace. These perspectives provided the lens to study typical classroom interactions in Ghanaian schools and suggest ways of improving instruction in mathematics in Ghana and other sub-Saharan African countries that share a similar situation to that in Ghana.

The Purpose of the Study and Research Questions

The purpose of this study was to contribute to the understanding of why Ghanaian public school pupils find mathematics difficult by exploring the nature of classroom interaction of teachers to ascertain how they promote meaning making in mathematics. This was done by inferring students' difficulties in learning and lack of meaning based on the examination of the opportunities to learn through lesson observations. The questions that guided the study were:

1. Which type of classroom microculture (traditional school mathematics or inquiry mathematics) does mathematics classroom interaction of experienced mathematics teachers in a typical Ghanaian primary school reflect?
2. How does the classroom microculture of the experienced teachers help pupils to learn mathematics meaningfully?

3. How does the teaching of mathematics by experienced mathematics teachers reflect the everyday context experienced by pupils?
4. How does the classroom microculture in typical Ghanaian primary mathematics classroom of experienced teachers reflect the rationale for teaching mathematics and the suggested approaches to teaching mathematics in the Ghanaian primary school mathematics curriculum?

Method

In addressing the research questions, a qualitative exploratory method involving the use of observations and document review (Creswell, 2012) was adopted to explore the nature of classroom interactions and how they affect pupils' opportunity to learn mathematics. One hundred and one primary six pupils and their teachers from three public primary schools, one each from below-average, average and above-average achieving schools from one District in Southern Ghana participated in the study. The average teaching experience of the teacher was 21years with the minimum being 13years and the maximum being 34years.The list of primary schools in the District based on their achievement levels were collected from the District Education Office, since basic schools in Ghana are usually categorised based on their achievement in the national examinations as above-average, average and below-average achieving schools. Treating each of the achievement levels as the strata, the stratified random sampling procedure was used. The simple random sampling procedure was used to select one school each from the list of below-average, average and above-average performing schools. In each of the selected schools, all primary six pupils were purposely selected. The number of pupils from the above-average, average and below-average schools were 33, 43 and 25, respectively. Primary six pupils were considered because it constitutes the end of primary education and transition between primary and junior secondary school in Ghana. In addition, primary six pupils have used English as the medium of instruction for three years, so as compared to pupils below primary six, they were more likely to express their ideas in simple English in the classroom interactions. The use of below-average, average and above-average achieving schools provided the opportunity for the researcher to investigate the issue across contexts of schools.

One mathematics lesson was observed from each of the teachers in the schools. The topic that was treated in the lesson at the above-average achieving school was "Multiplication of whole numbers by a fraction", the topic treated at the average-achieving school was "Arranging combination of fractions in ascending order", while "Division of fractions" was treated in the below-average achieving school. In order to ensure that the study did not interfere with the topics teachers had planned to teach for the term in each of the schools, the author requested teachers to choose topics based on their scheme of work for the term. The lesson observation was followed by review of the rationale, general aims, general objectives, scope of the syllabus, approaches to teaching and learning mathematics in the 2012 Ghanaian primary school mathematics curriculum. The observation schedule was developed by the author and validated in a pilot school outside the research locale to ensure that they elicited valid response. The observation schedule was structured according to the theoretical framework, they focused mainly on the type of classroom microcultures and the relationship between social processes in the classroom and psychological development of the learner. The data collection was done by the author with the support of two trained research assistants, who were also experienced teacher educators in October, 2017. Each of the lessons was video taped, whilst field notes were also taken during the lesson observation. The three observed the lesson after which their observations were synchronised.

Permission was sought from the District Education office and the participating schools before the study was carried out. The research project was explained to the research participants. Consent of teachers was sought. While assent of pupils was also sought before the commencement of the study. The research participants were assured of anonymity and confidentiality. They were informed that pseudonyms/codes will be used to identify the schools and the research participants in the presentation of results so nobody will know what they said. Informed by the theoretical framework, the data obtained were analysed qualitatively and presented as narrative description with some illustrative examples. The distinction between two types of public discourse in the mathematics classroom and the general theoretical positions on the relationship between social processes and psychological development of the learner, provided the theoretical support for this study (as already noted in the theoretical framework). The analysis of the data therefore covered the nature of classroom interaction, how the teaching of mathematics reflects the context of pupils and the effect of classroom interaction on pupils' opportunity to learn mathematics meaningfully. Pupils who participated from the below-average schools were coded PL1, PL2, ... PLn. Pupils who participated in the average school were coded as PA1, PA2, ... PAn and those from above-average schools were coded PAB1, PAB2, ...PABn. The teacher from the below average achieving school was coded TB, while the teachers from average and above-average achieving schools were coded TA and TAB, respectively.

Results

In this paper, classroom interaction has been positioned as an important factor in mathematical meaning-making in mathematics classroom. The study sought to explore why mathematics is difficult for Ghanaian school children by investigating the dominant public discourse in the classrooms of experienced primary school teachers to ascertain how that helps pupils to learn mathematics meaningfully. As already noted in the purpose of the study, students' difficulties in learning and lack of meaningful learning was inferred through classroom interactions during lesson observations. Learning difficulties and meaning-making in mathematics by students was therefore not measured directly from the students. In this section, the results of the analysis of data on the nature of classroom interaction is presented. Analysis of the rationale, general aims and strategies for teaching and learning mathematics in the preamble of the primary school mathematics curriculum is also presented to afford discussions on the relationship between the classroom microculture identified through lesson observation, and those espoused by the primary school mathematics curriculum.

Nature of classroom interaction

Teaching Approach

The observation of the lesson of the two teachers brought to light that classroom interactions were mainly in English Language and vertical in the form of teacher posing questions and pupils responding to the teachers' question as shown in the excerpt of the lesson taught by the teacher in the above-average achieving school (TAB) below:

TAB: Today we are going to look at multiplication of a whole number by a fraction. By the end of the lesson I want you to be able to multiply whole numbers by fractions.

TAB: Let's look at six times one-eighth.

TAB: [Writes] $6 \times \frac{1}{8}$

TAB: It means one-eight six times. One eight repeated ... or one-eight added six times

TAB: This procedure we are using is multiplication as repeated addition. So you will repeat one-eight six times.

TAB: So we have one, two, three, four, five, six. [writes] $\frac{1}{8}+\frac{1}{8}+\frac{1}{8}+\frac{1}{8}+\frac{1}{8}+\frac{1}{8}$.

TAB: Can you see that?

Pupils: Yes, madam [in chorus].

TAB: If you have fractions and they have the same denominator, you just add what?

Pupils: Numerator [in chorus].

TAB: Let's add the numerators

TAB: What is the answer, PAB20?

PAB 20: Six

TAB: Six out of what?

PAB 20: Eight.

TAB: Clap for him.

TAB: Let's look at another example...

It is evident from the interaction that pupil PAB, who was invited to contribute to the lesson just responded to the teacher's questions without explaining his answer. The teacher was interested in predetermined answers from the pupil. Again, pupils hardly posed questions to the teacher neither did they pose questions to their colleagues. The teacher's aim was to help the pupils to master rules and procedures. Issues relating to monologist nature of the classroom interaction will be discussed further at the final section of the paper as part of the overall discussion. These observations were not limited to only the above-average school. It was a common trend in all the three school types.

The sequence of lesson presentation was review of previous lesson, introduction of topic for the day and lesson delivery using the whole class approach. Exposure of pupils to formulae and how to use them appeared to be the main aim of the teachers in all lessons. The excerpts from the lesson from the below-average achieving school support these and some of the observations made earlier:

TB: [Writes division of fractions on the chalkboard]
TB: What did we learn in our previous lesson?
PB13: Dividing whole numbers ...
TB: Dividing whole numbers by what?
PB18: Dividing whole numbers by fractions
TB: So we looked at dividing whole number by fractions in our last lesson. In today's lesson we will look at dividing fractions by fractions.
TB: When we look at dividing fractions by fractions, we will get to a stage where we are going to use something called BODMASS. So let's look at dividing fractions by fractions.
TB: Let's start with an example [writes] $\frac{1}{2} \div \frac{1}{4}$
TB: If you recall, we did multiplication of fractions
Pupils: Yes sir [in chorus]
TB: Since we are dividing you change the sign to multiplication and turn one over four up side down. [writes] $\frac{1}{2} \times \frac{4}{1}$.
TB: Are you following?
Pupils: Yes sir [in chorus]
TB: After getting something like this [points at $\frac{1}{2} \times \frac{4}{1}$] what you can do is you can cancel two and four. So if the number cannot cancel each other, then you have to multiply the numerator by the numerator and the denominator by denominator.
TB: Okay how do we solve $\frac{1}{2} \times \frac{4}{1}$?
PB23: [puts up the hand]
TB: Yes, PB 23
PB23: One cannot cancel itself. When it cancels it will be the same. So you leave it as it is, and two can cancel itself one and go into four two times.
TB: What is next?
P23: You multiply and get two
TB: It is not necessary to say two over one. You do not have to say any number over one. Just mention the number. It is wrong, okay?
Pupils: Yes sir [in chorus]
TB: Let's take another example ...

Apart from the classroom interaction being vertical with the teacher always posing questions for the pupils to answer, the teacher did not give pupils the opportunity to discuss pupils' answers in detail to create a shared meaning of what they were learning. As with the lesson in the above-average school, the teacher appeared to be interested in predetermined answers. Very little attention was paid to students' understanding of concepts in the teaching and learning process. For example, pupils PB23's assertion that "one cannot cancel itself. When it cancels it will be the same. So you leave it as it is" was a misconception which the teacher should have dealt with but this was left unaddressed. Indeed, one divided by one is one so one cancel's itself once (using the student and the teacher's terminology for division).

At the average school where the teacher began engaging students in discussion about the topic the class was going to learn for the day and how that relates to previous topics done in primary four and primary five, the classroom interaction quickly turned into rules for solving mathematical tasks relating to the topic as shown in the excepts below:

TA: We talked about fractions and said it is a part of a whole. In arranging numbers we can do it in two ways, either in ascending order or descending order.

TA: When we say ascending order, who can tell me what it means?

PA25: Arranging something ....

PA1: Arranging something from the smallest to the other.

PA31: From the smallest to the biggest.

TA: Do you hear what she is saying?

Pupils: Yes madam [in chorus].

TA: I know you did it [ascending order of arrangement] in primary 4 and 5, so when they give you numbers and they ask you to arrange in ascending order, it means just arrange from the smallest to the biggest. Today, we are going to look at how to arrange fractions in ascending order, okay!

Pupils: Yes madam.

TA: Let's look at this example [writes] $\frac{1}{3}, \frac{1}{4}, \frac{1}{2}$ on the green board.

TA: How do you pronounce this [point at $\frac{1}{3}$ and asks PA38 to answer]

PA38: One out of three.

TA: Clap for her. It is not one over three but one out of three.

TA: We are going to arrange one out of three, one out of four and one out two in ascending order.

TA: When we look at it we can't tell which one is the smallest …. , unless you work it out. For us to be able to find out which one is the smallest we have to find the LCM [least common multiple] of the down numbers [denominators]..

It appears the main task was for children to remember rules and just apply them. The classroom interactions therefore focused on the realisation of this agenda. These issues will be discussed further in the final section of the paper as part of the overall discussion.

In each of the three lessons observed, classroom interactions was reduced to teachers posing questions occasionally and pupils responding to the teacher's question using short phrases. Pupils hardly asked questions and there was very limited explaining and justifications of response by pupils. Also, teachers hardly asked high order questions that required in-depth explanation of mathematical facts and justification of answers. This could be due to pupils' poor mastery of the English language, the language each of the teachers used in teaching each of their lessons. This issue will be revisited and discussed in detail in the discussion section.

How teaching of mathematics reflect the context of pupils

The use of contextual problems in the development of the topic was not evident in the classroom interactions in each of the contexts of schools. In teaching multiplication of whole numbers by fractions in the above-average achieving school, for example, teacher TAB worked two examples; $6\times\frac{1}{8}$ and $4\times\frac{1}{10}$, after which pupils were given these exercise $2\times\frac{3}{10}$, $4\times\frac{1}{12}$, $9\times\frac{2}{20}$, $6\times\frac{1}{15}$ and $7\times\frac{2}{5}$ to do in their exercise books. It is therefore evident that the topic was taught out of context. The mathematical concept that was taught had no link with reality such as comparing fractions of candy shared among pupils or real life problems involving comparing fractions of different crops in a mixed crop farm.

The results on the nature of the classroom interaction and how the teaching of mathematics helps pupils to relate mathematics to real life situation in the three school contexts have provided an insight to discuss the type of classroom microculture in typical Ghanaian public primary school mathematics classrooms and how that helps pupils to learn mathematics meaningfully.

Effect of classroom interaction on pupils' opportunity to learn mathematics meaningfully

The social process in the classroom, where the teacher who appears to know everything, and pupils who look up to the "all-knowing teacher", resulted in the situation where the social interaction produced very little effect on psychological development, both at the individual and group levels. This was evident in the unfulfilled promise of what pupils were told they were going to learn as a group in some instance; "when we look at dividing fractions by fractions, we will get to a stage where we are going to use something called BODMASS. So let's look at dividing fractions by fractions." (TB). Teacher TB in the below-average achieving school did not find space to create the opportunity for pupils to understand what the acronym BODMASS was neither did she use it to solve problems involving division of fractions. Lack of attention to pupils' contribution by the teacher and lack of collaboration among pupils denied some of the pupils the opportunity to attain psychological development at the individual level. For example, pupil PB23's assertion that "one cannot cancel itself. When it cancels it will be the same. So you leave it as it is" was an opportunity for pupil PB 23 to have obtained personal growth through the social process in the classroom. Others who had similar conception about one divided by one would have also understood. This issue will be discussed further in the discussion section.

The rationale for teaching mathematics and the suggested approaches to teaching mathematics in the Ghanaian primary school mathematics curriculum

The rationale, general aims, general objectives, scope of the syllabus, approaches to teaching and learning mathematics in the Ghanaian primary school mathematics curriculum is well documented and available online (see Ministry of Education, 2012). I will therefore not reinvent the wheel. In this section of the paper, I will provide just highlights of some of the main issues in the rationale for teaching and learning mathematics, and the suggested approaches to teaching and learning mathematics in the curriculum to enable me provide an analysis of the kind of classroom microculture, the social process and psychological development the curriculum envisages.

The rationale and the general aims of teaching and learning mathematics at the primary school suggest that mathematical training should empower the primary school pupils with mathematical thinking ability, problem solving skills, ability to communicate and good attitudes towards mathematics (MoE, 2012, pp.iv-v). For example, the rationale for teaching and learning mathematics at the primary level states that:

> The learning of mathematics at all levels [in the primary school] involves more than just the basic acquisition of concepts and skills. It involves, more importantly, an understanding of the underlying mathematical thinking, general strategies of the problem-solving, communicating mathematically and inculcating positive attitudes towards an appreciation of mathematics as an important and powerful tool in everyday life. (MoE, 2012 p.iv).

To achieve the rationale and the general aims of teaching and learning mathematics at the primary school level, the curriculum suggests the use of problem solving approaches and highlights the use of open-ended and contextual problems in the development of concepts as shown in the excerpts from the curriculum below:

> Children learn mathematics most effectively through the application of concepts and skills in interesting and realistic contexts that are personally known to them. This means that mathematics is best taught by helping children to solve problems drawn from their own experience ... Children need to be given various opportunities to work on open-ended problems (MoE, 2012, pviii).

It is clear from the preamble of the 2012 primary mathematics curriculum that the classroom microculture envisaged in the rationale, general aims of teaching and learning mathematics and the suggested teaching strategies support the public discourse in an inquiry mathematics classroom. This is because if mathematical training is aimed to empower the primary school pupil with mathematical thinking ability, problem solving skills, ability to communicate and develop positive attitudes towards mathematics (MoE, 2012, pp.iv-v) and this is to be achieved through problem solving, then teachers and students have to act as Platonists in communicating about a mathematical reality

(Cobb & Bauersfeld, 1995). Mathematical knowledge cannot be presented as a pre-packaged set of rules to pupils to take without questioning as was seen in the excerpts from the three lessons observed but as knowledge that can be discovered through social interaction in the classroom. Emphasis on open-ended real life problems shows that the intention of the curriculum requires pupils to experience mathematics as a human activity which is open to proof by all, including pupils. The question is why are the actual classroom situations recorded through observations differ from what appears to be the intention of the curriculum? Discussions in the concluding section will shed light on it and provide suggestions for future research.

Discussion

The Type of Classroom Microculture

It is evident from the results of the study that explanation in each of the lessons observed in each of the three context of schools was positioned as mainly involving specifying instructions for manipulating symbols. This was evident in how each of the three teachers made the effort to ensure that the pupils followed rules for manipulating mathematical symbols without making sense of mathematics; "since we are dividing you change the sign to multiplication and turn one over four up side down" (TB), "... for us to be able to find out which one is the smallest we have to find out the LCM [Least Common Multiples] of the down numbers[denominators]" (TA). The public discourse that took place in all the classrooms reflected what Cobb and Bauersfeld (1995) termed "traditional school mathematics". This is because in each of the lessons explanation was reduced to provision of instructions for manipulating mathematical symbols.

The social processes in each of the three classroom contexts did not promote effective psychological development of the learners. While in each of the lessons some degree of pupils' involvement was observed, pupils' involvement was reduced to answering teachers' questions. They did not have the opportunity to question the approaches used by the teachers, neither did they get the opportunity to contribute their own ideas in the development of the topics. They did not have the opportunity to construct their own understanding of the concept being taught. Social interaction did not promote quality cognitive development because interactions in the classroom only equipped the pupils with procedures for manipulating symbols without understanding why the procedures work "since we are dividing you change the sign to multiplication and turn one over four up side down ..." (TB). In this case, the pupils were asked to change the operation sign from division to multiplication and multiply reciprocal of the divisor by the dividend to obtain their answer without creating the opportunity for them to understand why it works. This shows clearly that social interaction in the classroom did not promote co-construction of knowledge by the teacher and the pupils (Steele, 2001). This provided very limited opportunity for the development of mathematical thinking, problem solving skills, communication skills and attitudes. The collectivist position exemplified by the Vygotskian tradition and in the sociolinguistic tradition (Cobb & Bauersfeld, 1995), was not evident in each of the lessons.

Pupils did not have the opportunity to learn mathematics through real life problem solving, even though the topics afforded the use of such developmental approaches. For example, contextual problem involving comparing the sizes of portions of land a chief in a village shared among three clans could have been a meaningful context for teaching and learning arranging fractions in descending order. With such meaningful context and flexibility in language use by pupils in the classroom, experience and research have shown that Ghanaian school children contribute actively in discovering mathematical truth (Davis & Chaiklin, 2012).

Traditional school mathematics microculture and meaning-making in mathematics

This study investigated the public discourse in three school contexts, below-average, average and above average achieving schools, and the result has shown that the "traditional school mathematics" microculture constituted the dominant public discourse in each of the lessons observed across the context of schools. The findings from the study have provided insight to reflect on how the dominant public discourse affected meaning-making by pupils in the lessons observed. It is evident from the results of the study and ensuing discussion so far that the traditional school mathematics microculture does not give pupils the opportunity to learn mathematics meaningfully. It promotes rote learning. In this type of classroom environment, becoming successful in mathematics means listening attentively to the teacher, following the steps the teacher uses to solve the problem and memorising it. This can only help pupils to acquire procedural knowledge and therefore develop instrumental understanding of concepts rather than relational understanding (Skemp, 2006). Studies have shown that prescriptive instructional approaches such as the ones observed in this study do not equip students with the understanding of why mathematical processes work (Selling, 2016). On the other hand, studies have shown that inquiry mathematics classroom environment provides better learning outcomes in terms of students' achievement in mathematics than the traditional mathematics classroom environment (Furguson, 2010).

The finding shows that issues relating to quality of lesson delivery of Newly Qualified Teachers (NQTs) in primary mathematics classrooms in Ghana and some sub-Saharan African countries reported by Akyeampong, et al, (2013) may not be limited to Newly Qualified Teachers (NQTs) alone, but also to some experienced primary school teachers. It appears teaching to promote meaning making in mathematics through the use of developmental teaching approaches such as problem solving is absent in mathematics lessons of not only newly qualified teachers, but also in the classrooms of experienced teachers in different context of schools. Contrary to literature on the effect on class size on classroom interaction and individual attention primary school pupils receive from teachers (Blatchfort et al, 2011), in this study class size did not have effect on the quality of classroom interaction. The nature of classroom interaction in the below-average school, which had class size of 25 pupils was not different from the average achieving school, which had class size of 43.

Relationship between the classroom microculture in typical Ghanaian primary mathematics classrooms and those espoused in the general aims, rationale for teaching mathematics and the suggested approaches in the pre-amble of the Ghanaian primary school mathematics curriculum

The findings from this study have shown that gaps exist between the classroom public discourse envisaged by the primary school mathematics curriculum as spelt out in the preamble and the actual public discourse observed from the lessons from each of the teachers.

While the rationale for teaching mathematics, the general aims and suggested teaching approaches support inquiry mathematics classroom microculture, the actual classroom practices of teachers observed reflected the traditional school mathematics microculture. While the curriculum emphasize development of mathematical thinking ability, problem solving skills, ability to communicate and attitudes towards mathematics through the use of developmental approaches such as problem solving (MoE, 2012, pp.iv-v), teachers used approaches that promoted memorisation of rules in carrying out mathematical procedures.

There could be several reasons why what seems to be a gap between the intention of the curriculum and outcome of its implementation exist. However, three of them would be discussed based on research and experience. These are (1) linguistic problems, (2) mismatch between rationale for teaching mathematics, the general aims and suggested teaching approach in the pre-amble of the curriculum on the one hand, and the specific objectives for individual topics and the suggested teaching approaches for teaching such topics on the other hand, and (3) lack of short term demand driven training for teachers.

Durkin (1991) posits that "mathematics education begins in language, advances and stumbles because of language, ... assessed in language" (p. 3). This shows that language plays a major role in the nature and quality of classroom interaction. It is the means through which advanced modes of thoughts are communicated from one individual to others (Sutherland, 1992). The language of instruction therefore has the tendency to influence the type of public discourse in the classroom and hence the kind of classroom mathematics microculture. In a class where the pupils have good mastery of the language of instruction, pupils are likely to express their ideas freely without being concerned about any form of embarrassment through the wrong use of language. This enhances the quality of classroom interaction and pupils' opportunity to learn mathematics meaningfully. However, in public school classroom contexts like Ghana where many of the children can barely express themselves in the language of instruction and are also shy of expressing their ideas because of fear of being embarrassed when they make grammatical errors (Abenyega & Davis, 2015), they hardly contribute to class discussions. They hardly ask questions or share their views about the topic being discussed.

Usually, only the few who can express their ideas in the English language participate in the classroom interaction. This might have contributed to the vertical nature of classroom interaction, in which teachers dominated the lessons. The teachers do most of the talking and invite pupils to come in as and when they deem it necessary to do so. The pupils' mastery of English language might have therefore been one of the major factors that affected the nature of classroom interaction in each of the lessons observed. Promoting classroom microculture which reflects inquiry mathematics requires good mastery of language of instruction. This calls for flexibility in the language of instruction at the upper primary level if pupils are expected to actively engage in classroom interactions that promote critical thinking, problem solving, communication and attitudes. As already suggested in Davis (2011), the Ghanaian language should always be available as an additional resource. What is the point teaching a child in a language the child struggles to understand? It appears the language of instruction policy in Ghana should be looked at again critically to ascertain whether the system is not setting up pupils who have weak mastery of the English language to fail.

There appears to be mismatch between rationale for teaching mathematics, the general aims and suggested teaching approach in the preamble of the curriculum on the one hand, and the specific objectives for individual topics and the suggested teaching approaches for such topics on the other hand. The suggested approach to teaching the ordering of fractions in the same curriculum, for example, does not support the use of problem solving approaches which was mentioned in the preamble of the curriculum. The approaches do not draw on a single real-life problem to exemplify how comparison of fractions could be taught in context through problem solving. They reflect pretty much what the teacher followed in the lesson. This trend is not limited to only the mathematics curriculum, it reflects the presentation of the development of mathematical concepts in some of the popular textbooks. In teaching volume of cuboids in primary five, for example, one of the popular textbooks provides an activity involving measurements of lengths, widths and heights of given cuboids and finding the product in each case, after which the formula for finding the volume of a cuboid is provided. Some exercises are given, afterwards (Yeboah, 2011, p. 69). Such approaches equip pupils with only procedural knowledge without helping them to acquire conceptual understanding of procedures since the activity did not explain why children should measure the lengths, width and the heights and multiply them. The children have to follow the author's prescriptions unthinkably. Clearly, the teaching approaches used by the teachers reflected those suggested in many of the best-selling mathematics textbooks and suggested the approaches to teaching specific topics in the mathematics curriculum.

This shows that while the preamble of the curriculum suggests approaches that support inquiry mathematics classroom public discourse, the suggested approaches for teaching individual topics such as comparing fractions and approaches suggested in other curriculum materials such as textbooks reflect tractional mathematics classroom public discourse. This might have contributed to the predominance of the traditional mathematics classroom public discourse observed in the lessons. It is evident that the intention of the curriculum is excellent but the concrete approaches that would lead to the realisation of these intentions is what mathematics education researchers in Ghana and developed countries that are interested in international cooperation in education should engage with.

Akyeampong et al. (2013), attributed the poor quality of teaching of newly qualified teachers to the initial teacher training. However, this study has shown that it goes beyond that. Lack of demand driven short term professional development programmes for school teachers may also contribute to the predominance of the traditional mathematics classroom public discourse in the lessons observed. There are no structured systems in place to support the continuous professional development of teachers through short teachers training programmes aimed at updating the knowledge and skills of teachers, neither are there avenues for teachers who are struggling with any given mathematics content or an approach to teaching mathematics to obtain support from the Ghana Education Service. The majority of the in-service opportunities are upgrade programmes that lead to the award of degrees or diplomas. The question is how then does a teacher who is having difficulty with the teaching of a topic or applying a developmental teaching approach or managing a class get help without necessarily enrolling on an upgrade programmes? For example, experience and research have shown that Ghanaian teachers often have difficulty drawing on the local context in teaching mathematics (Davis, 2010; Davis & Seah, 2016). If teachers have difficulty drawing on the local context, then they are likely to teach out of context as was seen in the lessons observed. Naturally, such teaching approaches would not support inquiry mathematics classroom microculture but rather the traditional mathematics classroom microculture because they provide very little opportunity for mathematical thinking, problem solving, communication and development of positive attitudes.

Contrast between what happened in class and what a different approach might have looked like.

It was evident from the results of the observation of the three lessons that teachers from all the three school contexts employed approaches that gave pupils very little opportunity to make meaning of mathematics. The structure of their lessons were similar; review of what was learnt previously/declaration of the objective of the lesson for the day, development of lesson using the exposition method, with the teacher occasionally asking questions from pupils and evaluation of the lesson by giving pupils related task to do. Each of the classroom interactions was teacher-centred. There appears to be no difference in the quality of classroom discourse across the three school context, from the lesson observation. Further studies would be needed to provide insights into what might account for the differences in performance of pupils across the three school context.

In the view of the researcher, a teaching approach that draws on everyday practical experiences of pupils to scaffold their understanding of school concepts, together with flexible language of instruction might have produced some different results. In teaching comparing fractions in the average-achieving school, for example, the classroom discourse would have promoted meaning making if the teacher had connected the concepts to the everyday real life experience of children such as comparing one-fourth of an orange to one-eight and one-sixteenth of the same orange. This would have made the concept more visible to the the pupils than the use of LCM at that stage of the lesson. The classroom discourse might have been more dynamic than it was in the three lessons, if the teachers had adopted an approach that permitted pupils, especially those with limited English language proficiency to express their ideas freely in any language of their choice, that is, in either

English language or the local language. Experience and research with Ghanaian primary school children have shown that in the classroom context where pupils who struggle to express their ideas in the English Language are permitted to express their ideas freely in the local language, the quality of class discussion improves (Davis & Chaiklin, 2015).

Conclusion and Implication

The author positions classroom interactions as an important factor in meaning making in mathematics teaching and learning and contributes to the understanding of why Ghanaian public school pupils find mathematics difficult by exploring the nature of classroom interaction of three experienced teachers to ascertain how their classroom interactions promote meaning making in mathematics. The author concludes that the dominant public discourse in each of the lessons observed was the traditional school mathematics microculture (Cobb & Bauersfeld, 1995). This discourse type affected the quality of lessons observed. It reduced meaning making in mathematics teaching and learning to correct reproduction of mathematical facts by pupils. Gaps existed between public discourse envisaged in the preamble of the mathematics curriculum and the public discourse observed during lesson delivery. In other words, gaps existed between the intentions of the curriculum and what was observed in the actual classroom situation. While the rationale and general aims of teaching mathematics in the preamble of the syllabus projected inquiry mathematics classroom microculture, the actual classroom practices reflected traditional school mathematics microculture. The results have implications for teachers' professional development, curriculum development and delivery in mathematics and future research.

It was evident from this study that the approaches used by the teachers reflected what was in primary mathematics textbooks. This implies that, there is the need for Curriculum Research and Development Division (CRDD) of Ghana Ministry of Education to ensure that the content of the basic curriculum materials in mathematics such as textbooks support the attainment of the general aims and objectives of teaching mathematics in Ghana, which include development of mathematical thinking, problem-solving, communication and attitudes. The findings from this study also point to the need for the National Teaching Council to create opportunities for teachers who want to update their knowledge and skills without necessarily obtaining degree/diploma to be able to do so. The National Teaching Council could create National Centres of Teaching Support across the country, where teachers who need support in areas such as pedagogy, content or classroom management could go and get the needed support. These National Centres of Teaching Support could collaborate with the teacher education universities and Colleges of Education across the country to offer support to teachers who have challenge with any aspect of their professional practice. The recommendations relating to curriculum development and delivery, and teacher professional development, if implemented, may go a long way to improve meaning making in mathematics lessons in the public schools that were involved in this study and those that share similar characteristics with the schools that participated in the study.

Although the study involved observation of classroom practices of only three primary six teachers, one each from below-average, average and above-average achieving schools, the findings may point to what may be happening in the classrooms of other experienced teachers in Ghana and other sub-Saharan African countries that share a similar situation to that of Ghana. Examining the situation across many primary schools in different school contexts might give a better picture about the dominant mathematics classroom microculture in Ghanaian primary schools. Further research can therefore be conducted on a large scale to examine the nature of classroom interaction of experienced primary school mathematics teachers and how that affects the quality of learning outcomes in mathematics. Such a project may also consider observation of each teacher more than once since this self funded project lacked funds to carry out such a large scale data collection.

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A comparative study of the effect of the methods of Decomposition and Base Complement Addition on Ghanaian children's performance on Compound Subtraction

Eric Magnus Wilmot

College of Education Studies, University of Cape Coast, Cape Coast, Ghana

ewilmot@ucc.edu.gh

Abstract

This paper compares the effects of teaching using the methods of Decomposition and the Base Complement Addition (BCA) on primary school children's ability to solve compound subtraction problems in Ghana. Ninety-six (96) Primary 2 children from two schools participated in the study. For four weeks, children in one of the participating schools were taught using the Base Complement method while their counterparts in the other school were taught using the Decomposition method. A pre-test and a post-test were organized for both groups before and after the teaching sessions respectively. In addition, four weeks after the teaching sessions a retention test was conducted. The study revealed that Base Complement Addition method of performing compound subtraction improved the performance of primary school children better and had a higher power for retention than the Decomposition method. In addition, the differences in performance between the two groups, as measured by the effect sizes (0.585 and 0.499 respectively at the post- and retention-test levels), was medium and therefore non trivial. Interpretation of these effect sizes has been discussed. In addition, recommendations for teacher professional development, curriculum developers and for further studies have been made.

Key words: Compound Subtraction, Method of Decomposition, Base Complement Addition.

Introduction

The importance of subtraction in our daily activities cannot be over emphasized. In the early years of primary education, addition and subtraction are two of the basic operations students encounter in their mathematics lessons. Unfortunately, primary-aged children have been reported in many studies to either lack in computational skills (see for instance, Carpenter, Coburn, Reys, & Wilson, 1978; Carpenter, Kepner, Corbitt, Lindquist, & Reys, 1980; Swanson & Beebe-Frankenberger, 2004; Jordan, Hanich, & Kaplan, 2003) or use rudimentary strategies such as finger counting in solving arithmetic tasks (see for instance Zaslavsky, 1973; Lindemann, Alipour & Fisher, 2011; Davis, 2012; Liutsko, Veraska, & Yakupova, 2017). The situation is even more critical, especially with children's performance on subtraction tasks because subtraction has been revealed to be more difficult than addition at the primary school level. For instance, Carpenter et al. (1978) in discussing the first National Assessment of Education Progress (N.A.E.P.) in the US revealed that, only 55 percent of the nine year olds could complete two-digit subtraction problem with regrouping. In the second N.A.E.P. report, Carpenter et al. (1980) stated that only 75 percent of the thirteen year olds could correctly perform compound subtraction (i.e., subtraction involving whole numbers composed of two, three, four or more digits) with three-digit numbers as against the 85 percent for addition with regrouping; while of the 17 year olds the percentage was 84 and 90 respectively. In other words, even in developed countries such as the US, primary-aged children's performance on addition tasks has been documented to be better than that on subtraction tasks.

In Ghana the situation is no different. The 1992 report on the Criterion-Referenced Test (C.R.T.) conducted and published by the Primary Education Programme (PREP) of the Ministry of Education is noteworthy in this respect (see Adu, 1993). The report showed that only 1.1 percent of the Primary 6 participants tested, achieved over 55 percent pass in Mathematics and about 60 percent could give correct answers to two-digit problems. In addition, primary school children's performance in addition has been by far been better than in subtraction. For instance, the Primary Education Programme (PREP) report (1995) indicated that in 1992 only about 60 percent of participants in primary six could answer correctly compound subtraction involving two digits as against 70 percent for addition with regrouping (see Adu, 1995).

The aforementioned complaints and research reports make it clear that there is the need to take a careful look at the conventional methods of doing subtractions in our primary schools. The need for an effective approach to teaching that helps children to develop effective strategies for solving their subtraction tasks can therefore not be over-emphasized. In Ghana, this need has been compounded by the reported poor performance of our junior high school students in international assessments. A good example is the Trends in International Mathematics and Science Study (TIMSS) at the Eighth Grades in 2003, where Ghana placed last but one or 44 out of 45 countries (see Mullis, Martin, Gonzalez, & Chrostowski, 2004).

Perhaps, the deficiency in computational skills among primary-aged children could be traced to the strategies such children employ in solving their addition and subtraction tasks. In fact, literature is replete with the findings that primary-age children use a lot of informal strategies in solving their addition and subtraction problems (see for instance, Brownell, 1928, 1947; Brownell & Chazal, 1935; Ginsburg, 1975, 1976, 1977; Davydov & Andronov, 1981; Houlihan & Ginsburg, 1981; Resnick & Ford, 1981; Adetula, 1990; Hanich, Jordan, Kaplan & Dick, 2001). These studies have shown that some children count on their fingers, others solve from known combinations, while some give immediate answers, mostly incorrect ones, indicating that they are guessing; to mention just a few. Though these studies have also revealed primary-age children are able to refine their strategies as they progress from primary one or first grade and that later, more efficient strategies evolve which are based either on more sophisticated counting techniques or on a core of known facts, it is also clear that some barriers exist to learning using such informal strategies (Thyne, 1941; Beattie & Deichmann, 1972).

These barriers, if not checked can prevent or delay the development of appropriate addition and subtraction strategies and eventually cause the growing child to have negative feelings about himself or herself, the process of addition/subtraction and mathematics in general.

To overcome such barriers, a number of researchers have argued for the need for teachers to link the mathematical concepts they are teaching to the experience of their students (see Davis & Sullivan, 2011). Davis and Sullivan (2011), for instance relied on the experience their Ghanaian subjects dealt had with contexts involving the use of money to facilitate their learning of number.

This present study, however, sought to focus on compound subtraction because of its numerous applications in social activities, which even primary-aged children face in life outside of school hours such as buying especially when money paid exceeds the selling price of the item being bought (Gyening, 1993). At the time of the study, the primary school syllabus in Ghana recommended the use of the DEC method in the teaching compound subtraction. I argue that this state of affairs (of DEC method being highlighted in the syllabus) is probably due to the fact that literature on compound subtraction has highlighted this method as if it was the most effective method (see, for instance Brownell, 1947; Seville, 1964; Sherill, 1979; Kennedy & Tipps, 1988).

In the literature, another method that has been given prominence is the method of Equal Addition (Murray1941; Ohlsson, Ernest & Rees, 1992). However, I argue that instead of adding any number to both the subtrahend and the minuend, it is easier to think of adding a number that will change the minuend into the nearest tens (i.e., addition to base). Therefore the introduction of the Base Complement Addition (BCA) method in this study is an alternative method to the DEC method.

It is in the light of these that this study was conducted to examine the effectiveness of the methods of Decomposition (DEC) and the Base Complement Addition (BCA) methods in compound subtraction.

Procedure

Two schools in a metropolitan community in Southern Ghana were randomly selected to participate in this study (the name of the community is withheld for anonymity). Participants were from the Primary 2, where compound subtraction (in this study, the subtraction tasks used comprised two-digit numbers as it was the time the curriculum introduced it to primary-aged children in Ghana) was introduced at the time of the study, in each of the two schools were the ones used in the study. A pre-test was structured and administered prior to the teaching sessions to determine the participating children's entry behaviour with reference to speed and accuracy. For four weeks, children in one of the participating schools were taught using the Base Complement Addition (BCA) method while their counterparts in the other school were taught using the Decomposition (DEC) method. To eliminate the possibility of one group being taught with a different expertise from the other, both groups were taught by the researcher. The teaching sessions began the week after the pre-test. A post-test was administered to both groups the week after the last lesson on compound subtraction. The same test items were used as pre-test and post-test to enable (the expected) change in participants' performance to be found. It was made up of 12 items all involving two-digit numbers on compound subtraction. A parallel form of this test was constructed and used for the retention test. It was of the same level of difficulty involving two-digit numbers on compound subtraction. The retention test was administered four weeks after the post-test for both groups. The main activities performed with the two groups are described briefly in the next sections.

To ensure face and content validity, the instruments (pretest, posttest and retention test) were subjected to review by two experts, a mathematics education professor from the Education Faculty of one of the Universities in Ghana and a primary school teacher with about 30 years of experience teaching at the lower primary level in Ghana. In addition, the instruments were piloted and the reliability coefficient calculated using the Kuder-Richardson formula (since the responses were simply scored as correct or incorrect). From the pilot, 0.82, 0.91 and 0.92 were obtained as the coefficients of reliability of for the pretest, posttest and the retention tests respectively.

Weekly Activity with the BCA Group

Week 1

Students were introduced to the fraction boards and squares. After that, accurate representations of numbers on the fraction board using cut out squares were discussed with them. For example, 36 was represented on the fraction board as shown in Figure 1.

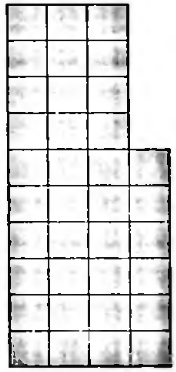


Figure 1: Representation of the number 36

Starting from the left corner, the first three columns of ten were filled and the remaining six were added on by beginning from the bottom of the next column.

Week 2

A demonstration of compound Subtraction was done with students using subtraction board and squares drawn on paper. For example, students were led to discover that to perform 44-28, they needed to begin from an accurate representation of the minuend 44 (see Figure 2A). Then to demonstrate the given subtraction task, they were led to consider removing the relevant number of shaded squares representing the subtrahend 28 from 44 as shown in Figure 2B.

Figure 2A: Representation of 44

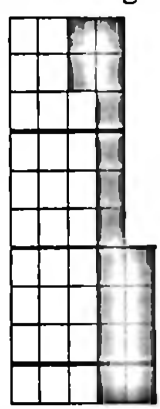


Figure 2B: Representation of the result of 44 - 28

Using questioning techniques, students were led to realize that from Figure 2B, it is clear that after removing the relevant shaded squares (as illustrated by the unshaded portion of two columns of 10 squares and 8 more from the third column) from the representation in Figure 2B to signify subtraction of 28 it was left with 2 shaded squares hanging up in the 3rd column, 10 squares in the 4th column and 4 squares in the 5th column (i.e., leaving a total of 16 shaded squares in Figure 2B). Thus, it could be concluded that Figure 2B is a representation of 44 - 28 = 16.

Week 3

Students were first provided with diagrammatic representations of various two-digit subtractions and encouraged to write down mathematical sentences representing the problems shown as one moves from the left hand diagram to the right hand side diagram as exemplified in Examples 1 and 2.

Example 1:

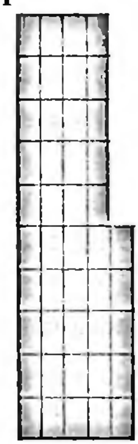


Figure 3A: Representation of 45

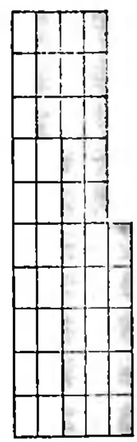


Figure 3B: Representation of the results of 45-17=28

Example 2:

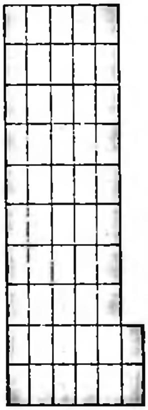


Figure 4A: Representation of 52

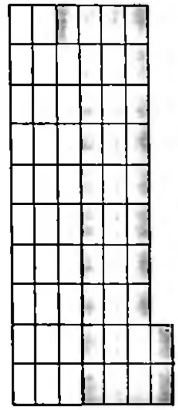


Figure 4B: Representation of 62 - 29

Next, students were provided with a number of representations of subtraction tasks and encouraged to write down equivalent forms of the mathematical sentences whose results are represented by the diagrams. Examples of these tasks are shown in Figures 5A and 5B.

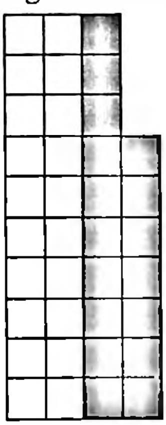


Figure 5A

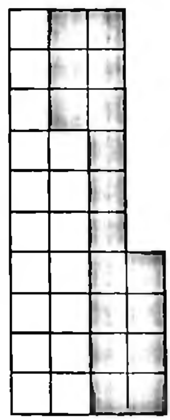


Figure 5B

Using questioning, students were led to explain the subtraction tasks represented first by Figure 5A followed by Figure 5B. The following protocol demonstrates an example of some of the class interactions. Pseudo names are used for the student to ensure anonymity. Also, in the vignettes presented in the sections that follow, the transcript of the interaction with the participant by pseudo name

Ama is used because she was the most articulate in explaining her responses.

Researcher: Ama, imagine that Figure 5A represents a subtraction task in which all the squares in the left hand columns were originally shaded. If we write this subtraction as C – B = D. What will be the value of the number C on the left hand of subtraction sign be?

Researcher: (*Ama scribbles something in the air where the unshaded two columns are, pauses for about 10 seconds and says*) Sir, we will have 37 shaded squares so C will be 37.

Researcher: Now imagine that the unshaded squares on the left represent squares that have been removed in the subtraction task (*pointing at the original representation of the subtraction task under discussion,* C – B = D). What letter of the subtraction task will these unshaded squares on the left hand side (i.e., in the first two columns) represent?

Ama: That will be B

Researcher: What will be the value of B?

Ama: (*Gazes at the fraction squares, quietly moves the head up and down twice as if counting the squares in the two columns and responds)* 20.

Researcher: Can you now tell me the subtraction task represented by Figure 5B?

Ama: (*Pointedly counts the remaining shaded squares*) 10, 11, 12, . . . 17 *(and says)*, 34 minus 17 (*while writing*) 37 – 20 = 17.

Next, Ama's attention was directed at Figure 5B.

Researcher: Now Look carefully at the fraction squares provided in Figure 5B. (*Students draw out their diagrams and begin observing it*). Describe what you see on this Figure.

Ama: There are three columns of ten squares and seven but the first two columns are not shaded. Only the third column and the seven units are shaded.

Researcher: If Figure 5B represents a subtraction task of the form X – Y = Z. What will that task be?

Ama: (*Pauses for about 5 seconds and points four times successively at the diagram while nodding the head each time, and then writes)* 34 – 17 =17.

Researcher: Can you explain why you think this should be the answer?

Ama: The unshaded portion (that is 17 units) represents what has been taken away from the original (which should have been three columns and four or 34) and the shaded column and seven or 17 represents what is left after the subtraction. So we have 37 minus 17 giving us 17.

Using a similar approach, students were led to perform other tasks.

Week 4

This week, using Figure 5A and Figure 5B, participants were also led to realize that removing the three squares hanging up the second column from the left of Figure 5B and fixing them one after the other to the 5th, 6th and 7th vacant positions of the fourth column in Figure 5B gives a picture as seen in Figure 5A.

This means that the task represented in Figure 5B (i.e., 34 – 17) could be transformed into the task in Figure 5A (i.e., 37 – 20) by adding 3 extra to what is being subtracted so the latter becomes a multiple of ten (i.e., 20 in this case) then adding the same 3 to the original 34 from which the subtraction is done (making that to be 37) as in Figure 5A.

Now since it is easier to perform 37 – 20 than 34 – 17 (the essence of base complement addition applied to compound subtraction), participants were encouraged to convert the latter into the former and solve.

From the concrete and iconic forms, participants were then led to perform similar tasks symbolically (i.e., solving compound subtraction without the use of materials) as shown in Example 3.

Example 3:

24		29
- 15	→	- 20
—		—
—		—

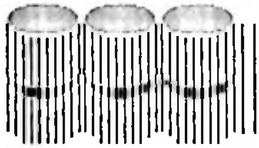
It was explained to participants how the compound subtraction, 24 – 15, was transformed to a simple subtraction, 29 – 20. Considering the subtrahend of the original problem, it could be seen to have 5 in the unit column. Adding the base ten complement of 5 (i.e. 5) to both subtrahend and minuend gives 20 and 29 respectively. Thus, converting into a simpler subtraction task of 29 – 20 with 9 as the result.

Weekly Activity with the Decomposition Group

Week 1

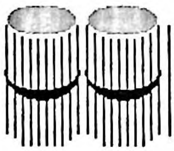
(a) Solve simple subtraction using concrete objects.

Using bundles of sticks 32 could be represented as



3 tens + 2 ones

Taking away 11 (1 ten and 1 one) sticks leaves



2 tens + 1 One = 21

(b) Solve simple subtraction problems without the use of concrete materials.

32-11 = (3 Tens + 2 Ones) – (1 Ten + 1 One)
= (3 Tens – 1 Ten) + (2 Ones – 1 One)
= (2 Tens + 1 One)
= 21

Using the vertical approach, the solution becomes

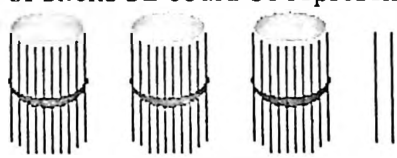
```
           T  O
  32       3  2

- 11     - 1  1
  —       ____
           2  1
          ____
```

Week 2

(a) Solving compound subtraction using concrete materials

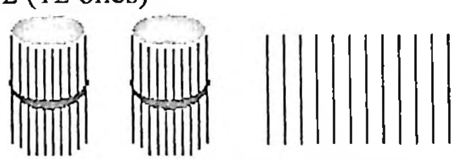
E.g. 32-18

Using bundles of sticks 32 could be represented as



3 tens + 2 ones

To subtract 18 (1 Ten and 8 Ones) there is the need to loosen or untie one bundle of 10 sticks and add them to the 2 loose ones to give a total of 12 (12 ones)



2 Tens + 12 Ones

Taking away (1 Ten and 8 ones) from (2 Tens and 12 Ones) leaves behind (1 Ten and 4 Ones) which is 14.

(b) Solve more compound subtraction problems with the use of materials.

e.g. (i) $\begin{array}{r} 52 \\ -26 \\ \hline \end{array}$ (ii) $\begin{array}{r} 63 \\ -35 \\ \hline \end{array}$

Week 3 and 4

(a) Solving compound subtraction without using materials.

For example

33 – 15	=	(3 Tens + 3 Ones) – (1 Ten + 5 Ones)
	=	(2 Tens + 13 Ones) – (1 Ten + 5 Ones)
	=	(2 Tens – 1 Ten) + (13 Ones + 5 Ones)
	=	(2 Ten + 8 Ones)
	=	18

A vertical representation gives.

		T O
3 3	=	²3 ¹3
- 1 5	=	- 1 5
		1 8

As was done to the Base Complement Addition group, students in the Decomposition group were also interviewed to see the extent to which they could articulate their thought process.

The vignette below shows an example of one of such interviews with Kofi, one of the most articulate students in this group (the point needs to be made here too that this is a pseudo-name).

Researcher: Now Kofi how would you solve 53–17?

Kofi: *(Kofi pauses for about 10 seconds while looking at the ceiling of the room and responds).* I think it is thirty-six.

Researcher: Are you sure?

Kofi: (*Pauses again, this time for about 5 seconds looking at the ceiling while nodding, and then writes)* 53–17 =36, (*and adds still nodding*), Yes I am sure it is thirty-six.

Researcher: Please explain to me how you got your answer.

Kofi: I know that 53 is 5 tens and 3 ones while 17 is 1 ten and 7 ones. Sir, I started by subtracting from the ones column. But because I cannot take 7 ones from the 3 ones, I changed one of the 5 tens into ones to change the 53 into 4 tens and 13 ones (*then Kofi stops).*

Researcher: (*After about 15 seconds asks)* are you done?

Kofi: No, Sir.

Researcher: Then continue.

Kofi: Okay so instead of (5 tens and 3 ones), I was left with (4 tens and 13 ones). Subtracting the 7 ones from the 13 ones gave me 6 one and the 1 ten from the 4 tens gave me 3 tens. So the answer is 3 tens and 6 ones, which (*and then writes 36 and utters)* 36. So 53–17 = 36.

Using a similar approach, students were led to perform other tasks such as the following.

(b) Solve more compound subtraction problems without materials.
e.g. (i) 32–27 (ii) 43–18 (iii) 38–19

Administration and scoring of tests

The two groups of participants were tested under similar conditions during the Pre-test, Post-test and the Retention tests periods. Each of the tests had questions boldly printed and well spaced out to allow participants' individual work (rough work). The finishing times of participants in both groups were recorded as they submitted their completed test papers. It was done at intervals of one minute by the use of tally marks. The frequencies observed were computed and used for analyses of the speed of students in the two groups of the study. Scoring of the tests was done manually by researchers on either correct or wrong basis. A point was awarded for a correct answer and a zero for a wrong in each of the three tests.

Analyses and Discussion

To test which of the two methods was better at improving the accuracy levels of participants (i.e., on the measure of accuracy), the marks or scores obtained by participants at each of the three test periods (pre-test, post-test, and the delayed post-test) was compared. As will be seen from the analyses below, first group statistics of each group at each test level was calculated to see which group performed better on the average. The analyses of the Base-complement addition group is presented as BCA, while the Decomposition group is presented as DEC. After this, independent samples t-test was conducted on the scores obtained by participants in the two groups (i.e., the BCA and DEC groups) separately during each of the three test periods to check whether any observed differences between the group mean scores were significant. At each of the three test periods, the independent samples t-test was considered appropriate because, as already discussed, participants of the study comprised participants from two completely different schools. The two groups could, therefore, be taken as independent samples that could be compared for possible differences in performance. The analyses at the pre-test level is presented first followed by the post-test level (i.e., immediately after the teaching session) and that at the retention level (i.e., two weeks after the teaching sessions) in that order.

Performance of the two Groups at the pre-test level

One purpose of the analysis at the pre-test level was to see whether any differences existed between the two groups prior to the commencement of the study. Ideally, the pre-test could have been avoided and Analysis of Covariance (ANCOVA) used to test for possible significant differences, if any, at the post-test and retention-test levels. This is because ANCOVA could have made up for any initial differences that existed between the performances of the two groups. However, this was not done because a deliberate decision was made to assign the lower performing group to the Base Complement method, the new method that was not in the curriculum in Ghana at the time of the study. Consequently, independent samples t-test was conducted at the pre-test level (i.e., prior to the teaching sessions) and repeated subsequently at the post-test and retention-test levels. The group statistics at the pre-test level have been presented in Table 1.

Table 1: Group Statistics at the pre-test level

Method	n	Mean	Std. Deviation	Std. Error Mean
DEC	48	8.6667	2.85339	.41185
BCA	48	7.4375	2.85766	.41247

From the group statistics shown in Table 1, it was clear that prior to the commencement of the teaching sessions (pre-test level) the group that was exposed to the method of Decomposition performed better than the group that was exposed to the method of Base Complement Addition. As already explained, to test whether this difference in performance was significant or not, an independence samples t-test was performed.

Table 2: Independence Samples t-test performed at the pre-test level

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig	t	df	Sig (2-tailed)	Mean Diff	Std. Error Diff
Equal variances assumed	.010	.919	2.109	94	.038	1.22917	.587
Equal variances not assumed			2.109	94.000	.038	1.22917	.587

From Table 2, it is clear that at the pre-test level the difference between the two groups was not significant (p>0.025 two-tailed). In other words, though the difference in performance was not found to be significant at the 5% level of significance, it is clear from the group means that the group that was later exposed to the method of Decomposition performed slightly better than the group that was exposed to the method of Base Complement Addition prior to the teaching sessions (as reported in Table 1).

Performance of the two groups at the post-test level

The purpose of the analysis at the post-test level was to see whether any differences in performance of the two groups would exist following the implementation of the two treatments (i.e., immediately after the teaching sessions). A similar independence samples t-test was performed on the participants' scores at this post-test level, the group statistics have been presented in Table 3.

Table 3: Group Statistics at the post-test level

Method	n	Mean	Std. Deviation	Std. Error Mean
DEC	48	9.3958	3.77415	.54475
BCA	48	11.0625	1.40525	.20283

From the group statistics shown in Table 3, it was clear that immediately after the teaching sessions (i.e., at the post-test level) the group that was exposed to the method of Base Complement Addition outperformed the group that was exposed to the method of

Decomposition. As already explained, to test whether this difference in performance was significant or not, an independence samples t-test was performed. It is worthy of note that though prior to the commencement of the teaching sessions, there was no significant difference in performance between the two groups, in terms of their mean scores this Base Complement Addition group was the group that performed slightly lesser (see Table 1). However, as Table 3 reveals, immediately after the teaching sessions (post-test level) the Base Complement Addition group had outperformed the Decomposition group. In other words, the Base Complement Addition group improved from being the slightly lower performing of the two groups prior to the teaching sessions to becoming the higher performing group immediately after the teaching sessions. To test whether the difference in the groups' performance at the post-test level was significant, independence samples t-test was performed as was done previously. The results of this test is presented in Table 4.

Table 4: Independence Samples t-test performed at the post-test level

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig	t	df	Sig (2-tailed)	Mean Diff	Std. Error Diff
Equal variances assumed	24.867	.000	-2.867	94	.005	-1.66667	.58288
Equal variances not assumed			-2.867	59.786	.006	-1.66667	.58288

A cursory look at Table 4 reveals that at the post-test level the difference between the two groups was significant ($p<0.025$ two-tailed). In other words, the group that was later exposed to the method of Base Complement Addition performed significantly better than the group that was exposed to the method of Decomposition immediately after the teaching sessions at the 5% level.

Sullivan and Fein (2012) have argued that "while a p-value can inform the reader whether an effect exists, the p-value will not reveal the size of the effect. [Therefore], in reporting and interpreting studies, both the substantive significance (effect size) and statistical significance (p- value) are essential results to be reported" (p 279). Guided by this view, a step was taken to test how large the difference in performance between the two groups was (see also Durlak, 2009). The first attempt was to use Hedges' effect size. Hedges' g was initially preferred to Cohen's d and Glass' delta for two reasons. First, according to Grissom and Kim (2005), for smaller samples such as those used in this study g provides a better estimate than d. This is due to the fact though both Hedges' g and Cohen's d pool variances on the assumption the population from which the two samples for the study has been drawn have equal variances, g pools using n - 1 for each sample instead of n. Second in comparison to Glass' delta, Hedges' g was again considered more appropriate because the Glass' delta uses the standard deviation of the control group. And since there was no control group in this study, Glass's delta was deemed not to be suitable in this study.

However, upon computation, Cohen's d and Hedges' g was found to yield the same result of an effect size of 0.585347. Consequently, what is reported here could be taken as either Cohen's d and Hedges' g. It is worth noting that per the interpretation given by both Cohen and Hedges (see Cohen, 1962; Hedges, 1981; Hedges & Oklin, 1985; Grissom & Kim, 2005) this effect size being close to 0.5 is not trivial but medium. In other words, the Base Complement Addition group did not only perform significantly better than the Decomposition group, the difference in performance was within the medium size. Another interpretation is that about 69% of the of the Decomposition group performed below the average person in the Base Complement Addition group (see Coe, 2002).

Performance of the two groups at the retention-test level

As already mentioned participants in this study were assessed four weeks after the teaching sessions to ascertain the extent to which the skills learnt during the teaching sessions were retained. Similar analyses performed at the pre- and post-test levels were conducted. A parallel form of the instrument used during the pre- and post-test was used as the retention test. Table 5 shows the group statistics on the retention test.

Table 5: Group Statistics at the retention-test level

Method	n	Mean	Std. Deviation	Std. Error Mean
DEC	48	8.8542	4.12047	.59474
BCA	48	10.5625	2.54246	.36697

As shown in Table 5, it was obvious that four weeks after the teaching sessions, (i.e., at the retention-test level) the group that was exposed to the method of Base Complement Addition continued to outperform their counterparts who were exposed to the method of Decomposition. To test whether this difference in performance was significant or not, an independence samples t-test was performed as was done previously. The result of this test is presented in Table 6.

Table 6: Independent Sample t-test performance at the retention level

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig	t	df	Sig (2-tailed)	Mean Diff	Std. Error Diff
Equal variances assumed	11.808	.001	-2.445	94	.016	-1.70833	.69884
Equal variances not assumed			-2.445	78.257	.017	-1.70833	.69884

A similar trend in performance observed at the post-test level was repeated at the retention level. This is obvious from Table 6, which shows that at the retention-test level, not only did the Base Complement Addition group perform better than the Decomposition group, the difference in performance was significant ($p<0.025$ two-tailed).

In addition, a computation of the size of the difference in performance yielded an effect size of approximately 0.5 (0.49897 to be precise). As was obtained at the post-test level, this effect size was the same value obtained for Cohen's d and Hedges' g. One interpretation of this is that being close to 0.5, this effect size is not trivial but medium. In other words, the Base Complement Addition group did not perform significantly better than the Decomposition group, the difference in performance between the Base Complement Addition group and the Decomposition group was not small but medium. Another interpretation is that close to about 69% of the of the Decomposition group still performed below the average person in the Base Complement Addition group (see Coe, 2002).

Conclusions, Implications and Recommendations

The results of the study have revealed that the performance of the Base Complement Addition (BCA) group on compound subtraction tasks was significantly higher at 95 percent level of confidence, than their counterparts who were exposed to the Decomposition method on measure of accuracy (i.e., immediately after the teaching sessions) and on the measure of retention (i.e., four weeks after the teaching sessions). This finding does not support the findings of a similar study by Essel (2003) who have no significant difference in performance of two groups in a similar study, also conducted in Ghana.

On the face value, the lack of agreement between this study's findings and that of Essel (2003) imply that further research is needed to throw more light on the relative effect of the two methods of compound subtraction. It is recommended that future studies in this direction would need to be done on a large scale to possibly use schools across a number of regions in Ghana.

The aforementioned lack of agreement notwithstanding, the present study has also revealed that size of the differences in performance, as shown by the effect sizes of approximately 0.5 at both the post-test and retention-test levels, are not trivial but medium according to Cohen's (1962) criteria. Such effect sizes, according to Coe (2002), implies statistically that in both cases about 69% of students who were exposed to the Decomposition method could statistically be said to perform below the average person who was exposed to the Base Complement Addition method.

The Decomposition method, at the time of this study, was the conventional method prescribed in the primary school mathematics syllabus in Ghana. This study has, however, highlighted that so far as compound subtraction is concerned, on the measure of accuracy the Base Complement method was a more effective for participants.

Since participants of the study were all Primary 2 students, the implication is that the Base Complement Addition method could be better at improving the performance of primary aged children in compound subtraction in Ghana. Consequently, it is recommended that the BCA algorithm be incorporated into the mainstream of the primary school curriculum in Ghana.

Where necessary, in-service training programmes would need to be organized for teachers on how to incorporate the Base Complement addition method in their teaching of compound subtraction. This recommendation is significant especially in the light of the fact a limitation to the method of Decomposition has long been documented to be problems many primary aged children have with regrouping (see for instance, Johnson, 1938; Brownell, 1947), the ability of children using the method of Base Complement to reduce compound subtraction into simple subtraction points to the possibility of reducing difficulties children have with compound subtraction. This in turn could reduce their fear of mathematics at the early stages and eventually get more Ghanaian students interested in the mathematically related subjects.

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Predictive Validity of Students' Entry Qualifications into Diploma in Basic Education Programme in Colleges of Education in Ghana

Jonathan Osae Kwapong

College of Education Studies, University of Cape Coast, Cape Coast, Ghana

Abstract

The study was conducted to investigate the relationship between students' West Africa Senior School Certificate Examination (WASSCE) grades and their performance in the Diploma in Basic Education (DBE) programme at the Colleges of Education level in Ghana. The purpose was to determine the extent to which the WASSCE results adequately predict performance of students at the College of Education level. The stratified random sampling technique was used to select a sample of seven Colleges of Education with a total of 1,443 students. The Pearson Product Moment Correlation coefficient statistic was used to determine the validity coefficients. The results showed a statistically significant positive but low relationship between the two variables ($r=0.209$ at $0.01\ \alpha$). It was also found out that using only the core subjects results will better predict performance at the CoE than using the core and some electives. This meant that though the WASSCE results can be used for selection, they do not adequately predict performance at the Colleges of Education for the DBE programme. It is, therefore, suggested that for effective selection of students for the DBE programme, the Colleges of Education may resort to additional predictors such as entrance examination and/or oral interviews beside the WASSCE result.

Key words: Predictive validity, validity coefficient, predictor, criterion, coefficient of determination, diploma in basic education, academic performance.

Introduction

The Colleges of Education in Ghana are institutions designated for the training of teacher trainees. Successful completion of the training leads to the award of Diploma in Basic Education (DBE) certificate. The process for the award of the Diploma in Basic Education certificate begins with the admission of candidates to pursue the programme. The requirements for admission into Colleges of Education to pursue the DBE since 2004 had not been consistent. In 2004, when the programme began, the requirement for admission was passes in six subjects in the Senior School Certificate Examination (SSCE) of the West Africa Examinations Council with, at least, Grade 6 in each of the subjects. The six subjects included three core subjects of Core Mathematics, English and Integrated Science and three other subjects. Those who satisfied this criterion were made to go through an interview and verification of certificates and results. The successful candidates were admitted for the programme. This criterion changed in 2007 when those with Grade 7 in the core subjects were considered for admission. In 2010, the minimum requirement of Grade D7 for the core subjects was reverted to Grade D6. However, in the 2015/2016 academic year the requirements were pegged at passes in six subjects including the three core subjects and three others with a minimum of Grade D7. However, three of the subjects, irrespective of their being core or elective must have a minimum of C6 (NCTE circular to principals of COE, 2015).

The West Africa Senior School Certificate Examination (WASSCE) (which had replaced the SSCE) results are not used as a criterion for admissions into Colleges of Education only but as a criterion for selection into a wider range of educational institutions and employment. Educationally, they are used for selection of candidates for admission into tertiary institutions, polytechniques, nursing, etc. In cases of recruitment into the security services they are included in the criteria for recruiting personnel into the army, police service, immigration service, Fire service and so on. The WASSCE results are also used as the basis for employing middle income personnel. In some of these situations no other criterion is required for the selection but in others, other criteria are required especially, interviews.

These suggest that some test scores may not adequately be used as criteria for a specific purpose. But they are used to determine the extent of the existence of an attitude, skill, performance, events, etc. in an individual. Miller, McIntire and Lovler (2011) observed that when test scores correlate with specific behaviours, attitudes or events, it is confirmed that there is evidence of validity. In other words, test scores may be used to predict the existence of those specific behaviours, attitudes or events. Consequently, it is not clear if WASSCE grades can adequately predict performance of students at the College of Education for the DBE programme.

In addition to the above, studies had shown that the credibility of the West African Examination Council School certificates had been questioned in Nigeria (Achigbe & Bassey, 2012; Ajuonuma & Mkpa, 2009). Achigbe and Bassey (2012) reported that the Nigerian educational scene had been riddled with a lot of controversies with the approval of a new and indigenous examining body, the National Examination Council (NECO), in 1999 to conduct the Senior School Certificate Examination (SSCE) alongside the more experienced WAEC. They observed that such action had raised the consciousness of stakeholders and agitations of the general public on the credibility of the SSCE being conducted by WAEC. In support of this view is the study by Ajuonuma and Mkpa (2009) which indicated that the credibility of public examinations conducted by WAEC was being queried and its certificates subjected to public scrutiny locally and in many foreign countries. They wondered if the universities have been admitting the right students. To compound the problem there is paucity of studies of WASSCE results in predicting performance in Colleges of Education, especially, in Ghana. The few studies on the relationship of the WASSCE results and academic performance in CoE pertain to other countries but those pertaining to Ghana concern Senior Secondary Schools. The problem of the study, therefore, is to investigate how adequately the WASSCE results predict performance of candidates who are admitted into the CoE to pursue the DBE programme in Ghana.

The purpose of the study

The purpose of the study was to provide evidence to support the decision to use the WASSCE results to predict performance of students pursuing the DBE at the Colleges of Education in Ghana. It is also intended to determine whether the Colleges should employ other predictors, such as entrance examination and oral interview in addition to the WASSCE results to reinforce the admission process.

Research questions

To guide the conduct of the study, the following research questions were formulated.

1. What evidence supports the decision to use the WASSCE results to predict the performance of students in the DBE programme?
2. What is the difference in using the WASSCE results of the core subjects only and core with some elective subjects in predicting performance of the DBE at the Colleges of Education?

Hypothesis:

The following hypothesis was also stated to guide the study.

H_0: The evidence to support the WASSCE results in predicting performance of students who pursue the DBE programme at the CoE in Ghana is not statistically significant.

H_1: The evidence to support the WASSCE results in predicting performance of students who pursue the DBE programme at the CoE in Ghana is statistically significant.

Literature review

To ensure the extent to which the WASSCE results predict performance in the Colleges of Education for the DBE programme calls for a predictive validity studies. Predictive validity refers to the extent to which a test could accurately forecast the extent to which a person would perform in a future related activity. It is an important sub-type of criterion-related validity, and it is the extent to which a test performance is related to some other measure of performance in the future. The concept of predictive validity was described by Faleye (2015) as a term used to describe the capacity of a measuring instrument to forecast future performance in a related task. Similarly, Afolabi (2012) described predictive validity as the degree of correlation between the scores on a test and some other measures that the test is designed to predict. Most educational and employment tests are used to predict future performance. Hence, predictive validity is regarded as essential in these fields.

A number of psychologists and assessment experts have described the predictive validation procedure (Miller, McIntire & Lovler, 2011; Kane, 2006; Crocker & Algina, 1986; Fraenkel, Wallen, & Hyun, 2012). The predictive validation method involves administering a test (predictor) to a large group of individuals and holding their scores for a pre-established period of time. Miller, McIntire and Lovler (2011) indicated that the time should usually, be six months or more. When the time has elapsed, a measure of one or more behaviours (criterion) is designed and taken with the same individuals. Then the test scores that were gathered earlier are correlated with the scores on the criterion. A test has a predictive evidence of validity when its scores are significantly correlated with the scores on the criterion. This means if examinees who obtained high scores on the predictor also obtained high scores on the criterion while those who obtained low scores on the predictor also obtained low scores on the criterion then it can be established that the test shows predictive evidence of validity. A high correlation indicates that the selection procedure worked perfectly, a low correlation signifies that there is something wrong with the selection procedure.

In criterion-related validation studies, the relationship between the test and the criterion is determined by the statistic called correlation coefficient (Miller, McIntire & Lovler, 2011). Crocker and Algina (1986) called such a statistic validity coefficient. Fraenkel, Wallen and Hyun (2012) noted that a key index in both forms of criterion-related validity is the correlation coefficient and observed that it indicates the degree of relationship that exists between the scores individuals obtain on two instruments. It may further be explained as a quantitative estimate of a linear relationship between two variables (predictor and the criterion).

All correlation coefficients fall between +1.00 and -1.00 (Fraenkel, Wallen & Hyun, 2012). A positive validity coefficient indicates that there is a relationship between the predictor and the criterion and that a high score on one of the variables is accompanied by a high score on the other (Fraenkel, Wallen & Hyun, 2012). In other words, the performance, attitude or behaviour of an applicant can be determined from the scores on the predictor. Similarly, (Fraenkel, Wallen & Hyun, 2012) observed that a negative relationship is indicated when a high score on one variable is accompanied by a low score on the other. However, a correlation coefficient of zero (0) is an indication that no relationship exists between the variables. Therefore, validity coefficients must be evaluated to represent a level that makes the test useful and meaningful. In view of this, Miller, McIntire & Lovler (2011) suggested that validity coefficient must be evaluated using a test of significance and by examining coefficient of determination.

Miller, Mclntire and Lovler (2011) noted that the test of significance is to determine the likelihood that the relationship between the predictor and the criterion resulted by chance or sampling error and that anytime test developers report validity coefficient they should also report the level of significance. They further noted that coefficient of determination determines the amount of variance that the test and the criterion share in common. It is possible for a validity coefficient to be statistically significant but the test can account for only a small portion of the variance (Miller, Mclntire & Lovler, 2011).

Studies had identified a number of problems associated with validity coefficient. Among these problems is the criterion problem. Thorndike cited in Crocker and Algina (1986) identified three measures of criterion. These are immediate, intermediate and ultimate. According to Crocker and Algina (1986), the immediate is readily available and easy to obtain but are often not sufficiently complete or important. In contrast, the ultimate criteria are recognised as substantially important but are difficult and expensive to obtain. Therefore in selecting a criterion for a study, there is a judicious trade-off to select one which can be reliably measured within the time and cost constraint and will have a relationship with the ultimate. Kane (2006) observed that the main limitation in the criterion model is the difficulty in obtaining an adequate criterion. In making reference to Cronbach (1980), Guion (1998) and Lord & Novich (1968), Kane (2006) further explained that it is difficult to obtain a criterion that is clearly better than the test itself.

Studies had shown that sample size affects the computation of validity coefficient. When validity coefficients are estimated for small sample sizes sampling errors are relatively large. Schmidt, Hunter and Uzry (1976) found that if sample sizes are between 30 and 50 a predictor that has acceptable level in the population is likely to have acceptable validity levels in the samples only 25% to 35% of the time. They, however, contend that sample size of 200 or more may be needed to reflect validity levels of population data accurately at level 90% of the time.

Crocker and Algina (1986) opined that if people who handle criterion scores have pre-knowledge of predictor scores they are likely to influence criterion scores. They contend that if they realize that candidates obtain low scores on the predictor, they will put in more efforts to improve their performance on the criterion. On the other hand, if they noticed that candidates obtained high scores on the predictor, they will be prejudiced in awarding high scores on the criterion variable to such candidates. Such actions reduce reliability. Consequently, Crocker and Algina (1986) described such situation as criterion contamination.

Another problem associated with validity coefficient determination has been identified by assessment experts as restriction of range (Crocker & Algina, 1986; Miller, McIntire & Lovler, 2011; Anastasi & Urbina, 2007). Not all those who participated in the predictor test are selected for admission or employment. Normally, those who perform well are selected. Therefore, the number of scores for the criterion becomes less than the number of the predictor scores thereby creating a restriction of range. Anastasi and Urbina (2007) referring to restriction of range as a problem of preselction of sample observed that the effect of such situation lowers the validity coefficient.

Literature report of positive relationship between WASSCE results, as entry requirement (predictor) and academic performance at Universities and Colleges of Education. Ajogbeje and Borisade (2012) conducted a study to investigate, among other things, the relationship between cognitive entry characteristics (CEC) and students' achievement in mathematics. The results of the study revealed that there is a positive and significant correlation between the criterion variable (Cumulative Grade Point Average CGPA) and CEC (Senior School Certificate Examination (SSCE) however, a correlation coefficient of 0.158 between CGPA and SSCE was considered a low relationship. Consistent with this low relationship are the studies conducted by Goldberg and Alliger (1992) and Morrison and Morrison (1995). Goldberg and Alliger meta-analyzed the validities of the Graduate Record Examination (GRE) for psychology graduate programmes, cumulating results across 10 studies. They obtained a correlation coefficient of 0.15 for both the GRE-V and GRE-Q in predicting graduate grade point average (GGPA; N = 963). Morrison and Morrison obtained similar but slightly larger correlations in their meta-analysis of 22 studies on predicting GGPA in various fields; the GRE-V and GRE-Q displayed correlations of 0.28 and 0.22 with this criterion. Consequently, the researchers remained critical of the GRE, stating that the observed average correlation was too small to be of use in prediction.

Faleye (2015) investigated the relationship between students' performance in entry examination and students' mathematics performance in College of Education (CoE) in Nigeria. Results showed that the Unified Tertiary Matriculation Examination (UTME) was the best predictor of College performance. Results also indicated that there is no significant relationship between students' performance in entry examination and their mathematics performance at the CoE. Finally, it was discovered that there was no significant relationship between students' entry qualifications and their mathematics performance at the CoE.

Obioma and Salau (2007) conducted a study on predictive validity with regard to university admissions in Nigeria. The study was to determine the extent to which scores in examinations conducted by the West Africa Examination Council (WASSCE), National Examinations Council (SSCE) and National Business and Technical Examination Board (NBCE/NTCE) in conjunction with the Joint Admissions and Matriculation Board (JAMB) predict future academic achievement of students in university degree examinations. The study revealed that there were low but positive relationships ($0.118 \leq r \leq 0.298$) between each of the predictor variables under study. Although, generally public examinations poorly predicted students' university academic achievement, when compared individually with other predictors, WASSCE was the best single predictor of the students' Cumulative Grade Point Average (CGPA).

Methodology

Research Design

The study is mainly a descriptive survey design. Borg and Gall (1983) described descriptive studies as those aimed at finding out state of objects. Descriptive survey is an attempt to obtain data from members of a population or a sample to determine the current status of that population with respect to one or more variables (Burnham, Gilland, Grant, & Layton-Henry, 2004; Fraenkel, Wallen & Hyun, 2012). A survey is often conducted to obtain description of a particular group of individuals (Gravetter & Forzano, 2006).

This design is suitable for the study because data were collected from the current natural setting of Colleges of Education to obtain the desired information. The study was conducted using a sample from the population of colleges of education in Ghana. Gravetter and Forzano (2006) observed some advantages of a survey to include its flexibility and efficiency in collecting a wide variety of information about different variables. One disadvantage has been noted to be its low response rate and non-response bias. In order to address such weakness the researcher tried to reach the sampled colleges personally and convinced them to make the data available, though with some difficulty.

Population and sample

The population included all first year students of the colleges who were admitted in the 2015/2016 academic year and offered English Language, Core Mathematics and Core Science. The total number of such students was 13,352 (Report on the 2015/2016 first year end-of-second semester examination results). As at 2016, there were 38 public and eight private colleges of education in Ghana.

The stratified random, sampling technique was adopted in selecting the sample. The study was conducted in seven Colleges of Education constituting 15.2% of the population. Using the stratified random sampling technique, three public Colleges of Education Zones in Ghana were randomly sampled out of the five zones. These zones were Eastern/Greater Accra, Volta and Central/Western Zones. In addition to these, a private College of Education was randomly selected. Names of the sampled public Colleges of Education in each sampled zone were written on pieces of paper, folded and placed in a bowl. The researcher shook the bowl vigorously and asked an eleven-year- old girl to pick two from the zone at random with replacement. This was done to ensure equal chance of a college being selected. The same process was used to select the sample for the private college.

Instrumentation

The main instrument used in the study was document analysis guide. A document is an instrument in language which has, as its origin and for its deliberate and express purpose to become the basis of, or to assist, the activities of an individual, an organisation or a community (Webb & Webb, 1932 cited in Burham, Gilland, Grant & Layton-Henry, 2004). Webb and Webb, (1932) cited in Burnham, Gilland, Grant and Layton-Henry opined that the social investigator must insist on the original document or an exact verbatim copy and that the aim of the investigator must be to consult the original source.

The purpose of the instrument was to examine records of students' WASSCE grades with which they were admitted into the College of Education and students' cumulative grade point average as at the end of second semester of the first year of the DBE programme. One advantage of examination of records is that it is relatively quick and complete since all the relevant information is usually stored in one location (Borg & Gall, 1983). Borg and Gall cautioned that the use of the technique involves invasion of subjects' privacy. In view of this, clearance was sought from the appropriate authorities of the Colleges of Education, Institute of Education and Institutional Review Board (IRB) of the University of Cape Coast.

Data collection and analysis

Data on documents were obtained from the Institute of Education and the sampled Colleges of Education. The researcher wrote to obtain permission from the Institute of Education, Institutional Review Board (IRB) of the University of Cape Coast and the sampled Colleges of Education to access the West Africa Senior School Certificate Examination (WASSCE) results with which the first year students (2015/2016 academic year) were admitted. This served as the predictor for the predictive validity of the admission requirement for the Colleges of Education. Similarly, for the criterion, the cumulative grade point average (CGPA) of the DBE at the end-of-second semester examination was also accessed from the Institute of Education records. The two sets of results were used to compute the correlation coefficient to determine the predictive validity of the WASSCE grades which are used for admission into Colleges of Education.

Data collected from the study were analysed using inferential statistics. The inferential statistics was suitable for the analysis because a generalisation to the population was made through the study of the data collected from the sample. The statistical tool used in the analysis was correlation. The statistical programme for Social Sciences (SPSS) was employed in computing this statistic.

Results

For research question 1, the Pearson product Moment Correlation Coefficient was used to compute the correlation coefficient (r) between the WASSCE results (predictor) and the final CGPA of the DBE results (criterion) of the sampled students to determine the predictive validity. In order to place the CGPA with the WASSCE grades on a uniform scale, the following weightings were assigned to the WASSCE grades; A1=4, B2=3.5, B3=3, C4=2.5, C5=2, C6=1.5, D7=1and D8=0.5. In order to obtain the WASSCE grades equivalence of the CGPA of the DBE programme the average of the WASSCE grades for each candidate was computed. (For convenience, the DBE credit weightings follow; A=4, B+=3.5, B=3, C+=2.5, C=2, D+=1.5, D =1).

The average of the WASSCE grades and the CGPA were correlated to obtain the correlation coefficient. The correlation coefficient determined the degree of the prediction. For example, a correlation coefficient of 0.6 means that there is 60% chance of predicting the performance of a candidate on a DBE programme correctly from the WASSCE results. In another sense it means using the WASSCE results to predict performance on the DBE programme, 60% of them will be correct. In addition, a positive index means that a high score on the predictor will result in a prediction of a high score on the criterion and a negative index would imply that a high score on the predictor would lead to a low score on the criterion and vice versa. Table 1 shows the results of the correlation between the WASSCE grades (predictor) and CGPA of the DBE.

Table1: Results of the Pearson Product-moment correlation coefficient of the WASSCE results and CGPA of the DBE

Number	r	α	r^2
1,443	0.209	0.01	0.044

The results in Table 1 show that there is a positive and significant correlation coefficient index. However, the index (r=0.209) indicating low validity coefficient show low relationship between WASSCE results and DBE cumulative grade point average (CGPA). In support of this is the low level of coefficient of determination of 0.044 (Table 1). This means that only 4.4% of the variance is shared by both the WASSCE results and the CGPA. Miller, McIntire and Lovler (2011) observed that it is likely that a validity coefficient can be statistically significant but the test can account for only a small portion of the variance.

This result is in conformity with the study of Obioma and Salau (2007) which revealed that though the WAEC result was the best predictor among other predictors, there was low but positive relationships ($0.118 \leq r \leq 0.298$) between each of the predictor variables under study including WAEC's. To buttress this result, Ajogbeje and Borisade (2012) also observed that there was a low correlation coefficient of 0.158 between CGPA and SSCE. Consistent with this low relationship are the studies conducted by Goldberg and Alliger (1992); Morrison and Morrison (1995). They respectively meta-analyzed the validities of the Graduate Record Examination (GRE) in predicting graduate grade point average (GGPA) in psychology graduate programmes. They obtained correlations of 0.15, 0.22 and 0.28 for both the GRE-V and GRE-Q. in various fields. Consequently, the researchers criticised the GRE, stating that the observed average correlation was too small to be of use in prediction. The result that the validity coefficient of WASSCE results and CGPA of the DBE programme is low, therefore, indicates that there is a weak evidence to justify that WAEC results adequately predict performance at the Colleges of Education of students who pursue the DBE programme although the correlation coefficient is positive and significant.

With regard to the difference in using only the core subjects and the core subject with other elective subjects of the WASSCE results in predicting the performance in the CoE the correlations of the criterion (CGPA) and the two predictors were computed and compared. The results are presented in Table 2.

Table 2: The results of the correlation between only the core subjects and the core with other subjects

Type of predictor	N	r	A	r^2
Core & electives	1443	0.209	0.01	0.044
Only core	1163	0.258	0.01	0.067

The results show that both the core & electives (regular) and only core have low validity coefficients though both are significant at 0.01α. However, the core only, as a predictor has a higher degree of validity coefficient (0.258) than the core & electives (0.209). This shows that using only the core subjects may predict performance at the DBE better than using the regular system of core and other elective subjects. This is buttressed by the fact that the coefficient of determination of using the core only as a predictor (0.067) is larger than that of the regular system (0.044) (Table 2). This implies that while 6.7% of the variance is shared by only the core subjects (predictor) and performance at the DBE (criterion) only 4.4% of the variance is common to both the predictor (the core with electives) and the criterion (CGPA).

From Table 1, the validity coefficient is statistically significant at the 0.01 level of significance ($r=0.209$, $\alpha=0.01$). This implies that it is statistically significant at 99% confidence interval. In other words, out of every hundred (100) cases there is 99 chances of the validity coefficient to be significant. Comparing this with Miller, McIntire and Lovler's (2011) assertion that for educational purposes the level of significance should be less than 0.05, then the relationship between the WASSCE results and the CGPA of the DBE is not by chance or sampling error. Contrary to this is the study of Faleye (2015) involving SSCE and performance in Mathematics in COE in Nigeria. He observed that there is no significant relationship between the two variables. But Miller, McIntire and Lovler (2011) observed that it is likely that a validity coefficient can be statistically significant but the test can account for only a small portion of the variance. This view is supported by the low level of coefficient of determination of 0.044 (Table 1). Therefore, the null hypothesis that the statistical evidence to support the WASSCE results in predicting performance of students who pursue the DBE programme at the Colleges of Education in Ghana is not significant is rejected at 0.01 level of significance.

Conclusion and recommendations

In conclusion, the justification to use the WASSCE results as a means to select candidates to pursue the DBE programme at the Colleges of Education is not adequate. Although, the validity coefficient between the WASSCE grades and the DBE CGPA is positive and significant, the correlation coefficient between the WASSCE grades and students' CGPA of 0.209 shows a low relationship. In addition, the low coefficient of determination ($r^2=0.044$) confirms that there is a weak relationship between the two variables. This implies that the WAEC results are not very strong enough to predict performance of students admitted to pursue the DBE programme at the Colleges of Education in Ghana. The results also showed that where the WAEC results would be used for selection using only the core subjects is better than using the core with other elective subjects.

It is therefore, suggested that in addition to the WASCE results, other measures can be used to reinforce the admission selection for the DBE programme at the Colleges of Education in Ghana. Some of the measures can be special entrance examination and oral interview.

Furthermore, with the WASSCE results, using only the core subjects of English, Mathematics and Science/Social Studies will better predict performance at the DBE programme than adding some elective subjects to the core. It is further recommended that further studies may be conducted to cover other PRINCOF zones. Studies can also be conducted on how individual subjects of the WASSCE results predict performance in respective subject areas of the DBE programme in the Colleges of Education in Ghana.

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What is happening in Ghanaian Junior High School mathematics classrooms?: A look at students' perception

Asomah K. R., Eric Magnus Wilmot* and Ntow, F. D

College of Education Studies, University of Cape Coast, Ghana

*Corresponding author's email address: *ewilmot@ucc.edu.gh*

Abstract

In recent times, there has been public outcry about students' poor performance in mathematics in Ghana. Since available literature is replete with the fact that students' perception of their mathematics classroom environment influences their participation in classroom activities and hence their mathematics achievement, this study was designed to examine how junior high school students perceived their mathematics classroom learning environment. A total of 350 eighth and ninth graders (i.e., junior high school forms two and three students) from four public and two private schools in a metropolitan community in southern Ghana participated in the study. The study adapted the *What is Happening in This Class (WIHIC) questionnaire,* a questionnaire designed to measure students' perception of their classroom environment on four different subscales. The results revealed that, though in general, the perception of students were positive, ranging from sometimes to often, that of the public school students were relatively more positive than their private school counterparts in each of the subscales. Implications of this are discussed and recommendations for classroom teachers and future research are also presented.

Key words: Students' perception of their mathematics classroom learning environment, Students' cohesiveness, Teacher equity, Teacher support, Students' involvement, Cooperation among students.

Introduction

Mathematics has played a strategic role in the development of humanity and it has always assumed a significant and unique role in many societies throughout history. Human beings have felt the indispensability of mathematics since they started to become aware of their environment. Mathematics is also perceived by many to be difficult and demanding. This notwithstanding, the pervasive role of mathematics is sometimes underestimated in both the world of work and everyday life (Hatfield, Edwards, & Bitter, 1997). Some have even considered a lot of the mathematics learned in school to be irrelevant, unnecessary and unrelated to the mathematics students will encounter in their professional and personal lives (Hatfield, Edwards, & Bitter, 1997).

In spite of such viewpoints, mathematics continues to be seen as one of the most important subjects in the school curriculum as a result of its many applications, though, according to Eshun (2004), it continues to be the most fearsome subject in the school curriculum. A number of studies conducted to understand this state of affairs have focused on the influence of learning environment on students behaviour, as well as the teaching and learning process (see Fraser, 1998, 2007, 2012; Webster & Fisher, 2003; Taylor, 2004). For instance, in a study involving 620 teachers and 4,645 students from 57 Australian secondary schools Webster and Fisher (2003) reported that the way in which curriculum is presented by teachers is directly proportional to how the students perceived the learning environment at the school level.

Fraser (2001) had earlier reported that students spend approximately 20,000 hours in classrooms by the time that they graduate from university, a time long enough for their learning outcomes to be influenced by the learning environment. On this basis, we posit that since the mathematics classroom is made mainly of interactions between students and their teachers and among students themselves and the way these interact with available resources, in studying the influence of learning environment it is necessary to focus also on students' perception of teacher-student relationship. This is the point Fraser, (1998, 2007, 2012) emphasizes as he argues that the classroom learning environment includes not only the physical space, but also the social, psychological and pedagogical contexts in which learning and teaching occur, and which in turn influence students' affective and cognitive outcomes. He further explained classroom environment as involving the shared perception of the students and teachers in a particular environment; a point also shared by Taylor (2004). To be more specific about the how students' perception of teacher-student relationship influenced their learning, Brekelmans, Sleegers and Fraser (2001) reported from their investigation that stronger perception of the influence of teachers increased according to the degree to which teachers got their students to be involved in the classroom activities.

Other studies, conducted in countries from Brunei to Australia, have identified associations between students' affective outcomes and their perception of their mathematics classroom learning environments (see Fraser, 1998). In addition to investigating the relationship between students' cognitive and affective outcomes in mathematics and their perception of their classroom learning environments, previous research (e.g., Benchaim, Fresko & Carmeli, 1990) also found that teachers and students perceive the same mathematics classroom learning environments differently. We contend that such lines of studies are important because students' perception of their mathematics classroom environment have the potential of affecting their attitudes towards the subject. Furthermore, it can be argued that any unfavourable students' attitudes about mathematics would in turn have negative impact on the mathematics they learn.

Gender and grade level differences in students' perception of their classroom environment have also been identified (see Goh & Fraser, 1998; Khalil & Saar, 2009). For example, Goh and Fraser (1998) found that girls in their study generally perceived their classroom learning environments more favorably than boys did. It is also clear that students at different grade levels also perceived their classroom learning environments differently. This is the point Khalil and Saar (2009) made when they reported that Grade 6 students perceived their classroom learning environments less favourably than did Grade 5 students, as the former needed to prepare themselves for junior secondary school learning.

The foregoing points to a strong indication that classroom learning environment has a crucial role to play as far as students' outcomes such as achievement are concerned. The way the classroom environment is organized is, therefore, a crucial factor in determining students' achievement or performance. Taylor (2004) had earlier made this point when he pointed to investigations into possible connection between mathematics and learning environments as a future research concern.

Such a call by Taylor (2004) is important for Ghanaian researchers considering how the low levels of achievement currently observed in the nation's basic schools has led to a number of concerns among the public (Acquaye, 2010; Gadugah, 2011), as well as low performance of Ghanaian eighth graders in international examinations such as Trends in International Mathematics and Science Study (TIMSS) (see Anamuah-Mensah, Mereku, & Asabere-Ameyaw, 2004; Anamuah-Mensah, Mereku, & Ampiah, 2008).

It is our opinion that one of the ways of addressing such low achievements in mathematics in Ghana's basic schools is by focusing on the conditions or circumstances within the school/classroom that promote effective teaching and learning. This is due to that fact that literature so far reviewed in this paper is replete with the fact that students' perception of their mathematics classroom environment influences their participation of their classroom activities and hence their mathematics achievement.

It is in the light of the aforementioned considerations that this study was designed to determine how junior high school students in Ghana perceive their mathematics classroom learning environment. At the time of the study, private sector participation in the establishment of basic schools (from Kindergarten to the ninth grade) in Ghana was high. It is not known whether any differences in students' perception of their classroom learning environment between students in the public and private school systems. Consequently, this study was designed to also investigate whether any differences existed in perception of basic school students from public and private schools of their mathematics classroom learning environment. Finally, in Ghana, like in many other countries, a form of common core mathematics is compulsory for all students at the pre-tertiary level of the educational system. It is our hope that findings and recommendations from this study, could point to possible changes to be made in the classroom learning environment to enable students find mathematics classrooms favourable; something that has the potential of improving the performance of students at the junior high school level who would, otherwise, have disliked the subject but are compelled to grind at it with the rest of their colleagues.

Research Questions

The study focused on the following two research questions:

1. What are the junior high school students' general perception of their mathematics classroom learning environment?

2. What is the junior high school students' perception of their mathematics classroom learning environment based upon school-type?

Procedure

The study was conducted at the Junior High School (JHS) level of Ghana's educational system. The JHS level was used for one main reason. According to Wilmot and Wilmot (2013), Ghana is a multilingual country with over 40 indigenous languages spoken within its boundaries. Unfortunately, none of these languages is used as the medium of instruction in schools in Ghana. Instead, English language, the language of its colonizers, is used as the medium of instruction from Primary class 4 (i.e., the Grade 4). As at the time of this research a transitional bilingual policy was implemented at the Basic school level in which teachers were allowed to use the local languages for instruction from KG to Primary class three while English language was studied as a subject. Students most proficient in English at the basic school level were, therefore, those at the JHS. Since the study involved getting students to articulate their perception of their classroom environment, the decision was made to use the JHS level as the research site.

Next, a decision was also made to use schools in a metropolitan community in Southern Ghana (the name of the community is withheld to ensure anonymity). This community is traditionally endowed with several good schools. As a result, within the schools in this community, there was the likelihood of getting students with backgrounds much spread across the country. Therefore, within the constraints of financial constraints that did not permit selecting schools across the country, schools within this metropolitan community were was used.

At the time of the study, there were eighty-five junior high schools comprising twenty-six private and fifty-nine public schools, in the chosen community. Out of this, six, comprising four public and two private schools, were selected at random for the study. In each of the selected schools the JHS 2 and 3 classes (i.e., grades 8 and 9) were used for the study. Thus, from the six selected schools, twelve intact classes were selected using convenience sampling method. Students from these two classes, having had the most experience (i.e., the longest stay) at the basic school level, were considered the best group to provide responses that could help understand the mathematics classroom learning environment in Ghana at that level.

In all, 350 junior high school students were selected to participate in the study. One hundred and forty-one (141) of these, representing 40.3% of the entire participants, were from the private schools while 209, representing 59.7%, were from the public schools. The age distribution of the respondents ranged from 12 to 20 years with an average age of 15.08 years and a standard deviation of 1.51. Table 1 summarises these characteristics of the sample used for the study

Table 1: Background Characteristics of the Participants

Class/	Number of participating students		
Grade Level	Private Schools	Public Schools	Total
JHS 2	60	89	149
JHS 3	81	120	201
Total	**141**	**209**	**350**

Instrument

Fraser (1998) described nine major research instruments for assessing student perception of classroom psychosocial environment. These included 1) the *Learning Environment Inventory*, 2) *Classroom Environment Scale*, 3) *Individualised Classroom Environment Questionnaire*, 4) *My Class Inventory*, 5) *College and University Classroom Environment Inventory*, 6) *Questionnaire on Teacher Interaction*, 7) *Science Laboratory Environment Inventory*, 8) *Constructivist Learning Environment Survey* and 9) *What Is Happening In This Class*, and reviewed how these instruments had been used in a good number of earlier studies.

Since the focus of this study was to understand what is happening in the junior high school mathematics classrooms in Ghana by investigating students' perception of their mathematics classroom environment, the *What Is Happening In This Class* instrument (abbreviated in this report as WIHIC) originally adapted by Ntow (2009) was used as the mathematics classroom learning environment inventory instrument for this study. As Ntow (2009) puts it,

> 'since the items on the Fraser (1998) WIHIC scale were developed based on a culturally different context of the countries in which they were used, the adaptation involved modifying some of the items on it to reflect the Ghanaian culture and make the items more understandable to the respondents" (p. 36-37).

For instance, in the Ghanaian cultural context an item such as "my mathematics teacher takes interest in me" in original item on the WIHIC instrument was modified by Ntow (2009) to read "my mathematics teacher maintains a healthy student-teacher relationship with me even after his/her lesson has ended" since the original formulation could be misinterpreted by Ghanaians to mean a teacher having an amorous relationship with a student.

In addition to rewording items to reflect the Ghanaian context, the modified version of the WIHIC instrument used in this study had five subscales (i.e., a reduction in Fraser's original seven subscale after our pilot) with each subscale having eight items; bringing the total number of items on the instrument to forty. A detailed description of the five modified WIHIC Subscales are presented in Table 2.

Table 2: Description and Sample Scale in the Modified WIHIC

Subscale	Description	Sample Item
Student Cohesiveness	Extent, to which students are friendly to, and supportive of each other.	I am a friend to members in my mathematics class.
Teacher Support	Extent to which teacher helps, relate to and show interest in their students	My mathematics teacher listens to and accepts my comments on how he/she teaches
Involvement	Extent to which students have attentive interest, participate in discussions and explain their solutions	My ideas and suggestions are used during mathematics classroom discussions
Co-operation	Extent to which students are prepared to help each other rather than compete with each other selfishly	In my mathematics class there is high competition among us which leads to selfishness.

Equity	Extent to which students view the treatment they receive from the teacher to be equitable	My mathematics teacher treats me the same way he/she treats other students in this class.

In addition, the modified version of the questionnaire was constructed using a five-point Likert-type response scale to indicate the degree to which students agreed with each statement made: (1) Never; (2) seldom; (3) Sometimes; (4) Often; (5) Always. In other words, a value of 5 indicated that the classroom practice being measured takes place almost on a regular basis while a value of 1 was interpreted as junior high school students perceiving the classroom practice to hardly take place. Furthermore, a five-point Likert-type response was adopted to ease interpretation of the results.

Validity and reliability of instrument

To ensure face-validity the modified version of the WIHIC instrument used for the study was subjected to review by two Ghanaian Mathematics Education Professors who were very familiar with the Ghanaian context and also engaged in related research involving the mathematics classroom learning environment. In addition, three experienced junior high school mathematics teachers were also given the instruments to review independently. Suggestions from these five reviewers were later used for drafting of the instruments before piloting. Following the review and final draft, the instrument was piloted in two schools (one public and one private) in a nearby district with similar characteristics as those that were used for the actual study. On the whole, fifty-eight junior high school students, comprising 30 males and 28 females, from four intact classes (i.e., the JHS 2 and 3 of each school) were involved in the pilot. Data from the pilot was analysed by computing inter-item correlations. Based upon the inter-item correlation, some of the items were modified.

To determine the extent to which items in the various subscales was related to each other, reliability estimates using Cronbach's alpha, was calculated for each subscale. Since Cronbach's alpha is a measure of internal consistency, (i.e., how closely related a set of items are as a group), and the instrument comprised a set of items as a group for each subscale, Cronbach's alpha was considered to be an appropriate measure of reliability to use for each subscale. Table 3 shows the reliability estimates obtained for each of the five subscales of the modified WIHIC instrument used for the study. As Table 3 reveals, the Cronbach's alpha reliability coefficients for the subscales ranged from 0.62 to 0.91. These values were taken to be good since they showed that within each subscale, the items had shared covariance and fairly measured the same underlying concept.

Table 3: Reliability Estimates of the Subscales on the WIHIC instrument

Subscale	Reliability Estimate	No. of Items
Student Cohesiveness	0.75	8
Teacher Support	0.86	8
Involvement	0.79	8
Co-operation	0.62	8
Equity	0.91	8

Analyses of Data

Two research questions guided this study. As a result, data analysis has been done in respect of each of the research questions separately. To do this, data obtained from the students in this study were scored for individual students after which individual item means and overall subscale means were calculated, first without the school-type and later aggregated for each school-type. In addition, on the five-point scale, the response coded 3 is the central value. On this instrument in particular, it is the code of the "Sometimes" response since a response of "Sometimes" does not indicate whether the respondents had a positive or negative perception of their mathematics classroom learning environment. Consequently, responses or averages more than 3 would be taken as positive while those less than 3 would be interpreted to correspond to negative perception. Thus, in the analysis of data from this study, the "Sometimes" response, which was coded 3, served as the average and this was used to determine the direction of students' responses; with an average score below 3 in these analyses being interpreted as negative perception while that above 3 was interpreted as positive.

Analysis of data related to research question one

One of the major aims of the study was to explore junior high school students' perception of their mathematics classroom learning environment. As a result, the first research question that guided the

study was: "*What are the junior high school students' general perception of their mathematics classroom learning environment?*"
Item mean scores were used to describe how the research participants perceived their mathematics classroom learning environments in this study. These mean scores were obtained by dividing the subscale mean score by the number of items in each subscale. The average item mean provides a meaningful basis for comparing subscales that contain different items on the WIHCI instrument used for the study. Table 4 summarizes the mean perception (and their coded scores on each subscale) of all the 350 participants in the study.

Table 4: Junior High School students' general perception of their mathematics classroom environment.

Subscales	Mean	Std. Deviation
Students' Mean rating of equity	4.16	0.55
Students' Mean rating of teacher support	3.99	0.61
Students' Mean rating of their cohesiveness	3.79	0.64
Students' Mean rating of their involvement in lessons	3.74	0.69
Students' Mean rating of their cooperation in class	3.15	0.54

These mean scores range from 3.15 to 4.16, indicating that, for all subscales, the junior high students surveyed perceived that in their mathematics classroom learning environment they experienced the phenomenon asked about between "sometimes" and "often". In other words, though they generally perceived their mathematics classroom learning environments as positive, not all the aspects were perceived as "always" positive. Also, the relatively small standard deviations also implied that the variability among students' perception on all the subscales were quite small.

The item mean score for Co-operation was the lowest among the five subscales at 3.15, (which approximates to 3.0 to the nearest whole number) indicating that students perceived that they "seldom" or at best "sometimes" got opportunities to cooperate with their peers in their mathematics classes. In other words, participants indicated that in general, they sometimes (not even often or always) carry out mathematics inquiry activities in their mathematics classroom learning environment, such as agreeing with each other as to the solutions, mathematics related activities, and explanations to mathematical problems rather than compete with one another on the learning task. The items mean scores for Student Cohesiveness and Involvement, all of which were above 3.50 suggesting that participants perceived that they less than "often" know themselves, are friendly to one another and most importantly, supportive of each other as well as pay attention, participate in class discussions and explain their solutions in their mathematics classroom learning environment.

The item mean scores for Equity and Teacher Support recorded, were 4.16 and 3.99 respectively, were the highest in the study. This suggests that on these two subscales, participants perceived that they often received help from their mathematics teacher, and viewed this treatment they received from them as equitable.

Analysis of data related to the second research question

Next, in order to determine whether junior high school students in the public school system had a different perception of their mathematics classroom learning environment than their counterparts in the private school system, a second research question was formulated to guide the study as follows; "*What is the junior high school students' perception of their mathematics classroom learning environment based upon school-type*?"

As was done in the case of the analysis of the first research question, mean ratings for each of the subscales were computed and used to understand how respondents perceived their mathematics classroom learning environments in this study but this time based upon their school-type. That is, participant were grouped based on their school-type (i.e., whether they were in a public or private school). Table 5 summarizes the mean scores for each subscale obtained with respect to the students' mean rating based on their school type.

Table 5: Junior High School students' perception of their mathematics classroom environment based on School-Type.

Subscales	Private (N = 141)		Public (N = 209)	
	Mean	**S.D**	**Mean**	**S.D**
Student Cohesiveness	3.70	0.60	3.80	0.60
Teachers Support	4.00	0.60	4.00	0.60
Involvement	3.60	0.70	3.80	0.70
Co-operation	3.00	0.60	3.20	0.50
Equity	4.00	0.60	4.20	0.52

A cursory look at Table 5 reveals that in general, the junior high school students who participated in the study from the different school-types perceived their mathematics classroom learning environment to be positive in terms on all five subscales. However, students from the public school system generally perceived their mathematics classroom environment slightly more positively than the private school students on each of the subscales except on "teacher support". In terms of the order, from the most perceived to the least the order of rating was the same among students in both the public and private school system. For instance, the public junior high school students perceived Equity as the most positive followed by Teacher Support, Student Cohesiveness and Involvement, and Cooperation in that order. Similarly, students in the private schools, also perceived Equity and Teacher Support as the most positive, with Student Cohesiveness, Involvement and Cooperation following in that order.

Thus, the participating junior high school students were from the various school-types, they were unanimous in perceiving the Equity and Teacher support subscales as the most positive and the Involvement and Co-operation Subscale as the least positive.

Discussion of results

As already discussed, this study used an adapted and shorter version of WIHIC Questionnaire to investigate how junior high school students in a metropolitan community in Southern Ghana perceived their mathematics classroom learning environment. The item mean scores for the questionnaire's five subscales were all close to 4 and in a few cases slightly above 3. These findings are consistent with scores reported in previous studies conducted in other contexts (e.g., Afari, Aldridge, & Fraser, 2012; Opolot-Okurut, 2010). This finding that, generally participants perceived their mathematics classroom learning environment as positive in all of the five subscales, is also in line with the findings of Koul and Fisher (2005) and Taylor (2004) among others. Also, the high positive rating for Equity and Teacher support in both school-types is an indication that irrespective of the school type, participants perceived that they received equitable treatment from and were supported well by their respective mathematics teachers. Even with the subscales of Involvement and Cooperation which are the least positively perceived subscales, the positive perception gives an indication that, the students from both the private and public schools are sometimes involved in their mathematics lessons and are sometimes friendly to or supportive of each other though they are from different school types.

This notwithstanding, it must be said that the relatively lower mean ratings for the subscales of *Involvement* and *Cooperation* implies that in terms of their mathematics classroom learning environment, the areas participants had the least perception of were the aspects of being involved in their mathematics lessons (i.e., *Involvement)*, as well as being given the chance to cooperate with their classmates during mathematics classes (i.e., *Cooperation)*. Again, Cooperation being the least perceived positive subscale imply that participants feel that they are seldom given the opportunity to help one another in learning in class rather than compete with each other on a learning a task. These issues of Involvement and Cooperation are important because literature is replete with the fact that providing opportunities for students not only to participate or get involved in their lessons but also to work together with their classmates, both their individual learning and their learning outcomes could be improved (see for instance, Johnson & Johnson, 1989, 2009; Race, 2005; Hermann, 2013). As if to highlight the importance of the subscale of Involvement, Race (2005) has argued that one of the crucial factors supporting successful learning is involving students in class by making them to "do". Hermann (2013), on the other hand, has emphasized the importance of Cooperation, by explaining that when students are allowed to work together in groups they are likely to develop shared learning goals and come to positively depend on the actions of the group for their individual success. According to her, such positive interdependence is characterized by "students encouraging and helping each other to reach their goals, students giving each other feedback, students challenging each other's conclusions and reasoning, and students taking the perspectives of others to better explore different points of view" (Hermann, 2013, p.1); processes which we argue are vital to improving students' learning outcomes.

Conclusions, Implications and Recommendations

Three major conclusions are drawn from this study. In this section, these conclusions have been drawn and their implications discussed. In addition, recommendations related to each of the conclusions have been made. However, before taking each of the conclusions, it must be emphasized that this study was limited to junior high school students in a metropolitan community in Ghana. Further research is needed on a large scale to cover more communities in Ghana. Replication of this study at the Kindergarten to Primary, as well as the Senior High School levels is also recommended.

First, it can be concluded that, with the exception of the subscale of *Teacher Support* which were rated equally by students of the two school types (i.e., private and public schools), students from the participating public schools rated their classroom environment marginally better than their counterparts in the private schools on four out of the five subscales of focus in the study. However, where there were differences, the differences in ratings were negligible. For instance, on the subscales of *Cooperation, Involvement*, and *Student Cohesiveness*, where ratings were below 4 (which interpret as occurring only occasionally) the two groups were in agreement. As a result, we hesitate to read meanings into the marginal differences in ratings and conclude that irrespective of school type, students who participated in the current study had similar perception of their mathematics classroom environment. Since the number of schools use in the study was not that large (i.e., four public and two private schools), further research on a larger scale is recommended to see if differences would be observed as the sample size of schools is increased.

Second, the participating junior high school students' perception of their mathematics classroom learning environment was found to be positive on each of the surveyed subscales of *Equity, Teacher Support, Cohesiveness, Involvement*, and *Cooperation*, irrespective of the students' school-types. The implication of this is that students perceive that there is more room for improving their mathematics classroom environment. As has been discussed, these five subscales are essential in looking at the mathematics classroom environment because the extent to which they prevail in the classroom may be a measure of how students perceive their legitimate participation in lessons. For instance, a classroom where teacher *support* is perceived highly by students is that type of classroom where students value the help the teacher gives them and the extend to which the teacher shows interest in their learning. We argue that in such classrooms students will be free and willing to give feedback on how their teacher works with them and this could in turn influence how students learn mathematics and their learning outcomes. It is, therefore, recommended that mathematics teacher educators build into their training programmes effective ways of improving the mathematics classroom environment. Professional development programmes for practicing teachers or in-service teachers on ways of improving the mathematics classroom environment is also recommended. In this regard, a focus on those subscales are recommended for effective learning of mathematics and its implications. It is further recommended that practicing teachers take note of this need for further improvement and adopt strategies for achieving the needed improvement due to the possibility of a resultant improvement in student performance.

Third, irrespective of the school type, the lowest of these average perception ratings were on the subscales of Cooperation and Involvement, and Student Cohesiveness. These were all below 4 meaning they only occurred occasionally (i.e., did not happen often). The implication of this is that in the junior high school mathematics classrooms in Ghana, students perceive the opportunities given to them to cooperate with each other in class and to actively participate in their lessons to be quite inadequate. In addition, this study has revealed that students' perception of the extent to which they are encouraged to be supportive of each other (i.e., student cohesiveness) to be adequate. Though these findings have emanated from students' self-report, we argue that they should not be downplayed but be taken seriousness since their perception of their classroom environment tells us a lot about how they are experiencing the type of teaching they are exposed to. Consequently, we recommend that teachers adopt more student-centred pedagogies, especially those that use approaches such as constructivist, inquiry-based, problem-based and project-based methods since these have the tendency to not only improve students' involvement in their mathematics classes but also provide more opportunities for students to collaborate with each other in class and eventually their learning outcomes.

Lastly, this study has also revealed that irrespective of the school type, the subscales with the greatest average rating were Equity and Teacher Support with averages close to 4 generally and irrespective of the school-type. As already explained the average rating of 4 implies that, according to the students, the classroom environment related to these two subscales (Equity and Teacher Support) often existed in the junior high school mathematics classrooms in Ghana. Another implication of this is the possible suggestion from the participating students from both the public and private schools perceive their mathematics classroom learning environment to be most influenced by Teacher Support and Equity. The fact that students perceive the mathematics teachers to be equitable implies, in the perception of students, the existence of equal opportunity for all students (or fair treatment of students) in the mathematics classrooms at the junior high school level in Ghana. In addition, rating the support from their teachers high also implies that students consider the ability of their teachers quite high. This implies that students trust their teachers to be fair and are also happy with their teachers' support for their learning. Such conditions have the tendency to remove the phobia usually attributed to mathematics and surrounding the mathematics lessons. This finding about the junior high school mathematics environment is commendable. However, since students' ratings of these are not up to 5, sustained efforts are recommended to further improve equity and teacher support.

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Implementation of the School Performance Improvement Plan in Ghana: What lessons can be learned?

Christopher Yaw Kwaah* and Joseph Ghartey Ampiah
College of Education Studies, University of Cape Coast, Ghana
*Corresponding author's email address: *christopher.kwaah@ucc.edu.gh*

Abstract
This study investigated the implementation of the School Performance Improvement Plan (SPIP) through the Capitation Grant (CG) scheme introduced by the Government of Ghana in the 2004/2005 academic year for basic schools. The scheme was introduced to abolish all forms of fees paid by pupils in basic schools with the aim of improving access and enhancing the quality of education. The study, which was conducted in 2016 used the interpretive qualitative approach to obtain data from 48 teachers and 8 head teachers from 8 basic schools in one of the largest Municipalities in the Central Region of Ghana. The participants for the study were selected by simple random sampling from five circuits in the Municipality. Interviews were held with the head teachers in all the 8 schools while 8 focus group discussions were held with groups of 6 teachers in all the schools. The findings show that head teachers involved all stakeholders such as the Parent Teacher Association (PTA), School Management Committee (SMC) and teachers in preparing the SPIP to ensure transparency. Furthermore, the SPIP preparation ensured that schools budgeted all items they would need. However, lukewarm attitude on the part of some SMC/PTA members and some teachers towards the preparation of SPIP, the bureaucratic nature of accessing the CG, exorbitant fees charged by the Municipal Education Office and lack of transparency on the part of some head teachers in the disbursement of CG were some of the challenges that emerged. The study also found that delay in disbursing CG to schools affected the purchase of resources for teaching and learning. Recommendations for the Ministry of Education and the Ghana Education Service have been suggested.

Key words: capitation grant, school performance improvement plan, quality education, school management committee, parent teacher association.

Introduction

Many developing countries including Sub-Sharan African (SSA) countries have implemented fee-free policies in order to increase access to basic education especially to poor households. These policy interventions were tied to international policies such as the Education for All (EFA) of 1990 and the Millennium Development Goals (MDGs) to achieve universal primary education by 2015 (UNESCO, 2010; World Bank, 2009). The School Fee Abolition Initiative (SFAI) by the World Bank further sought to globally enhance progress in achieving basic education quality for all school-age children by supporting initiatives aimed to remove cost barriers which prevented parents from enrolling and maintaining their children in school (World Bank, 2009). Fee-free policies however have resulted in schools having inadequate financial resources to procure teaching and learning materials to improve education quality, hence relying totally on the central government for funding. For example, in Ghana, after the introduction of the Free Compulsory Universal Basic Education (FCUBE) policy in 1995, many districts were still charging levies as a means of raising funds for school repairs, printing of examination papers, and for supporting cultural and sporting activities. Consequently, this situation prevented many families, particularly the poorest from sending their children to school (Akyeampong, 2011). Governments in these developing countries therefore saw the need to provide grants to schools in order to improve quality education in the implementation of fee-free policy which had reduced schools' funds. Developing countries' response to providing funds to schools in the wake of fee-free policies has been the adoption of strategies for allocating funds to schools within various decentralisation policy frameworks. For instance, schools in Tanzania and Uganda receive capitation grants through local governments while schools in Kenya receive their grants directly from the central government due to the country's less decentralised system (Yuichi & Nishimura, 2009). The Malawian government also introduced Direct Support to Schools (DSS) in 2006 as a grant to enable schools to purchase basic teaching and learning materials to enhance the quality of teaching and learning. In all these countries, regardless of the mode of funds transfer to the schools, School Management Committees (SMCs) and school management in most of the countries administer the grants, monitor and report to community members on daily basis the implementation of the grants (Gaddah, Munro, & Quartey, 2016; World Bank, 2009; Yuichi & Nishimura, 2009).

In Ghana's bid to achieve universal primary education, Government of Ghana (GOG) identified that one of the main reasons that children do not attend school is that their parents simply cannot afford to pay the levies charged by schools. The Ministry of Education, therefore, set up a Capitation Grant (CG) Scheme through the British Department for International Development (DFID) funding for all public schools in the 2005/2006 academic year. The scheme allocated every basic school an amount of Gh¢ 3.00 (US$0.67 in 2005) per pupil enrolled, which has been reviewed over the years. At the time of conducting this study in the 2016/2017 academic year, the CG was Gh¢ 4.50 (USD1$) per pupil.

It was the belief of GoG that this fee-free policy would serve to remove the financial barrier created by levies charged by schools, and more than compensate schools for any loss of revenue they face as a result. The utilisation of the CG was designed to empower the schools to effectively use financial resources to plan and carry out school quality improvement activities under the "School Performance Improvement Plan" (SPIP). The SPIP is a school's road map that sets out the changes a school needs to make to improve the school's performance, especially, the level of pupils' achievement. The SPIP indicates most pressing activities that will help the head teacher, teachers and the SMC to determine the changes that would improve pupils' achievement and monitor the process of improvement in the school (GES, 1999). The SPIP was therefore introduced as a condition for the allocation and utilisation of funds to schools. The plan is prepared by the head teacher and teachers with the approval of the SMC, this is then forwarded to the Metropolitan, Municipal or District Education Directorate for review and final approval. The SMC has the responsibility to oversee the implementation of the SPIP. It was the expectation of the GoG that the process of planning the activities would be participatory (involving head teachers, teachers, SMCs and PTAs) and transparent. The grant is therefore, expected to serve as an opportunity to help build school capacity to effectively implement fiscal decentralisation which is a long-term goal of the GoG. It is also intended to help implement the SPIP to improve the quality of education in schools.

The implementation of the CG in Ghana and other SSA countries is however fraught with challenges such as corruption, poor record keeping, misappropriation of resources among others (World Bank, 2009; MoESS, 2006; GES, 2008). In the Ghanaian context, not much has been done empirically to examine how the schools implement the SPIP to access CG in improving the quality of education. This study therefore investigated the preparation of the SPIP that is linked to the CG scheme for basic schools in improving quality education in Ghana. The study therefore was guided by the following research questions:

1. How do schools prepare their SPIPs?
2. What challenges do schools face in the preparation of the SPIP?
3. How do schools use the SPIP to access the CG?
4. How do schools implement the SPIP and what are the challenges?

Conceptual Framework

This study is premised on decentralisation processes that formulate and govern educational policies for the promotion of education quality. Advocates of decentralisation argue that those closest to the community are in a good position to make decisions about educational processes that best serve the needs of the community (Chikoko, 2009; Gaddah et al., 2016; Osei & Brock, 2006). Within the context of educational decentralisation, increased community involvement in school activities has been a vital vehicle in improving pupils' enrolment and persistence in school as well as school accountability and management. Many developing countries which adopted educational decentralisation policy have seen some improvement in students' achievement and school management (Abadzi, 2013; Gaddah et al., 2016; Mfum-Mensah & Friedson-Ridenour, 2014).

In the decentralised process in the Ghanaian basic education sector, there are three levels of administration: the Ghana Education Service under the Ministry of Education, Regional Directorate of Education and the District/Municipal/Metropolitan Directorate of Education. At the local level, the District/Municipal/Metropolitan Directorate of Education, School Management Committee (SMC) and PTA are the main actors in the implementation of government policies at the basic school level to ensure education quality. The inclusion of communities in Ghana's education decentralisation strategy was expected to improve efficiency and effectiveness of education through the communities' watchdog role they play in their schools.

School management boards or committees and parent- teacher associations are formed in order to involve communities in decision making processes in the schools. It is therefore expected that in the education decentralisation process, the involvement of the community through bodies such as SMCs, PTAs and the school teacher/head teachers will improve education quality. These decentralised actors (head teachers, teachers and SMCs) at the local level are supposed to prepare the SPIP to access the CG and implement it. It is expected that the preparation of the SPIP will enable schools to provide teaching and learning materials and undertake minor repairs in the school, among others, with the ultimate aim of improving the quality of education. It is important to note that the Ghana Education Act of 1995, espoused that the SMC is mandated to ensure effective community participation in education and mobilisation for efficiency in schools, hence by extension the SMC ensures that SPIP improves schools through school management, contribution to school resources and instructional programme in their various communities. Hence, in the context of this study, the SMC which has a greater role in the education decentralisation process is supposed to hold the school accountable with regards to improving school quality.

Based on this premise, this study finds out how schools prepare the SPIP to access the CG and the challenges they face in implementing the SPIP, with the intention of informing policy and practice of decentralisation generally and school performance improvement processes particularly.

Method

Participants

The participants for this study were teachers and head teachers in selected schools in the Mfantsiman Municipality in the Central Region of Ghana. All schools in the Municipality were grouped into rural-urban category based on the Municipal Education Directorate criteria. Krejcie and Morgan (1970) suggest that 5% of a given population is good for a study's sample. In this study therefore, 8 out of 89 schools in the Municipality (or 7%) were randomly selected from the rural-urban category. Consequently, 48 teachers in all the selected schools participated in the study. All eight head teachers in the selected schools automatically participated in the study.

All the teachers were professionally trained except four who had only completed senior high school. Nine of the teachers had first degree, 24 had a diploma and 10 were teacher's Certificate 'A' holders. Most of the teachers had considerable experience ranging from 2 to 18 years. Two of the head teachers had been in their schools for only one year while the others had been in the school between 2 to 6 years. Furthermore, only two of the head teachers had been heads of their respective schools for 5 to 6 years and the rest had been headteachers in other schools before being transferred to their present school. Hence, the assumption was that five out of the eight head teachers had considerable experience in the preparation of SPIP. All the eight schools had SMCs and Parent PTAs. In one school, the PTA and SMC had been in existence for 20 years, the youngest PTA and SMC being 7 years old. All the schools described their SMCs and PTAs as either active or very active.

Instruments

Individual and Focus Group Interview Protocols were used for head teachers and teachers respectively. The Head teachers Interview Protocol was used to seek detailed information on how the CG was used to implement the SPIP. The Focus Group Interview Protocol was designed to discuss issues with regards to the preparation and implementation of the SPIP. To ensure validity, the instruments were pre-tested in the Cape Coast Metropolis. To ensure reliability, we used only teachers and head teachers who had been in the school for at least three years in order to ensure that the preparation of their SPIP was informed by what they had done previously in the school.

Procedure

Data were collected by a team of researchers involved in the study during the months of June and July 2016. In each school, head teachers were interviewed by a researcher. Six teachers in each school were purposively selected to participate in the focus group interviews. It took a maximum of two days in each school for all the data to be collected. The interviews were recorded and later on transcribed by members of the research team.

Data Analysis

We organised the data using the inductive process by categorising and identifying patterns among the categories. These categories and patterns emerged from the data by reading the transcripts on several occasions and listening to the audio tapes many times until we got ourselves immersed into the data collected. Issues drawn from the data were used as themes to structure the data presentation. Furthermore, direct quotations from the respondents were used to enhance the credibility of the data.

Limitation

Limitations arise in that this paper draws primarily on a small data set from eight schools in one district in Ghana rather than the wider project data, but it is precisely in the nuances of the qualitative data that the findings emerge as so interesting. A further limitation is that due to time constraints it was not possible to involve some SMC members to seek their views on their involvement in the preparation of the SPIP, hence further study is needed to involve SMCs so as their investigate their role in the school activities.

Results

Preparation of SPIP by Schools and SMCs

All schools are supposed to prepare SPIP as a requirement to access the CG grant from the Metropolitan, Municipal and District Education offices across all regions. From the head teachers' accounts, the steps used in the preparation of the SPIP were generally as follows:

1. Fixing a date convenient for teachers, SMCs and PTAs to discuss the SPIP;
2. Listing items needed by the school (e.g., teaching and learning materials) and knowing the unit price of each item and on the meeting day, discussing thoroughly the items to be captured on the SPIP and budget projections for the various items;
3. Estimating the total cost of items to be bought and other expenditures;
4. Vetting and signing of the SPIP by the circuit supervisor, SMC, head teacher and staff secretary/all teachers, as the case might be;
5. Submitting the final SPIP to the District Education Office for approval.

The focus group interviews with teachers revealed that the SPIP is prepared every year through the collaborative efforts of the head teachers and teachers in each school. In four out of the eight schools, this took the form of a SPIP committee with one of the teachers acting as the secretary. The head teacher requests inputs from teachers as the starting point in the preparation of the SPIP. In the other four schools, teachers were assigned specific roles to make budget projections for some of the major items to be captured on the SPIP for the academic year. All eight head teachers indicated that they involved SMCs, PTAs and teachers in the preparation of the SPIP. In addition to these three groups of people, two of the head teachers included Circuit Supervisors responsible for their schools in the preparation of the SPIP. After the preparation of the SPIP, the head teacher discussed the final SPIP with the teachers before it was submitted to the Municipal Education Office for approval. Thus, teachers were very familiar with the SPIP and its preparation. This is summed up by what a teacher said during the focus group interview in one of the schools:

> *We are very familiar with the SPIP because of the individual roles assigned to us by the head teacher before and during preparation of the SPIP. The environment in this school can be described as democratic and each and every teacher is given opportunity to contribute to make projections and do proper budgeting of the major and minor items of the SPIP (Teacher1, School A).*

The main components on the SPIP are pre-determined by the Ministry of Education (improving access, provision of teaching and learning materials, school management, examination, INSET, school facilities, transportation, sanitation and minor repairs). Hence, there is very little variation in the way schools allocate funds for the improvement of school performance. The information in Table 1 is an example of a SPIP for school A. The Table illustrates the components of the SPIP and how school A had budgeted to access the CG for one academic year. Schools are however levied 30 and 60 pesewas per pupils/student (USD $ 0.25) by the district education office every academic year for cultural and sporting activities respectively. The levies are calculated using pupils' enrolment (enrolment*0.90pesewas). The information in Table 1 shows that 72% of the budgeted funds was going to be spent on items related to school management, improving access, community and school relationship and school facilities other than items having direct bearing on improving quality of teaching and learning. For example, expenditure on school management and community/school relationship took 55.2% of the total budget. The SPIP under the CG seeks to improve quality education at the basic education level (GES, 1999). However, it seems the SPIP and CG are to improve the school in general and not the quality of teaching and learning. Furthermore, the Table reveals that the SMC monitors activities related to improving access, school management and school facilities, which suggests that SMCs are limited in contributing to the monitoring activities related to teaching and learning.

Table 1: Implementation of School Performance Improvement Plan for School 'A' in Mfantseman Municipality for 2015/2016 academic year

Component/Target	Action to be Taken	Who is responsible	Resources Needed					Time Frame	Who Monitors
			Description	Qty	Freq	Unit Cost ¢	Total cost ¢		
Improving Access	To embark upon enrolment drive	Culture teacher	Repair of school band	1 set	1	40	40	16/09/14 - 27/07/15	Head teacher/SMC
Enrolment Drive	Through marching in the community and morning assembly						40		
Provision of teaching and learning materials	To purchase teaching and learning materials to improve learning	Staff secretary	Lesson notes	10	1	15	140	16/09/14 - 27/07/15	Head teacher
			Brown sheet	15	1	3	45		
			Markers	6	1	6	36		
			Poster colours	10	1	5	50		
			Blue pens	2 boxes	2	12	24		
			Registers	11	1	3	33		
			Assessment record book	9	2	3	27		
			Foolscap sheet	1	1	12	12		
			Files	10	1	1	10		
			Chalk	30	1	4	120		
			Red pens	2 boxes	2	12	24		
							521		
School Management	To make photocopies	PTA secretary	Photocopies	3	3	10	30	16/09/14 - 27/07/15	SMC/head teacher
	To organise PTA/SMC meetings		Snacks (minerals and pie)	12	6	4	100		
	School based INSET and cluster meeting		Wiring of one classroom	1	1	170	170		
							300		
	Electrical wiring of one classroom in the school	SMC/PTA							

Table 1: Continued

Component/Target	Action to be Taken	Who is responsible	Resources Needed: Description	Qty	Freq	Unit Cost	Total cost	Time Frame	Who Monitors
Community and School relationship	To pay circuit affiliation	Head teacher	Circuit sports fee	411	1	42.7	42.7	16/09/14-27/07/15	Circuit Supervisor/Head teacher
	To buy drugs		Paracetamol	1 box	1	6	6		
			Bandage	12	1	1	12		
			Plaster	6	1	2	12		
			Cotton wool	1	1	6	6		
			Glucose	2	1	4	8		
			Liniment	2	1	4	8		
	To participate in circuit sports	Sports secretary	Games, athletics (feeding for teachers & pupils)	1	3		128		
			Canopies	25	3	6	18		
			Plastic chairs	3	3	40	30		
			T & T			chairs	450		
	To pay headmistress' T & T	Assistant Head teacher					720.7		
School facilities	To purchase materials to facilitate the work of the school	Assistant Head teacher	Padlocks (big size)	8	1	6	30	16/09/14-27/07/15	Head teacher/SMC
			Padlocks (small size)	8	1	5	47.6		
			T. bolt	15	1	3	45		
			Labour		1	9	27		
			Football	3	1		55		
	To purchase sports materials	Sports secretary	Volley ball	3	1		35		
			Tennis ball	8	1	0.40	3.2		
			Weighing scale	1	1	25	25		
							267.8		
							1,849.5		

Number of pupils on roll (411) multiplied by 4.5 **411*4.5=1,849.**

Challenges faced by Schools in Preparation of the SPIP

Although, the SPIP has been designed to empower schools to effectively manage the CG, its preparation does not lie solely with the head teacher and other teachers serving under him. The SMCs are supposed to be brought together in the preparation of the SPIP thereby making the process participatory for the stakeholders of the school. In most of the schools, prioritising items could therefore turn into a lengthy debate lasting for hours as teachers recounted. Similar to this was the mismatch between the needs of the schools and the budget. Respondents from School 'C' said school needs outweighed the annual budget approval for the school. Consequently, disagreements with regards to items to buy delayed the process of the preparation of the document. Similar sentiments were echoed by respondents from other schools, and this constituted a major challenge in the preparation of the SPIP.

Another challenge was the difficulty of getting a suitable day and time for all members to meet. Respondents stated that the composition of the team that prepared the SPIP did not consider the preoccupations of members. Some were self-employed while others were salaried workers. Moreover, members were scattered all over the catchment area of the schools. As such, some members of the team attended meetings late or did not turn up at all for scheduled meetings. This challenge was raised in all the schools in the study. For instance, head teachers in Schools 'B' and 'C' complained that it was very difficult to get in touch with their SMC chair persons. This is how a head teacher of a school expressed her frustration:

> *Some members are less enthusiastic and absented themselves from the preparation. Others also don't turn up for meetings just because sometimes they (SMCs) don't understand the process even though much education has been done for them on SPIP* (Head teacher 2, School D)

These situations called for postponements, potential factors that militate against the smooth preparation of the document. Furthermore, the number of items to be captured on the SPIP also posed a challenge. Not only did members have to write down a very long list of items but also they had to break down some of the items into smaller units. According to respondents, the breakdowns were extensive, thus rendering the process very tedious and energy sapping. They added that this exercise was not carried out easily as members of the group lacked professional competence. Compared with the earlier challenge, it could be inferred that some of the beneficiary schools might not meet their annual budget requirements on time.

Furthermore, the ability to make projections constitute a major challenge in preparing the SPIP. For instance, school heads and teachers could not predict the certainties of future events. It was not possible to foresee emergencies and project towards them. According to respondents, people were sent out to verify the prices of items, but prices for the same items differed from one shop to the other. Projections as required by the SPIP were therefore not easily identified though they constitute a very essential component in preparing the SPIP. This is what a teacher recounted with regards to price fluctuations:

> *Last term, I projected the prices of certain items during the preparation of the SPIP. However, the prices had gone up when the CG was finally disbursed, hence we could buy only one of the items instead of two (Teacher one, School D)*

This remark suggests that the instability of the Ghanaian economy is a crucial element worthy of consideration in estimating prices since any wrong under-estimation may have dire consequences on the needed items for the school. Some teachers in Schools 'C' and 'D' were reluctant in taking decisions with regards to estimates for all items captured under the SPIP. Respondents described this challenge as a thorny issue, a necessary evil that could not be ignored in the preparation of the document. Estimating of items had two dimensions for the beneficiary schools. Firstly, if the estimate was on the high side, the schools would be forced by the District Office to review the entire document. That is, they would have to review almost the whole process which was considered tedious and energy consuming. The review process could constitute an obstacle for early disbursement of the CG which could contribute to the failure of the project. Secondly, when the cost of the items was under-estimated, the schools were forced to make up for the difference. This was not easy for schools which had no other source of financing their needs. This observation is echoed in the following comment by one teacher:

> *I had to review our SPIP only when the office saw that some of our prices were on the higher side and this prevented us from purchasing some important items needed by the school early enough* (head teacher 3, School D)

This remark could mean that some schools lacked skills needed in budgeting for the items in the preparation of SPIP. Respondents from School A suggested they had to seek professional advice in the budget preparation. Those from School D thought it was necessary to seek assistance from skilful colleagues who were not necessarily teachers. Respondents suggested that parents should be asked to pay levies in order to help supplement the budget for projects earmarked in the SPIP. They explained that the grant from the central government was inadequate for the smooth administration and financial management of the schools. However, they catalogued some improvements in the various schools under investigation.

How Schools use the SPIP to Access the CG

The District Education Accountant and the Director give approval to schools' SPIP after a thorough scrutiny. Heads of schools are required to submit a completed Form B (statement of account for the money received for a particular school) to access the CG. This Form B is signed by the head teacher or the assistant, then the SMC chairman and finally by the Circuit Supervisor. The Form B is then sent to an officer at the Municipal Education office who will go through it to make sure the proper procedures have been followed before the Municipal Director signs it. An authority note and a cheque are then issued to the head teacher to obtain the money at the bank.

The interview data from the various heads of the sampled schools expressed serious misgivings in accessing the CG from the Municipal Education office. They recounted the bureaucracy involved in signing the Form B and the issuance of the authority note to the bank. Head teachers sometimes had to make several journeys to and from the District Education office since it is only the District Director of Education who is authorised to issue the authority note. This is how two head teachers expressed their frustration in accessing the CG:

> *'... due to the persistent absence of the Director of Education to sign the Form B, procedures to cash the*

money are too cumbersome' (School B, head teacher X)

'the procedure is so lengthy and it involves a lot of travelling to the office which sometimes means that transportation uses up a sizeable part of the money' (School E, Head teacher Y).

This bureaucratic procedure comes as a result of measures that have been put in place by authorities to check embezzlement and misappropriation of the funds by school heads.

Implementation of the SPIP and its Challenges

This study has identified the procedures followed by schools in implementing the SPIP as well as bottlenecks associated with the implementation. The interview data reveal that schools strictly follow plans outlined in the SPIP document. This is reflected in a remark by one head teacher thus:

We follow what we have in the SPIP and items that are not captured which become emergency are not purchased since you can't account to the authorities (head teacher 4, school H)

The implication of this statement is that the implementation of the SPIP is rigid and makes no room for adjustments to cater for incontinences which could be useful to improving the school. Even though the policy prohibits teachers to pre-finance some activities in the school before the release of the CG, respondents from School C, E, and F indicated that teachers who pre-financed some of the items or projects were reimbursed as soon as monies were released. This was contrary to views expressed by other teachers. This raises doubts as to whether rules were duly followed in the implementation process.

Finally, the implementation process had to deal with accountability. Individuals or spending officers were directly accountable to the head teacher. Despite these implementation regulations, the process is not without shortfalls. Four major shortfalls were identified: Firstly, all the six schools in this study raised the issue of inadequate funds. It should be re-emphasised that the primary aim of the CG was to assist schools to manage their own finances. These covers, among other things, the purchase of teaching and learning resources, minor repairs and first aid drugs. Though respondents did not explain further, we could deduce that funds released to schools were not sufficient to meet all the financial obligations of the said schools. Since its introduction, inadequate funding has become a major obstacle in implementing the SPIP. The District Education office aggravates this problem by deducting other charges from funds allocated to schools as recounted by this head teacher:

> *It is not only the undue delay of funds that worries me but also the exorbitant district education office charges such as sports and culture fees reduce the money available to the school (head teacher 6, school F)*

These charges were normally not budgeted for in the SPIP, but are demanded by the District Education office. The charges were therefore deducted from the grant and the rest released to schools.

There was also the challenge of the use of the funds. Some teachers recounted incidents where some head teachers were not transparent when it came to disbursing the funds to purchase items captured in the SPIP. This is what a teacher indicated:

> *Some head teachers do not adhere to what has been captured in the SPIP and do not account to any of us after spending the grant (Teacher 13, School H).*

Transparency has been a big issue between teachers and their head teachers when it comes to the implementation of the SPIP after funds have been released to schools. Some head teachers had become single spending officers without accounting to teachers and other members, thus breeding apathy when it comes to SPIP issues.

Discussion

This study has shown that the preparation of the SPIP by head teachers and teachers in the schools has some level of democratic process. However, the head teachers' and teachers' accounts were silent on the role of the SMC members with regards to the SPIP preparation process. This could be due to the low education background of some SMC members which prevented them from contributing meaningfully in the decision making in the schools. Hence, some SMC members show apathy in the process of preparing the SPIP.

The findings further reveal that SMCs were much involved in the monitoring of activities related to access, school management and school facilities with very little contribution to monitoring of teaching and learning activities. This finding is corroborated by the argument that SMCs' role in school governance is restricted to monitoring students' attendance to school, the financing of infrastructure development at the expense of contributing to curriculum programme of the school (Barnett, 2013; Rose, 2003; Yamada, 2014). Taniguchi and Hirakwa (2011) have argued that the success or failure of community participation depends on the stakeholders' capacity. Our data suggest that even some of the teachers and their heads lacked some book keeping skills, let alone SMC members especially in poor communities who are not literate (Essuman & Akyeampong, 2011; Yuichi & Nishimura, 2009) to contribute to the preparation of the SPIP. This situation makes head teachers and teachers the main stakeholders in preparing the SPIP in most cases.

Furthermore, apathy on the part of some SMC members affected meetings to prepare the SPIP. Some SMC members were not motivated to attend meetings concerning the SPIP. The question that emerges from this situation is: 'what will be the effects of late preparation of the SPIP on teaching and learning in the schools?' Teaching and learning could become less effective in view of the fact that teachers are not allowed to pre-finance any basic items such as chalk or whiteboard markers. On the other hand, the financial management of the school could be seriously affected since monies needed in the day-to-day administration of the school could only be received after the SPIP is presented to the authorities.

Estimating the prices of items in the preparation of the SPIP was also a major challenge as the study reveals. The instability of the Ghanaian economy affects any budget estimates that one does since inflation in Ghana has not been stable. Therefore, this may make head teachers and teachers overestimate or underestimate prices on the items. In Ghana, prices of some items differ from one location of a school to the other. As such, schools located in areas where prices of items are low will have the advantage of having more resources than those located in areas where prices are quite high. This will result in some inequalities in resource allocation, coupled with varied SMCs support to schools which may exacerbate existing inequalities in schools (Deacon, Osman, & Buchler, 2010; Essuman & Akyeampong, 2011).

Under these circumstances, there could be disparity in education quality in schools. Nevertheless, some measures had been put in place by schools to limit the negative effects of the above challenges in the preparation of the SPIP.

Some head teachers failed to account to members of staff and the SMC about expenditure made from the CG during implementation of the SPIP. This finding resonates with what the literature described as corruption and misappropriation of funds to schools through other capitation grant schemes in some SSA countries (Nampota & Chiwaula, 2013; Sasaoka & Nishimura, 2010). Another major challenge in the implementation of the SPIP was irregular flow of the CG. Delays in the release of funds from the central government and the cumbersome procedures of accessing the grant worsen the plight of schools with no other source of income. Hence, in the government's attempt of checking embezzlement by some heads of schools, the measures put in place have made the access of the grant more bureaucratic which affects the quality of teaching and learning in schools (Chikoko, 2009; Yuichi & Nishimura, 2009).

Conclusion and Recommendations

Decentralisation of educational administration, finance and management policy shift some of the responsibilities to the districts, communities, schools and parents. The initiative also gives districts, communities, schools and parents powers in the administration of schools. It is envisaged that this will in turn help provide quality education to all Ghanaian children at the basic school level. To a large extent, decentralisation of educational administration, finance and management policy have been implemented by the Ministry of Education through the use of SPIP and the provision of CG funds. This is a laudable achievement by the Ministry of Education. This means that part of the responsibility of ensuring the delivery of quality education has been given to the schools and district education offices, and they are living up to it.

However, this laudable objective faces some serious challenges that could derail its success. These have been highlighted in this study. In spite of implementation regulations, there were major shortfalls such as inadequate funds, lack of knowledge in book keeping, irregular flow of CG and payments of extra monies to the district office. Most SMCs have 'pseudo-participation in school governance where members are expected to accept decisions made by the school and are committed to supporting with resources for school maintenance and construction, etc. Challenges faced in the preparation of the SPIP if carefully addressed could ease the preparation process. This presupposes that the initial step in accessing the CG would not be characterised by unnecessary obstacles. Thus, the financial management of basic schools would become effective. The fact that pupils can no longer write all the end-of-term examinations in print form due to the inadequate amount of the CG to schools is a drawback to helping pupils get used to answering standard examination questions such as multiple-choice items. This is because teachers cannot write all the items on the chalkboard if the multiple-choice format is used. This is why in some cases parents are made to contribute to end-of-term examinations even though funding for this is captured under the CG scheme.

Finally, the irregular flow of the CG means that funds are not always available to purchase some important items captured in the SPIP for school improvement. The plans of the schools through the SPIP can only be effective if money is available to execute the SPIP. Perhaps the quality of education in some other respects is being achieved by the schools but this is yet to be seen in terms of improved teaching and learning after the introduction of the SPIP and the CG.

Based on the issues raised, we would recommend that the Ghana Education Service and the Ministry of Education must organise periodic workshops to improve the capacity of SMCs, head teachers and teachers to improve the preparation of the SPIP. The Municipal Education Office must ensure that bottlenecks and bureaucracies associated with the approval of SPIP and the delivery of CG to schools are removed. Additionally, Metropolitan, Municipal and District Assemblies must not levy schools for sports, culture and mock examinations as this reduces the amount needed for school improvement. Finally, the government has to ensure regular release of funds to schools in order to achieve the objectives of the policy initiative of improving education quality in basic schools. These study findings from a sample of schools have illuminated issues with regards to the preparation of school plans tied to capitation grant in Ghana. There are some lessons to be learnt in Ghana and other SSA contexts that have implemented similar policies in the wake of school fees abolition. Further research is needed in Ghana to study the good practices of schools to improve teaching and learning in the absence of non-release of funds to schools.

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Analysis of Institutional Climate at High Performing Schools: The case of St. James Senior High School, Sunyani, Ghana

Michael Amakyi

College of Education Studies, University of Cape Coast, Ghana

*Corresponding author's email address: *mamakyi@ucc.edu.gh*

Abstract

A mixed-method design adopting a non-experimental survey and a basic interpretive study was conducted to analyse the institutional climate of high performing schools with the focus on Saint James Senior High School. Data were collected using a closed-ended Likert type items from a defined population of all the 43 academic staff and six management members of the school and a semi-structured interview protocol from 10 purposefully-selected heads and assistant heads of departments. The study revealed that there is a positive school climate showing respondents having a high level of institutional identity, strong collegiality, favourable supervisory styles, and a good sense of professionalism. These four elements of the positive climate correlate strongly with institutional effectiveness at St. James Senior High School. The study further revealed that St. James Senior High School has achieved a climate of success through professional development workshops, team reflective practices, and supportive school leadership.

Key words: school climate, school improvement, learning outcomes, student performance, test scores.

Introduction

Institutions have a defined mission to accomplish. According to Fullan (2003), institutions exist to address authentic human needs for individuals and provide support for the common good of society. Schools are expected to perform specific tasks in the society and it is the school's mission that gives indication of what those specific tasks are. For example, in addition to preparing students to pass standardized tests, schools are to teach students to be adaptable, creative, innovative, and to have information processing skills and be able to use technology to solve problems (Amakyi, 2017). A school's strive towards high performance and the attainment of its mission are driven by the beliefs, assumptions, expectations, norms, and values, both shared and idiosyncratic to individual members of the school. Thus, the extent to which a school realizes its mission is predicated on myriad of factors, notable among them is the climate of the school (Nelson & Quick, 1994).

A school's climate, which is the descriptive beliefs and perceptions individuals hold of the school (Rousseau, 1990), is pivotal in determining the performance of the school. According to Morgan (2006), the feelings evoked by the way members of a school community interact with each other, with outsiders, and with their environment, including the physical space they occupy constitute the climate of the school. School climate may be seen as a combination of shared history, expectations, unwritten rules, and social mores that affect the behaviours of everyone in the school (Kowalski, 2010).

Mullins (2016) sees the school climate as the relatively enduring quality of the internal environment of the school and proceeds to give a three-prong description of a school climate: (a) it is experienced by the members of the school community, (b) it influences their behaviour, and (c) it can be described in terms of the values of a particular set of characteristics or attributes of the school.

The concept of school climate is an important aspect to consider because it greatly affects the school's ability to utilize its technical and human resources. Every school has a climate of its own. This climate affects how members of the school community behave which ultimately impacts their performance. Sarason (1996) intimates that a school climate is not a goal unto itself but a key link in a school's ability to maintain and improve performance.

Literature is replete with findings of relationships between institutional climate and various measures of institutional success, such as staff retention and empowerment in decision making, improved student performance (Reichers & Schneider, 1990), and increased productivity (Patterson, Warr, & West, 2004). Reviewing extant research on institutional climate, Kopelman, Brief, and Guzzo (1990) established a nexus between institutional climate and institutional performance. They concluded that if the institution has a positive institutional climate, then favourable conditions are created for the institution to attain high performance. A positive institutional climate includes attributes commonly found in high performing institutions (For example, collegiality, adequate resources, trust, and high expectations).

On the other hand, if the institution has a negative climate, then the institution experiences unfavourable conditions which become a hindrance to the institution's efforts to achieve high performance. In a negative institutional climate, members of the institution have inadequate resources, function independently, and are guided by counterproductive convictions and unethical practices (Stringer, 2002).

Creating an enabling school climate is sine qua non to attaining success in the school. Carr, Schmidt, Ford, and Deshon (2003) identify institutional climate as a critical determinant of individual behaviour in institutions. Institutional climate is shaped by employee perception which is contingent on an internal drive to satisfy an unsatisfied need and the will to achieve. Carr et. al., (2003) observe that institutional climate is the driving force behind the level of commitment employees choose to exhibit in the institution. The level of commitment enables members of the school community to strive to (a) do things better, (b) outperform others, (c) establish internal standards of excellence, and (d) set realistic goal accomplishment (Cunningham, 2002).

Kowalski (2010) sees climate as an intervening variable in the process between input and output, and one that has a modifying effect on this process. Climate affects institutional and psychological processes and thus acquires an influence over the results of institutional operations. It thus behoves schools to endeavour to create the climate that will facilitate high performance. However, many schools fail to cultivate the enabling climate such as, emphasizing creativity and innovation, staff commitment, retention of their most highly effective staff and resource availability to succeed.

In an environment where demand for stewardship and accountability of school leadership is high and institutions are expected to perform creditably well, benchmarking best-operating-practice (BOP) of high performing school provides a path to enhancing school performance. Expectedly, the school climate of high performing schools, especially the ones making giant leaps in recent years, has come under scrutiny. The inquiry centers largely on identifying schools adjudged to be high performing institutions and interrogating their climate to determine the type and nature of climate that facilitates the attainment and sustenance of high performance.

McEwan (2008) highlights three key elements—the climate, the learning, and the people—as the defining characteristics of a high performing school. These three elements impact each other and the results are manifested in a high performing school. McEwan identifies a high performing school as having a climate that is academically focused; multi-direction communication channels that keep information flowing among the school head, staff, students, and parents; members of the school-community agreeing on parameters of acceptable behaviour; high academic expectations for students; teachers are well-trained, motivated, and use methods that produce results; and students are motivated, disciplined, self-directed, and eager to learn. In a high performing school, the school head sets the school agenda, communicates the school's mission, determines what gets measured and noticed, and distributes the necessary resources. The school boasts of a collective effort to sustain innovations and create meaningful, time-sensitive plans that keep the school on course (Amakyi, 2017).

Statement of the Problem

School differences manifest themselves in the spirit, energy level, and quality of the interactions between members of the school community. Every school has a rather distinctive atmosphere. However, schools learn from each other and look for ways to stay competitive. The search for best-operation-practice (BOP) entails examining the way schools having high performance conduct their operations; ***what is it that the high performing schools are doing right?*** For schools seeking to attain excellence, one of the key paths to follow is to learn from other schools achieving high performance and adapting their best practice.

Students in senior high schools in Ghana take standardized tests (i.e., West Africa Senior School Certificate Examinations, WASSCE) at the end of their final year in senior high school. Schools are expected to be efficient and effective in preparing the students to pass the final examinations. The test scores play a key role in students' progress and pursuit of their highest levels of academic and personal achievement. Additionally, the test scores of the students provide objective measure about learning outcomes in a school and ultimately provide valuable information about effectiveness of school processes. The test scores are used as key determinants to judge how schools are performing in terms of realizing their mission. Also, the test scores of the students are used in ranking schools and categorizing them as high performing or low performing schools in the country.

Rankings for the past five years have revealed that the performance of students of certain schools are consistently improving. Schools that were hitherto not included in the list of top performing schools are rubbing shoulders with the ones that have been acclaimed as top performing schools in the past (Ministry of Education, 2017). Notable among the schools that are having improved test scores is St. James Senior High School in Sunyani. The school is graduating a high percentage of students with grades that qualify them to proceed to tertiary institutions. The WASSCE results revealed that out of the 226 candidates presented in 2015, 213 of the candidates were shortlisted for university admission. In 2016, out of the 348 candidates presented, 347 were shortlisted for university admission. In 2017, out of the 266 candidates presented, 220 were shortlisted for university admission. The summary analyses of the WASSCE results of St. James Senior High School for 2015, 2016, and 2017 are presented in Table 1.

Table 1: Summary analyses of WASSCE results 2015 – 2017

Year	Candidates Presented	Number of Passes in Subjects							
		8	7	6	5	4	3	2	1
2015	226	226	0	0	0	0	0	0	0
2016	348	346	2	0	0	0	0	0	0
2017	266	263	2	0	0	1	0	0	0

The emergence of the "*new kid on the block*," St. James Senior High school to be considered among the league of top performing schools that have well-established institutions with history and traditions that predate the independence of Ghana, has generated keen interest in the operations of St. James Senior High School. Clearly, there is a general belief among key stakeholders in the management of education in Ghana that the leadership of St. James Senior High School may be doing "something right" and the school may have some innovations and a climate of school improvement practice to offer to the other schools. In other words: *what are the lessons that can be learned from St. James Senior High School?*

To adequately address the above enquiry requires the availability of data on the operations and processes of St. James Senior High School. An examination of the type of climate at St. James Senior

High School which is propelling the school to greater heights as a high performing institution in Ghana lies at the heart of this study. In attempting to understand institutions, researchers have examined a wide range of variables (Lindahl, 2006). These variables include the structure as well as the climate of the institution. This study examines the institutional climate of St. James Senior High School from the perspective of both the school management and the staff.

Research Questions

The following research questions were posed to guide the study:

1. What is the nature of institutional climate of St. James Senior High School?
2. To what extent do the elements of the institutional climate of St. James Senior High School account for institutional effectiveness?
3. How was the prevailing climate of St. James Senior High School attained?

Significance of the Study

The findings and conclusions reported in this study are important for the following reasons. First, they provide data about the institutional climate at St. James senior high school to identify elements of the climate that are supportive of high performance. Second, they provide baseline information to foster improved working relationships between the management and staff at St. James senior high school in their quest to have common perception about school improvement. Third, they provide data to other institutions desiring to benchmark St. James senior high school. Fourth, they constitute an important addition to the professional knowledge base on institutional climate to attain school improvement in Ghana.

Methodology

A mixed-method design adopting a non-experimental survey and a basic interpretive study was used to collect data for the study. Survey design is a very valuable tool for assessing opinions and trends. The capability of the survey design to gather meaningful facts about a situation under study informed the researcher's choice of the design for collecting data. Basic interpretive study is helpful in understanding a phenomenon and the perspectives of the people involved and how they construct their worlds, as well as the meaning they attribute to their experiences.

The study population consisted of 43 academic staff and six management staff. A census sampling was adopted and all the academic staff and the members of the management team in the school were solicited to participate in the study. Using the entire population for the study increased the potential power of the study by providing the largest possible *N* size, thereby, strengthening the data analyses (Heiman, 2013).

The instrumentation used for the study was made up of a semi-structured interview protocol and 55 closed-ended items. The semi-structured interview protocol was used to elicit information from 10 purposefully-selected school staff made up of heads of departments and their assistants. The closed-ended items consisted of 40 Likert-type statements describing dimensions of institutional climate, and 15 Likert-type statements describing institutional effectiveness. The works of various researchers over the years (e.g., Jones & James, 1979; Litwin & Stringer, 1968; Schein, 1996; Zammuto & Krackower, 1991) on dimensions of institutional climate and institutional effectiveness served as the primary sources for the development of the questionnaire items. The statements on the questionnaire elicited responses from participants who selected from one of four response choices that were coded: *Strongly Disagree (1), Disagree (2), Agree (3), And Strongly Agree (4).*

The Likert-type items describing dimensions of institutional climate covered four broad dimensions of institutional identity, collegiality, supervisory style, and professionalism.

Institutional identity deals with staff understanding of the goals of the institution, the sense of direction of the institution, staff commitment to the institution, and staff plans to build a career in the institution. The institutional identity dimension has 10 items—Questions 1, 9, 18, 23, 25, 34, 40, 53, 58, and 63.

Collegiality includes how staff relate to one another in the institution portraying the degree of openness and the informal associations that exist. The dimension of collegiality has 10 items—Questions 3, 12, 13, 24, 26, 35, 43, 46, 54, and 57.

Professionalism addresses member autonomy, role clarification, innovative spirit, and ability to demonstrate competence to execute assigned duties. The professionalism dimension has 10 items—Questions 5, 10, 15, 22, 29, 39, 44, 51, 60, and 61.

Supervisory style addresses how leadership governs the institution, the structures and policies created by the institution to facilitate the work of the staff, the leadership style and strategy adopted in the institution, and performance appraisal. The supervisory style dimension has 10 items—Questions 2, 11, 16, 20, 30, 36, 41, 49, 56, and 62.

The Likert-type items describing institutional effectiveness covered employee motivation, job satisfaction, and job performance. The institutional effectiveness has 15 items—Questions 7, 8, 14, 17, 27, 28, 32, 37, 38, 42, 47, 48, 52, 55, and 59.

The researcher received 38 surveys out of the 49 surveys distributed. The final returned survey used for the data analyses was 38, constituting a response rate of about 77.6%.

For research question one, data were analysed using a decision rule over a continuous scale for the computed mean scores, M (including group mean scores) and standard deviations to describe the climate at St. James senior high school. The adopted decision rule was as follows:

$M \leq 1.5$ indicates strong disagreement with statement
$1.5 < M \leq 2.5$ indicates disagreement with statement
$2.5 < M \leq 3.5$ indicates agreement with statement
$3.5 < M \leq 4.0$ indicates strong agreement

For research question two, the researcher conducted correlation analyses using Spearman's correlation coefficient, (r_s) to ascertain the association between dimensions of institutional climate and institutional effectiveness as perceived by respondents. The decision rule to determine strength of association was established as follows:

1. $r_s < .20$, negligible association
2. $.20 \leq r_s \leq .35$, small association
3. $.35 < r_s < .65$, moderate association
4. $r_s \geq .65$, large association

A quantitative measure, the coefficient of determination, was used to indicate the proportion of variance in the elements of institutional climate accounted for or explained by the variance of scores of institutional effectiveness. To determine significance throughout the study, the standard $p < .05$ was used.

To address research question three, the interview data were analysed and put into themes that provided a description on how the prevailing climate of the school was attained.

Findings and Discussion

To address research question one, *what is the nature of institutional climate of St. James Senior High School identified by the study population?* respondents indicated the extent of agreement with statements on school climate dimension by selecting one of four response choices: strongly disagree, disagree, agree, and strongly agree. Means and standard deviations were calculated for the responses to each climate dimension. The computed means revealed that the respondents were in strong agreement with positive statements on the four dimensions of school climate: institutional identity, collegiality, supervisory style, and professionalism. The respondents describe the school climate as positive. This finding is consistent with research conducted on characteristics of high performing schools (e.g., Shannon & Bylsma, 2007; Teasley, 2017) that describe high performing schools as having a positive school climate. According to Teasley (2017), staff in a school with positive school climate have institutional identity, promote collegiality, share in supervisory roles, and exhibit high sense of professionalism.

Further analysis was conducted where the means were rank-ordered from highest to lowest and the results are presented in Table 2. The top 10 statements about climate dimension that respondents were in strong agreement with were then analysed to determine if they were related to institutional identity, collegiality, supervisory style, or professionalism.

Table 2: Rank-ordered means of climate dimension

Climate Dimension	M	SD
1. I am committed to the goals and vision of this school	3.89	.577
2. The school has a supportive work environment	3.86	.506
3. I feel respected by my coworkers	3.85	.490
4. Teamwork is encouraged in this school	3.85	.664
5. My department collaborates well with other departments	3.83	.512

6. The goals of this school have been communicated clearly	3.82	.547
7. My job duties have been clearly explained to me	3.82	.622
8. Staff in this school are held accountable	3.80	.529
9. Conflicts are resolved to the satisfaction of feuding parties	3.77	.486
10. Good relationships prevail in the work environment	3.77	.487
11. I have received the training I need	3.77	.818
12. The regulations and procedures in place are easy to understand	3.76	.517
13. Management encourages me to be innovative in my work	3.76	.613
14. Management delegates tasks and responsibilities to others	3.75	.733
15. Staff assume personal responsibility to achieve the school's goals	3.75	.592
16. The operations in the school are governed by many rules	3.75	.592
17. This school makes good use of its staff' skills and abilities	3.75	.677
18. My coworkers support me in my work	3.72	.517
19. I can talk to my coworkers about my problems	3.72	.632
20. This school recognizes that success depends upon its staff	3.72	.784
21. Management encourages staff	3.72	.863
22. I understand how the performance appraisal system works	3.71	.665
23. Delegation is handled well in this school	3.68	.665
24. Career development is taken seriously in this school	3.67	.718
25. More experienced members of the school take time to help	3.67	.801
26. This school values its staff	3.63	.704
27. I am made aware of the results of my performance	3.63	.843
28. Management assists me in solving my work	3.60	.786

29. People in this school ask about each other	3.60	.891
30. I am allowed to participate in major decisions	3.60	.891
31. This school takes an active interest in the progress of its staff	3.59	.662
32. This school responds well to new technical innovations	3.59	.739
33. I have confidence in the process by important decisions are made	3.59	.775
34. Staff are given opportunity for leadership roles	3.59	.781
35. I understand what most staff in this school do	3.59	.781
36. My job aligns with my interests	3.59	.858
37. Staff members trust one another	3.56	.828
38. This school provides opportunities to receive training and education	3.56	.724
39. This school is willing to be flexible to meet the needs of its staff	3.56	.760
40. Management encourages constructive criticism	3.56	.830

Among the top 10 statements that respondents were in strong agreement with, six of the statements refer to collegiality. None of the top ten statements refer to supervisory role. The remaining four statements were equally divided between institutional identity and professionalism. Collegiality, where staff members of the school are able to interact with one another to achieve goals and objectives of the school is manifested in St. James Senior High School. Literature on effective school practices points to collegiality as key element in relational trust in schools. Bryk and Schneider (2002) posit that where relational trust abounds, schools are bound to highly perform.

To address research question two, *to what extent do the elements of the institutional climate of St. James Senior High School account for institutional effectiveness*? Spearman's correlation coefficient was computed to measure the association between institutional identity, collegiality, supervisory style, and professionalism as predictor variables and institutional effectiveness as criterion variable.
Complete correlation information is provided in Table 3.

Table 3: Association of institutional climate and institutional effectiveness

Climate Dimension	Institutional Effectiveness		
	r_s	Strength of Association	*p value*
Institutional Identity	.748	Large	.002
Collegiality	.865	Large	.000
Supervisory Style	.700	Large	.008
Professionalism	.732	Large	.002

The findings showed large associations between the dimensions of institutional climate and institutional effectiveness at St. James Senior High School. The associations were statistically significant. Computation of the coefficients of determination revealed that;

1. A change in institutional identity accounted for about 56% of the change in institutional effectiveness at St. James Senior High School.
2. A change in collegiality accounted for about 75% of the change in institutional effectiveness at St. James Senior High School.
3. A change in supervisory style accounted for about 49% of the change in institutional effectiveness at St. James Senior High School.
4. A change in professionalism accounted for about 54% of the change in institutional effectiveness at St. James Senior High School.

The findings show that institutional identity, collegiality, supervisory style, and professionalism significantly account for the institutional effectiveness at St. James Senior High School, manifesting in outstanding student test scores. Sarason (1996) draws the conclusion that schools will experience institutional effectiveness when there is favourable supervisory style and staff have institutional identity, promote collegiality, and practice professionalism.

To address research question three, *how was the prevailing climate of St. James senior high school attained?* a semi-structured interview was conducted with 10 informants. The interview data were coded and analysed. Recurring themes that emerged were grouped under (a) school-based workshops, (b) team reflective practice, and (c) supportive school leadership.

The study informants intimated that school-based workshops scheduled at regular intervals provided opportunities for staff to exchange ideas, be abreast of new pedagogical skills, and set challenging targets to improve student learning outcomes. A study informant indicated: *"because we have purposeful gatherings, we are able to identify areas we need to improve upon and also identify why we are doing well in certain areas."* Another informant observed that: *"I am regular at the school-based workshops because they provide the forum for us to learn new things, put them into practice, and then return to share your experience with the others. This is all done under relaxing conditions."*

The study informants identified team reflective practice as helpful tool in building a climate of success in the school. An informant pointed out that the team reflective practice has enabled them to conduct self-assessment in the school: "*we get together and we ask ourselves questions such as, what did we plan and we were not able to accomplish and why? and what did we plan and we accomplished and why? These questions get us to surface issues and discuss them."*

The study informants also identified supportive school leadership as a contributing factor in attaining the climate they have. An informant stated: "*we have school leadership that continues to demonstrate that they care about our wellbeing. The school head is even interested in how your family is doing."* Another informant pointed out that: "*often times in the school, we do not get material rewards, but this is not an issue because you can feel that the school head is genuinely concerned about your progress in life."* The informants also talked about the readiness of the school leadership to provide adequate resources for work to be done. An informant stated that: "*within the constraints of providing all we request for in terms of TLMs, the leadership does well to respond positively to our needs. If they have the means, they will surely provide for us."*

According to Kowalski (2010), schools are apt to create a conducive school climate for success when staff have opportunity for career professional development, especially through school-based workshops. He states further that school-based workshops are tailor-made to meet the needs of staff. Engaging in team reflective practice in the school enables staff to acquire the skill for studying experiences to improve on the way they function. Schon (1990) states that reflective practice entails looking back on an experience and making sense of it to identify what to do in the future.

Conclusions

A positive school climate has attributes commonly found in high performing schools. Based on the findings of this study, two conclusions are drawn. First, the study concludes that St. James Senior High School has a positive school climate defined by strong institutional identity, collegiality, favourable supervisory style, and a good sense of professionalism. Second, St. James Senior High School has achieved a climate of success through professional development workshops, team reflective practices, and supportive school leadership.

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Prof. Eric Nyarko-Sampson
Department of Guidance and Counselling
Faculty of Educational Foundations
College of Education Studies
University of Cape Coast
Cape Coast
Ghana

Email: oguaa.educator@ucc.edu.gh
Telephone: +233 (03321) 36925
Mobile: +233 244 255530