University of Cyprus

DEPARTMENT OF EDUCATION

SEARCHING FOR TEACHING FACTORS THAT EXPLAIN VARIATION IN STUDENT LEARNING OUTCOMES: A LONGITUDINAL STUDY IN PRIMARY SCHOOLS OF GHANA

DOCTOR OF PHILOSOPHY DISSERTATION

JOHN BOSCO AZIGWE

2015

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SEARCHING FOR TEACHING FACTORS THAT EXPLAIN VARIATION IN STUDENT LEARNING OUTCOMES: A LONGITUDINAL STUDY IN PRIMARY SCHOOLS OF GHANA

JOHN BOSCO AZIGWE

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John Bosco Azigwe

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Abstract

One of the key findings of Educational Effectiveness Research (EER) is the importance of the classroom level as a predictor of pupil outcomes. Research from developed countries has therefore centered on the classroom, and classroom processes as an important determinant of students' learning outcomes. Unfortunately, little of this strand of research has been conducted in sub-Saharan African countries, particularly in Ghana. This study is the first of its kind in Ghana, if not the entire sub-Saharan African region. The conceptual framework of the dynamic model of educational effectiveness was used in studying the impact of teaching factors on student learning gains in mathematics. The aim was to determine the degree to which teaching processes identified as effective in developed countries are equally effective in developing countries.

The dynamic model refers to factors operating at four levels: student, teacher, school, and educational system. At the classroom level, the model refers to eight factors relating to teacher behavior in the classroom: orientation, structuring, questioning, teaching-modeling, application, management of time, classroom learning environment, and assessment. The model assumes that each of the factors can be defined and measured using five dimensions: *frequency, focus, stage, quality, and differentiation.* Seven longitudinal studies in Europe provided empirical support to the validity of this measurement framework and also revealed that teacher and school factors are associated with student learning outcomes. However, none of these studies has been conducted in developing countries where class sizes can be large. In this context, the study sought to determine whether the teacher factors of the dynamic model can be observed in primary classrooms in Ghana, and/or whether they are associated with student achievement.

A multi-stage sampling procedure was used to generate data. Specifically, a representative sample of 73 primary schools in Ghana was selected and all grade six classes/teachers (N=99) and students (N=4386) participated in the study. Written tests in mathematics were administered to all the students both at the beginning and end of the school year 2013–2014. Data on student background factors (i.e., SES, home learning environment) was also collected. One high-inference and one low-inference observation instruments, and a student questionnaire were used in collecting data on quality of teaching.

Confirmatory factor analyses provided support to the construct validity of each instrument. The questionnaire and the high-inference instrument produced valid data about each factor whereas the low-inference instrument generated data about each dimension and factor. Multilevel analyses were conducted investigating the extent to which teacher scores generated by each instrument were associated with student achievement. Data from the questionnaire could not identify any effect of teacher factors. However, data about each teacher factor from the instruments were found to be associated with student achievement. Moreover, data from the low-inference instrument revealed the importance of using different dimensions to measure each teacher factor. The instrument enabled the determination that the teachers emphasized more on the quantitative aspect of teaching which is basic to instruction. This revealed the importance of providing the teachers with training on the qualitative characteristics of teaching.

The importance of using multiple instruments for measuring quality teaching was also revealed. With only the student questionnaire, wrongful conclusions would have been drawn about the effects of the teacher factors. Based on the impact of the factors on achievement, it can be claimed the factors are probably more important in the developing school context. All teacher factors and their dimensions were found to have much bigger effect sizes on student achievement (i.e., above 0.30) than the effect sizes reported by studies conducted in developed countries (i.e., smaller than 0.20). The importance of using observation instruments to measure the impact of teaching on student achievement in developing countries, especially African countries is also discussed. Policy on teacher professional development in Ghana, and implications for theory and research on educational effectiveness are finally drawn.

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CHAPTER 1

INTRODUCTION TO THE STUDY

Educational Effectiveness Research (EER) is a theme that links together research in teacher behavior, curriculum, school organization, and educational policy (Creemers, Kyriakides, & Sammons, 2010). The main research questions addressed are which factors in teaching, curriculum and the learning environment at the level of classrooms and schools directly or indirectly explain differences in students' learning outcomes; taking into account their background characteristics (e.g., Socio Economic Status (SES) and prior attainment). The origins of EER stem from the work on equality of opportunity in the United States of America (i.e., Coleman et al., 1966; Jencks et al., 1972). The two studies after controlling for student background characteristics concluded that not much variance in student achievement can be explained by educational factors (Creemers, 2005).

Much of the earlier work within the EER tradition had the explicit goal of refuting the ''schools-don't-make-a-difference'' interpretation that was attributed to those two research outcomes (Luyten, Visscher, & Witziers, 2004, p: 249). Starting in 1980s with studies showing that schools matter, to studies on the characteristics of effective schools and teachers; by the 1990s, the integrated and theoretical models were introduced on why specific factors at the level of students, schools and educational systems are important for explaining variation in student learning outcomes (i.e., Creemers, 1994; Scheerens, 1992; Stringfield & Slavin, 1992). Then after 2000, the focus turned more to a detailed analysis of the complex and dynamic nature of educational effectiveness and school improvement (i.e., Creemers & Kyriakides, 2008).

Thus far, the concept of EER has shown great development and improvement in both theoretical and methodological grounds (Reynolds, Sammons, De Fraine, Townsend, & Van Damme, 2014). Decades of research has revealed the significance of teaching factors as the most important predictor of student learning outcomes (Scheerens & Bosker, 1997). Researchers from developed countries have therefore centered on the classroom, and classroom processes as an important determinant of student learning outcomes (Townsend, 2007). While the evidence points to teaching quality as the most critical factor for student learning, little of this strand of research has been conducted in developing countries, particularly in sub-Saharan African countries (Riddell**,** 2008; Thomas, Kyriakides, & Townsend, 2016).

This is unfortunate since teaching quality is particularly crucial for developing countries. International comparative studies such as Trends in Mathematics and Science (TIMSS) have consistently shown the achievement of students from developing countries to be poor (Mullis, Martin, Foy, & Arora, 2012). For example, Ghana, Tunisia, Morocco, Botswana and South Africa participated in the TIMSS 2011 assessment for mathematics. With the exception of Tunisia, the rest of the said African countries performed below the Low Benchmark score of 400. Tunisia achieved an average score of 425; Ghana 331; Morocco 371; Botswana 397; and South Africa 352. It can be argued that because TIMSS is a cross sectional study, the achievement measures are entangled by the SES composition of the students. The impact of SES on child learning varies with the economic development of a country (OECD, 2013).

However, other studies (e.g., SACMEQ and PASEC) focusing exclusively on African countries arrive at similar conclusions on the performance of their education systems (Fehrler, Michaelowa, & Wechtler, 2009). More specifically, SACMEQ (Southern and Eastern Africa Consortium for Monitoring Educational Quality) monitors school quality in 15 countries and PASEC (Programme for the Analysis of Educational Systems of the CONFEMEN Countries) measures learning in 17 French speaking African countries. The most recent SACMEQ III (2007) study assessed reading and mathematics achievement of 61,421 sixth grade students in 2,779 schools. The results suggested that only 57% and 25% of students attained the basic level in reading and mathematics respectively (Spaull, 2010). Moreover, in a World Bank study in Ghana, Niger, Peru and Yemen, not more than 19% and 11% of sixth graders achieved the mastery level in language and mathematics respectively (Moore, DeStefano, & Adelman, 2012).

The low academic standards notwithstanding, developing nations generally spend a large component of their national budgets on education (World Bank, 2013). The global average expenditure on education is 6% of GDP (World Bank, 2013). Ghana spends on an annual basis 7% of her GDP on education, with over 94% of that budget going into paying salaries of teachers and other education sector workers (Casely-Hayford et al., 2013; Wereko & Dordunoo, 2010). Furthermore, Ghanaian teachers earn 1.2 units of GDP per capita over the Education for All Fast

Tract Initiative (FTI) benchmark average salary of 3.5 units; and 0.5 units over that of the sub-Saharan African average of 4.2 (UNESCO, 2012). Given the investment in the teaching force in Ghana, understanding how the teachers contribute to learning is a key to improving both educational effectiveness and efficiency (i.e., Lockheed & Komenan, 1989).

One of the most recent theoretical models which deal extensively with factors operating at the different levels of education is the dynamic model of educational effectiveness (Creemers & Kyriakides, 2008). Therefore, using the conceptual framework of the dynamic model at the classroom level, a longitudinal research design, and multilevel modeling techniques; the impact of teaching factors on student achievement was explored. The aim was to determine the degree to which teaching processes identified as effective in developed countries are equally effective in developing countries. And more importantly, the teaching processes which are effective in resource constraint contexts. The study is the first of its kind in Ghana, if not the sub-Saharan African region. The findings might therefore broaden the scope of EER from the perspective of Ghana and the sub-Saharan African region.

The dynamic model of educational effectiveness is empirically grounded, and the theory behind it is comprehensive in nature (Coe, Aloisi, Higgins, & Major, 2014; Reynolds et al., 2014). The dynamic model is multilevel in measuring educational effectiveness, and refers to different effectiveness factors at the level of the student, classroom, school and educational system (Creemers & Kyriakides, 2008). At the classroom level, the model refers to eight effectiveness factors which were found to be consistently related to student learning outcomes in teacher effectiveness research (e.g., Brophy & Good, 1986; Creemers, 1994; Muijs & Reynolds, 2000). The eight factors are: *orientation, structuring, questioning, teaching modeling, applications, management of time, teacher role in making classroom a learning environment, and assessment* (Creemers & Kyriakides, 2008). A major distinction of the dynamic model as compared to the earlier theoretical and integrated models (i.e., Creemers, 1994; Schereens & Bosker, 1997; Stringfield & Slavin, 1992) is that it uses a measurement framework that examines not only the frequency of an effectiveness factor but also the *qualitative* characteristics of the functioning of each factor (Kyriakides & Creemers, 2008). The model assumes that each of the factors situated at the classroom, school and educational system can be defined and measured using five dimensions: *frequency, focus, stage, quality, and differentiation.*

The validity of the dynamic model for measuring educational effectiveness has been provided in longitudinal studies conducted in Europe (e.g., Antoniou et al., 2011; Creemers & Kyriakides, 2009; Creemers & Kyriakides, 2010; Demetriou & Kyriakides, 2012; Kyriakides & Tsangaridou, 2008; Kyriakides, Christoforou, Charalambos, 2013; Panayiotou et al., 2014; Vanlaar et al., 2015). Overall, the findings provided support to the main assumptions of the model. For example, a meta-analysis of 167 studies (1980-2010) investigating the effects of teacher classroom behavior on student learning outcomes provided support to the classroom factors: All the teacher factors of the dynamic model were found to have statistically significant positive effects on the student learning outcomes examined (Kyriakides et al., 2013). Based on the results of validation studies, it can be claimed that the dynamic model is plausible for measuring educational effectiveness.

However, since all the said studies were conducted in the developed educational contexts, studies in other contexts radically different are needed to further determine the generic nature of the model. Further justifying the need for such studies is that no study from developing countries met the criteria to be included in the meta-analysis referred to above (i.e., Kyriakides et al., 2013). Schools in developed countries generally share similar characteristics of a uniform material and economic infrastructure (Scheerens, 2004). How studies emanating from such educational context apply in other context radically different such as in African countries may not be straightforward (Thomas et al., 2016). To be useful beyond the countries where they are initiated, studies offering policy guidance need to be based on a sound understanding of how far prevailing conditions are the same or different in other contexts (Saunders, 2000).

Effective schooling in sub-Saharan African countries is unique to the African context, cultures and local school conditions (Riddell**,** 2008; Yu, 2007). As a result of economic constraints, learning conditions in many schools in African countries are inadequate for education delivery (Gauthier & Dembélé, 2004). For example, educational inputs (e.g., quantity and quality of teachers, teaching and learning materials, and school facilities) in many African countries are comparatively inadequate (Motivans, Smith, & Bruneforth, 2006). In this perspective, the Ghanaian educational environment provided a unique context to further test the generic nature of the dynamic model of educational effectiveness.

Research purpose and aims

The study examined the extent to which the dynamic model of educational effectiveness can be considered a generic model for measuring educational effectiveness. The objective was to determine whether the eight teacher factors and the five measurement dimensions of the model function in explaining variation in student learning gains in mathematics. The specific questions addressed are as follows:

1) Whether there is variation in the functioning of the eight teacher factors and the five dimensions in teaching practice in Ghanaian schools.
2) Whether the eight teacher factors are multi-dimensional constructs, and if they can be defined in reference to each of the five dimensions (i.e., frequency, focus, stage, quality and differentiation) as proposed by the dynamic model.
3) Whether each of the eight factors and the five dimensions can explain variation in student achievement gains.

The choice to first test the dynamic model at the classroom level is because classroom factors typically explain a higher percentage of variance in student achievement than factors at the school and educational system level (Scheerens & Bosker, 1997). Whereas classroom factors (i.e., time on task, quality of instruction) and student background factors (i.e., aptitude, motivation, SES) are concepts directly related to learning outcomes; factors at the school and system level influence learning indirectly through the quality of teaching (Creemers, 2005). It was envisaged that the results to emerge from the classroom level might provide a basis for further research at the school and educational system level.

Contribution to the theory

EER has developed to a level where it is possible to model more realistically the complex web of factors influencing quality education (Reynolds et al., 2014). The availability of new computer software has made possible the analyses of longitudinal data and the estimation of teaching effects more efficiently (Goldstein, 1999). Thus, researchers from developed countries have taken advantage of new methodological developments (e.g., multi-level modeling, Value Added Models (VAM) in measuring the effects of teaching more efficiently (e.g., Creemers & Kyriakides, 2010; Rowan, Correnti & Miller, 2002). Unfortunately, little of this strand of research has been conducted in developing countries, particularly in sub-Saharan African countries (Fleisch, 2007; Riddell, 2008; Scheerens, 2004; Thomas et al., 2016).

To the knowledge of the researcher, very limited studies in sub-Saharan Africa have examined the impact of teaching quality on student learning outcomes. Particularly lacking are studies deploying advanced methods (e.g., longitudinal designs, multilevel modeling) in studying the effects of teaching quality. Specifically, studies in Ghana are mostly based on cross-sectional data exploring the impact of student and school background factors on student learning outcomes (e.g., Ampadu, 2012; Ampiah, 2008; Ansong, 2013; Gyimah 2011; NEA, MOE, 2014). Studies of this nature can shed light on the status of educational attainment in schools; but are limited in not exploring the teaching processes contributing to learning outcomes (Riddell, 2008). For example, the biannual Ghana National Education Assessment (NEA) provides useful information on the performance status of schools; but does not take into account the teaching skills explaining variation in student learning outcomes nor the value added by the schools or teachers to student learning outcomes (MOE, 2014).

Measurement of students' learning outcomes at only one time point raises concerns regarding the interpretability of the results, and its usefulness for policy decisions on school or teacher performance (Anderman, Gimbert, O'Connell, & Riegel, 2015). Education is a cumulative process building on past learning (Ehrenberg, Dominic, Brewer**,** Gamoran**,** Willms**,** 2001). A student's achievement in an assessment stems not only from his/her experience at the point of testing, but also from previous experience (Rowan et al., 2002). Multiple factors at the level of students (e.g., prior achievement), schools (e.g., quality teaching) and community level interconnect to determine student learning outcomes (Hiebert & Grouws, 2007).

Thus, a more efficient approach in EER is to collect longitudinal data; and in analyzing the data also pay attention to the multilevel structure of education (Creemers et al., 2010). This enables the study of growth and/or changes in student learning gains; and thus can lead to a more valid and fair measure of teacher performance (Reynolds et al., 2014). Growth models are more equitable because schools can vary greatly in terms of the initial levels of student achievement and/or SES (McCoach, Rambo & Welsh, 2013). Furthermore, VAM can account for the multiple factors in education, and thus is capable of isolating school or teacher effects on student learning gains (e.g., an estimate of a teacher's unique contribution to student learning outcomes) (Lomax & Kuenzi, 2012).

In this respect, a longitudinal design was used by collecting data on student achievement in mathematics both at the beginning and end of a school year. Also, using the measurement instruments of the dynamic model, data on the quality of teaching provided by the teachers of the students was collected within the school year. In addition, data on background factors (e.g., student SES, home learning, and school context factors) were also collected in order to control for their effects on achievement. Then, using multilevel modeling techniques, the joint effects of multiple factors at the level of the students, classrooms, schools and the community level that interconnect to impact on student achievement were explored. This comprehensive approach makes the study a unique one in Ghana, if not the entire sub-Saharan African region.

Developing countries are under-represented in the EER literature (Thomas et al., 2016). To achieve a global perspective, research from the context of other countries is needed to contribute in building a more equitable, fair and fraternal world (Murrillo, 2007). In this respect, the findings might broaden the scope of EER from the perspective of Ghana and to a larger extent the sub-Sahara African region: First, by extending the evidence on the effects of teaching quality on student achievement. Second, by determining the degree to which teaching processes identified as effective in developed countries are equally effective in developing countries; and more importantly, the teaching processes most effective in impoverished educational context. And third, by providing the first comparable study in Ghana that have used a longitudinal research design, and multilevel modeling techniques in studying the effects of teaching quality on student achievement.

Significance of the study

As indicated earlier, the average academic performance of African students appear much poorer than elsewhere in the world. Children in developing countries generally learn much less than what their curricula states they should (Glewwe & Kremer, 2006). For example, Boissiere's (2004) review of studies from developing countries revealed a large discrepancy between the official time for teaching and the actual instructional time (i.e., a reduction in time on task of between 30-50%). Similarly, Abadzi's (2007) study on teacher absenteeism in Tunisia, Morocco, Ghana and Brazil revealed that children were getting as little as 39% of the instructional time specified in their respective curricula. As to be expected, teacher absenteeism was found to have a statistically significant negative effect on the tests scores of fifth graders in Burkina Faso, Cameroon, Cote d'Ivoire, Madagascar and Senegal (Michaelowa, 2001).

Specifically to Ghana, sector performance reports of the Ministry of Education have consistently indicated the quantity and quality of teaching in schools to be inadequate for meeting set standards (MOE, 2013). For example, teacher absenteeism was reported to be at 27% in primary schools; and that from a school year of 197 days, the average days worked by teachers was 80 days (MOESS, 2008). As to be expected, student learning outcomes as measured by the National Educational Assessment (NEA) and the Basic Education Certificate Examination (BECE) have consistently been very low. For example, in the NEA 2013 for grade 6 Mathematics, 50% of pupils achieved at the minimum competency level, and only 10% achieved at the proficiency level (MOE, 2014). A similar trend had been recorded in the NEA for 2005 and 2007 (Allsop, Attah, Cammack, & Woods, 2010).

Outlining the weaknesses in the teaching and learning situation in African countries, and particularly Ghana was to make a case for the study. As a matter of priority, there is the need for research on effective teaching that captures the peculiarities of developing countries. Students assigned to ineffective teachers, one after the other have significantly lower achievement than those assigned to a sequence of highly effective teachers (Sanders & Rivers, 1996). It is particularly desirable to have effective teachers in all schools since the effects of poor teaching linger into many years after children have left school (Wendel, 2000). But precisely what constitutes effective teaching, and how can such practices be determined and promoted in schools? For a developing country such as Ghana, pinpointing what effective teachers do for a greater impact on student learning should be a matter of greater urgency.

Summary

As discussed throughout the chapter, the quality of teaching and learning in African countries is comparative very low. Unfortunately, research output on teaching quality that captures the context of developing countries is limited. While features of effective teaching identified in developed countries are relevant and useful for understanding effectiveness, it is equally evident that teaching effectiveness is context specific (Saunders, 2000; Riddell**,** 2008). As indicated earlier, educational effectiveness in sub-Saharan African countries is unique to the educational context, national cultures, and the local conditions in those countries (Yu, 2007).

In this context, as part of the larger effort for school improvement, the study used the conceptual framework of the dynamic model in studying the teaching factors that have an impact on student learning gains in Ghana. As indicated earlier, the dynamic model adopts an integrated approach by incorporating teaching factors associated with both the direct teaching model and skills related to the constructivist approach to teaching (Creemers & Kyriakides, 2006). The study was envisaged to provide a comprehensive definition of teaching quality from the perspective of Ghana. It was envisaged that the findings might serve as a basis for policy on teacher initial training or professional development for not only Ghana, but other countries of similar characteristics. The methods through which data was collected and analyzed (e.g., value added measures of student achievement, classroom observations and the ratings of students on quality of teaching) form a defensible criterion for obtaining reliable data on teacher effectiveness (i.e., Berks, 2005).

As a step for presenting the conceptual framework of the study, it is important to review the literature on teaching effectiveness. In chapter two to follow, a review teacher effectiveness research (TER) is presented. An attempt is made to review the major findings that have accumulated over time. This is followed by the conceptual framework of the study: A more detailed presentation of the dynamic model, its main assumptions and features. Also, the classroom level of the model (i.e., the teaching factors) is presented in greater detail.

CHAPTER 2

LITERATURE REVIEW

The first step in any research project must be to establish what is already known about a topic or problem since knowledge accumulates over time (Baker, 2001). In this respect, the literature review is arranged as follows: First to follow is a review of Teacher Effectiveness Research (TER), and its historical developments. An attempt is also made to review the major findings that have accumulated over time. The conceptual limitations of EER at inception and how that has informed its development is also reviewed. This is followed by the conceptual framework of the study: A more detailed presentation of the dynamic model of educational effectiveness, its main assumptions and features. Also, the teaching factors of the model are reviewed in greater detail. In the concluding part of the chapter, the studies conducted to test the validity of the dynamic model are also reviewed in greater detail.

Teacher Effectiveness Research (TER)

The concept of an effective teacher is someone who can operate in the classroom in ways that lead to increases in student performance (Stemler, Elliott, McNeish, Grigorenko, & Sternberg, 2012). Teacher effectiveness is concerned with teacher success in fostering the mastery of students in formal curricula, and as well their socialization, affective and personal development (Brophy & Good, 1986). More broadly, teacher effectiveness involves a collection teacher characteristics, competencies, and behaviors that enable students to attain desired educational outcomes, and other broader goals such as problem solving skills, critical thinking, collaborative skills, and effective citizenship (Hunt, 2009).

TER has mainly been providing answers to the optimum fit of instructional conditions (e.g., opportunity to learn, time on task/homework, aspects of structured teaching, feedback, adaptive instruction) as an impact on student learning outcomes (OECD, 2010). More specifically, the focus of TER is on ascertaining whether classroom factors do impact on student learning outcomes, and if so to determine the nature of their impact (Scheerens, 2004).

The field of TER has a formidable history within the total spectrum of empirical enquiry in education (Doyle, 1975). Researchers have over the period utilized various teacher related variables and their relationships with student learning outcomes as an indicator of effectiveness

(Campbell, Kyriakides, Muijs, & Robinson, 2003). Campbell et al. (2003, p: 348-349) construct a four-phase classification of TER studies summarized as follows: The first phase (i.e., 1930s-1940s) were the presage-product studies. The attempt was to identify the psychological characteristics (e.g., personality characteristics, attitude, aptitude and experience) of an effective teacher. The second phase (i.e., 1940s-1960s) concerned with experimental studies in which different methods of teaching were investigated for a perfect method. Third (i.e., 1960s-1980s) were process-product studies focusing on the impact of teacher classroom behavior on pupils' attainment and progress. And the fourth phase (i.e., 1990s), in which teachers' subject and pedagogical knowledge, and beliefs were investigated to determine their relationship with pupils' attainment and progress.

The models and/or criteria are broadly interpreted as what happens before, during and after learning (Phillips, McNaught, & Kennedy, 2010). A distinction is made between product, process, and presage variables (Seidel & Shavelson, 2007): Product variables are the possible outcomes of teaching such as student achievement. Process variables are properties of the interactive phase of instruction during which students and teachers interact around academic content. Presage variables are the properties of teachers (e.g., qualification, experience) that can have an influence on the interactive phase of teaching. Finally, context variables (e.g., school size and organization, and student SES) are variables that can have direct effects on instructional outcomes and/or condition the effects of the process variables on student learning outcomes.

There was also a search for a more reliable and feasible way of modeling teacher effectiveness (Doyle, 1975; Kyriakides, 2005). The presage-product studies produced some consensus on virtues considered desirable in teachers, without any information about the relationship between the psychological factors and student performance (Kyriakides, 2005). The experimental studies investigated specific teaching methods to assess their impact, and to determine if such methods actually cause student achievement; but majority produced inconclusive results i.e. the differences between the teaching methods were not significant enough to produce meaningful differences in student achievement (Brophy & Good, 1986). Moreover, ethical considerations involved in experimental studies made their use in the real school situation problematic i.e. it is difficult to allocate a promising intervention to some students while withholding it to others in a control group (Cohen, Manion, & Morrison, 2007).

Thus, the popularity of the *process-product model* emerged as it yielded more consistent data about the differences between the more effective teachers and the less effective (Graham & Heimerer, 1981; Magliaro, Lockee, & Burton, 2005; Muijs, et al., 2014). The process-product model puts an emphasis on the relationship between measures of teacher behavior (process) and measures of student achievement (product)(Doyle, 1975): 1) the development of an instrument which can be used systematically to record the frequency of certain specified teaching behaviors; 2) the use of that instrument to record classroom behaviors of teachers and their pupils; 3) a ranking of the classrooms according to a measure of pupil achievement adjusted for the initial background differences ; and 4) a determination of the behaviors whose frequency of occurrence is related to adjusted student achievement scores.

Spanning across several years, researchers of the process/product paradigm have identified specific pattern of instructional procedures used by the most effective teachers (Magliaro et al., 2005). Teaching functions associated with improved student achievement were abstracted and combined into a set of models labeled direct explicit instruction (Archer & Hughes, 2011; Good, Biddle, & Brophy, 1976; Rosenshine, 1976; Yates, 2005; Westwood, 1996). It was demonstrated that effective teachers used similar elements of teaching in lessons fairly consistently (Rosenshine, 2008): This involves a logical selection and sequencing of content; breaking down the content into manageable units based on students' cognitive capabilities; instructional delivery characterized by clear descriptions and demonstrations of relevant skills; and then supported practice and timely feedback. The initial practice is carried out with high levels of teacher involvement, but once student success is evident, teacher support is systematically withdrawn for independent performance.

Thus far, an ever-growing knowledge base on effective teaching practices has been built (Creemers & Kyriakides, 2008; Muijs et al., 2014). Studies using large databases and multilevel modeling techniques have consistently found that teacher effectiveness influences student achievement, and is one of the main influences on student progress over time (Muijs & Reynolds, 2000). The findings suggest that effective teachers through their instruction and classroom management can create a learning environment that is motivating for student engagement and learning (Creemers & Kyriakides, 2008). Also, the most consistent findings of studies conducted in different countries link student achievement to the quality of instruction, time on task and opportunity to learn (OTL) (Muijs et al., 2014). The sections to follow presents a summary of the major findings in sub-headings of teacher behavior (quantity and quality), and classroom climate.

Variables related to quantity of teaching

As indicated above, time on task and opportunity to learn (OTL) are critical factors for student learning gains (Creemers & Kyriakides, 2008). Time is an instrument to measure for instance the opportunity pupils get to learn the curriculum, or to give struggling learners better opportunities to master the basics of the curriculum, and the efficiency of classroom management (van de Grift, 2007). The instructional variable time has two interrelated aspects: how much time is spent teaching and how much time students spend on learning tasks (Good et al., 1976). Increasing instructional time however does not always lead to an increase in the time students spend on learning tasks (Archer & Hughes, 2011). A distinction is made between time-on-task or engaged time and academic learning time (ALT). Whereas time-on-task refers to the portion of time during which students are paying attention to a learning task (e.g., listening to teacher, or doing homework); ALT refers to the amount of time during which students are successful in meaningful learning (Huitt, Monetti, & Hummel, 2009).

The amount learnt is related to exposure to content, which is determined by the length of school year and school day (Brophy & Good, 1986). The amount learned reflects both study time and curricular focus which can maximize both time on task and OTL (Grouws & Cebulla, 2000). The teacher can increase OTL or content coverage with the use of the following (Walberg & Paik, 2000): 1) by examining the curriculum and deciding what is important for learning; 2) selecting critical skills and objectives, whiles deemphasizing the less critical; and 3) use of parsimonious ways of delivering instruction by avoiding digressions, decreasing transition time, whiles increasing opportunities for learning. Assigning homework is another strategy that can lengthen study time (Kauchak & Eggen, 2012). However, to maximizing the impact of homework, effective teachers not only provide homework, but also provide feedback to reinforce what has been done correctly, and re-teach what has not (Walberg & Paik, 2000).

Furthermore, the teacher's ability to create a productive classroom environment that is orderly and focused is critical for maximizing engagement rates (Anderson, 2004; Jones & Jones, 2012). Classroom management includes the way the teacher navigates the classroom, interacts with students, and demonstrates purposefulness in student learning (Redding & Walberg, 2012). It consists of all teacher thoughts, planning, actions and routines that create a productive learning environment for promoting a positive and task oriented behavior in classrooms (Anderson, 2004). Student learning is linked to the quantity and spacing of instruction; with the more effective teachers allocating more time, and actually spending more of their time for teaching (Brophy & Good, 1986). Effective teachers conserve instructional time by planning activities and tasks to fit learning materials; set and convey both procedural and academic expectations; ensure that transition between activities or lessons is smooth; and monitor learning, and provide feedback for student work (Evertson & Weinstein, 2006).

In order to make the most gains in language, math and other subjects, time on task must be maximized (Moore, DeStefano & Adelman, 2012). In a study in the USA, Rowan et al. (2002) hypothesized that active teaching can have a positive effect on student achievement in reading and mathematics. Data was collected on the average minutes per week spent on instruction. Data was also collected on the percentage of time used in various active teaching activities (e.g., presenting or explaining material), and monitoring student performance (e.g., group discussion, and feedback). Using Hierarchical linear modeling (HLM) techniques in analyzing the data, the percentage of time spent in whole-class instruction and time on task were found to have statistically significant positive effects on student achievement in both reading and mathematics.

Opportunity to learn also bears directly on especially student learning in mathematics (Grouws & Cebulla, 2000). Using a sample of 103 teachers and 2000 students drawn from 36 schools in England and Wales, Muijs and Reynolds (2000) sought to determine whether differences in teacher behaviors can have an impact on student achievement in mathematics. The students were tested both at the beginning and end of school year. Observational data on teacher classroom behaviors (e.g., classroom management, behavior management, direct teaching, classroom interaction, and classroom climate) were also collected. The time spent by the students on learning tasks was also measured. Using multilevel analytic techniques in analyzing the data, time-on-task was found to be strongly related to student achievement. Also, the more effective teachers involved all pupils in class work, and also spent a greater proportion of the time communicating with the whole class. On the other hand, spending a high proportion of time communicating with individual students was found to be negatively related to achievement.

Similarly, Hay McBer (2000) studied the impact of teaching skills, classroom climate on student achievement in reading and mathematics. The teaching skills that were measured included involving all students in lessons, differentiation of teaching, applying teaching methods appropriate to the national curriculum, and questioning techniques that probed student knowledge and understanding. Start-of-year and end-of-year student attainment data was used to underpin the relative effectiveness of the teachers. It was found that the more effective teachers used a great deal of direct instruction or active teaching. Such teachers started their lessons on time and finished crisply with a succinct review of the lessons. Also, the more effective teachers managed time and classroom teaching resources efficiently which promoted good behavior and an efficient use of time. Such teachers established and communicated clear boundaries for behavior, a result of which class activities run smoothly, with brief transitions and little time lost in getting organized or dealing with disruptions.

In Cyprus, Kyriakides (2005) examined the extent to which teacher behavior is related to grade six students' achievement in mathematics, Greek Language and the affective aims of schooling. Achievement data of the students was collected. Also, the perceptions of the students were measured on the quantity of academic activities, the form and quality of teacher organized lessons. In analyzing the data using multilevel modeling techniques, statistically significant positive effects were found for the quantity of an academic activity (i.e., instruction, smoothness, and momentum in lesson pacing) for all the outcome measures. The variance in achievement explained was attained at the levels of 0.81, 0.80 and 0.70 for mathematics, Greek language and the affective outcome measures respectively.

In Flanders (Belgium), Opdenakker and Van Damme (2006) examined teacher classroom management and teaching practices that have an impact on student achievement in mathematics. The variables OTL and instructional support were found to have statistically significant positive effects on student achievement; and explaining 12% of the variance in achievement. Also, using the PISA 2006 data set for Israeli, Lavy (2010) examined the impact of the length of instructional time on student achievement. Instructional time was found to have a statistically significant positive impact on student achievement. The findings also suggested that an additional hour of instruction per week increases student achievement by .07 standard deviation.

The findings summarized above concerned with the impact of the quantity of an academic activity on student learning outcomes. The *quantity* of instruction can be seen as necessary but insufficient for successful learning. A combination of *quantity* and *quality* of instruction is what can lead to successful learning (Archer & Hughes, 2011).

Variables related to the quality of teaching

The form and quality of a teacher's organized lessons can be divided into those dealing with giving information (structuring), asking questions (soliciting), providing feedback (reacting), and application opportunities (Kyriakides, 2005). Student learning is enhanced when they spend most of the time being taught or supervised by teachers, rather than working on their own (Muijs & Reynolds, 2000). Effective teachers ensure that students efficiently acquire, rehearse and connect background knowledge with new learning (Rosenshine, 2012). Also, learning is maximized when material is actively presented by beginning with overviews and/or reviews of objectives, outlining the content to be covered, and giving signals of transitions between lesson parts (Brophy & Good, 1986). Attention must also be drawn to key points and subparts of lessons; with summaries, and reviews of the main ideas at the end (Westwood, 1996).

Furthermore, teacher questioning can be used for eliciting classroom discourse, and for supporting student cognitive engagement (Cotton, 2003). This includes questioning by the teacher of students, students of the teacher, and as well among students (Good & Brophy, 1986). Teacher questioning is the single most effective strategy for promoting student engagement and learning regardless of grade level or content area (Kauchak & Eggen 2012). It can be used for the following (Jacobsen, Eggen & Kauchak, 2009): 1) to diagnose the understanding of learners and their motivation for learning; 2) to facilitate communication, and to alert learner focus and attention on key points in a lesson; and 3) for reviews of essential content.

Teacher questions are classified into two categories (i.e., fact and higher order questions (Gall, 1984): Whereas fact questions require students to recall previously presented information; cognitive questions require students to engage in independent and critical thinking. There should be a mix of product questions and process questions in which students are not only required to give answers but to also explain the rationale behind answers (Creemers & Kyriakides, 2008).

Teacher questioning should be at beginning of a lesson, after every short presentation, and during summaries at the end (Muijs et al., 2014). Effective teachers ask questions that reflect an optimal match of the content, learning objectives and the needs of students (Stronge, Ward, & Grant, 2011). Such teachers also provide feedback resulting either from student questions or from their answers to the questions (Muijs et al., 2014): Most questions should elicit correct or at least substantive answers. Correct answers should be acknowledged in a positive and businesslike fashion. And when an answer is partially correct, the teacher needs to prompt students to find the remaining part of the answer. On the other hand, when an answer is incorrect, the teacher needs to point out swiftly and politely that the answer is wrong and why.

Another way to influence student learning via questioning is through wait-time (Kauchak & Eggen, 2012). Wait-time is the time given to students to think and reflect on past experiences; which can increase the quality of both their immediate responses and long-term achievement (Kauchak & Eggen, 2012). According to Westwood (1996), extending wait time to three (3) seconds can lead to an increase in the length and number of responses to questions; decrease non response; and can enable more child-to-child interactions, especially for slower learners.

Additionally, effective teachers monitor student learning with the use of both informal and formal assessments (Cotton, 2003). Such teachers use both formative and diagnostic assessment in monitoring and providing appropriate feedback to students (Brophy & Good, 1986). Whereas summative assessment can be used for summarizing what students have learnt at the end of an instructional segment or a lesson; diagnostic and formative assessments provide the fuel for teaching and learning (McTighe & O'Connor, 2005): Diagnostic assessment precedes instruction, and can be used to identify student prior knowledge and skill level, or any misconceptions on a topic. It occurs concurrently with instruction, and provides specific feedback to students and teachers on how to improve learning. According to Hattie (2009), effective teachers pay particular attention to the formative aspect of assessment in order to prevent student misconceptions about a topic or learning content area before they occur.

Also, the literature highlights the distinction between simply learning facts and gaining usable knowledge that is built upon learning how facts are interconnected, organized, and conditioned upon one another (Mayer, 2004). In this respect, teaching should be organized in a way that invites pupils to regulate and monitor their own learning behavior and to assist pupils in becoming independent and self-regulatory (Ellis & Worthington, 1994; van de Grift, 2007). For example, by teaching students efficient ways of approaching learning tasks, particularly those with learning problems, who commonly exhibit poor or inefficient learning styles (Westwood, 2005). The use modeling, cognitive coaching and scaffolding can help in this endeavor (Chinn, 2011; Seifert & Sutton, 2009). Cognitive modeling involves the articulation of the reasoning that learners can use in learning activities (Jonassen, 1991). In modeling, the teacher guides students on precisely how to go about a learning task, which can help in developing skills such as rehearsal, elaboration, organization, and meta-cognition strategies (Ellis & Worthington, 1994).

Scaffolding provides temporary framework to support learner performance beyond present capacities as follows (Archer & Hughes, 2011) :1) taking a complex skill and teaching it in manageable and logical pieces or chunks; 2) sequencing skills so that they build on each other; 3) selecting examples and problems that progress in complexity; 4) providing demonstrations and completed models of problems; 5) providing hints and prompts as students begin to practice a new skill; and 6) providing aids such as cue cards and checklists to help students remember the steps and processes that can be used to complete a task. According to Jonassen (1991), learners who experience difficulties in performing a task can imply insufficient prior knowledge or readiness level. In which case, the teacher should adjust the difficulty of the task by restructuring the task to supplant the lack of prior knowledge, or provide alternative tasks.

Furthermore, in a typical classroom setting, students vary in terms of culture, age, socioeconomic background, attitudes, learning style and ability. Differentiation or adaptive instruction when skillfully implemented can cater for the needs of all learners (Creemer, 1994). This can be through assigning tasks based on the needs of students, or giving more time to slower learners to complete a learning task (Walberg & Paik, 2000). Differentiation of teaching however does not necessarily imply that students are not expected to achieve the same purpose. On the contrary, adapting teaching to the needs of each student or group of students can ensure that all of them are able to achieve the same purposes (Creemers & Kyriakides, 2006).

Studies conducted in several countries affirm the importance of quality teaching for student learning outcomes. In a study in the U. S., Stronge et al. (2011) sought to determine if the teaching practices of effective and the less effective teachers differ in any discernible ways. Data was collected on student test scores in reading and mathematics over a two year period. Data was also collected on student ratings of teacher behavior. In analyzing the data, it was found that the more effective teachers attained statistically significant scores than the less effective in instructional differentiation, clarity of presentation, high expectation, assessment, and feedback. Such effective teachers also identified clearly to students the learning objectives; and the structure of lessons and learning activities were carefully linked to the objectives.

Also, in a longitudinal study in the U.S., Desimone, Smith and Phillips (2013) found that increased emphasis on more advanced topics and solving novel problems were associated positively with achievement growth, whereas an emphasis on basic topics and memorization were associated negatively with achievement growth. For example, a focus on basic math topics predicted slower than average growth in math achievement ($b=-0.042$, $p<.036$), while a focus on advanced math topics predicted faster than average growth ($b=.061$, $p<.045$) (p: 30).

Still in the U.S., Reyes, Brackett, Rivers, White, & Salovey (2012) hypothesized the emotional connections (CEC) students foster in their classrooms are likely to have an impact on fifth and sixth-grade student learning in English language arts. Data were collected from 63 teachers and 2,000 students in 90 fifth and sixth-grade classrooms from 44 schools. Classroom observational data and the perceptions of the students on emotional support, classroom organization, and instructional support were collected. In analyzing the data using multilevel mediation analyses, it was found that teachers who focused more on advanced mathematics topics (e.g., operations with fractions, distance problems, solving two equations with two unknowns, and statistics) and emphasized solving novel problems, student achievement grew more quickly. Also, teachers' teaching efficacy was associated positively with student engagement ($t=2.02$, $p=.048$, $\delta=.24$).

Furthermore, in a study in four European countries (i.e., England, Flanders (Belgium), Lower Saxony (Germany) and The Netherlands), van de Grift, (2007) studied the effects of teaching quality on the achievement of children of the age of 9 years derived from 854 classrooms. Classroom observational data on classroom were collected on the following five teacher behaviors: efficient classroom management, safe and stimulating learning climate, clear instruction, adaptation of teaching, and teaching–learning strategies. It was found that the five aspects of quality of teaching were positively and significantly correlated (ranging from .32 to .68) with pupil involvement, attitude, behavior and attainment.

In England, Muijs and Reynolds (2000) hypothesized that interactive teaching, individual review and practice can have an impact on student achievement in mathematics. It was found that, review and practice, interactive teaching significantly correlated positively with student achievement. Similarly, structured sessions, and the use of higher-order questioning were found to have statistically significant positive effects on achievement. Similarly, Hay McBer (2000) found that effective teachers had a clear structure for their lessons. Such teachers presented information to students with a high degree of clarity and enthusiasm. Also, the lessons of such teachers proceeded at a brisk pace, and with students fully engaged in the lessons.

Another study in England (Kington, Regan, Sammons, & Day, 2011) sought to determine the effects of teacher behaviors on student achievement in mathematics. Data was collected on student learning scores over a three year period. Also, data on quality teaching was collected. In analyzing the data, it was found that the highly effective teachers included a starter activity and plenary as part of their lessons to provide greater opportunity for review of learning goals. Such teachers also scored very highly in terms of well-organized lessons, clear objectives, and coherent lessons, quality questioning, and feedback to the students. Also, such teachers used intellectually challenging, interactive, whole-class teaching methods.

Similar results were reported in longitudinal studies conducted in Cyprus (e.g., Creemers & Kyriakides, 2009; Creemers & Kyriakides, 2010; Kyriakides & Creemers, 2008; Kyriakides, Antoniou & Creemers, 2009). For example, using a longitudinal design and a representative sample of schools in Cyprus, Kyriakides and Creemers (2009) examined the impact of teaching factors on grade six students achievement for the cognitive and affective aims of education in mathematics and Greek language. Value added data on student achievement was collected. Also data on teaching quality (i.e. orientation, structuring, application, questioning, modeling, classroom management, management of time, assessment) were collected. In analyzing the data using multilevel modeling techniques, the authors found statistically significant positive effects on the outcome measures for all the teacher factors.

The findings presented above concerned with factors associated with the quantity and quality of teaching and learning. As a compliment to the quantity and quality of instruction, the teacher's ability to manage the classroom in ways that can create a positive classroom climate is also critical for student learning gains (Jacobsen et al., 2009).

Variables associated with classroom climate

One of teacher's most important jobs is the ability to create a positive and efficient classroom environment since students cannot learn in chaotic and poorly managed classrooms (Anderson, 2004). A positive classroom climate is when the emotional feeling in classrooms is healthy and supportive: where students feel capable, secured and inclusive; and where the relationship between teacher and students, and as well among students is conducive for learning (Jacobsen et al., 2009). It also involves the quality of the social and emotional interactions among students and the teacher (i.e., teacher/student relations, student/student relations) (Jones & Jones, 2012).

Furthermore, a positive classroom climate is inviting, task oriented and well organized (Anderson, 2004): 1) inviting classrooms are those in which the perceptions of students is that of mutual respect between teachers and students, the co-operation and relationships is positive, and there is overall sense of satisfaction for all members; 2) Task oriented classrooms are those in which students perceive there to be goals to pursue, and are accountable for the goals, and spend a large proportion of class time working towards the goals; and 3) well organized classrooms are those in which students believe the expectations for behavior and learning are explicit and clear, and with appropriate structures to guide behavior and learning.

At the same time, many factors including the individual differences of students stemming from their histories, culture, and SES contribute to classroom climate (Dunbar, 2005). Mcinerney and Liem (2008) contend that in a typical classroom context, while some students can be disruptive and fail to actively engage in learning, others behave appropriately and flourish in their learning. Therefore, to facilitate learning for all students requires an orchestration of effective teaching, proactive preventive strategies and techniques (Evertson & Weinstein, 2006). As noted by Anderson (2004), it is virtually impossible to maintain an orderly classroom in the absence of good teaching, and that when instruction is effective, management problems can decrease or be eliminated.

Effective teaching can prevent most management problems when teachers actively engage students in high-interest lessons geared towards their interests, needs, and abilities (Jones

& Jones, 2012). However, effective instruction alone is insufficient for establishing a positive classroom environment (Dunbar 2004; Marzano & Marzano, 2003). Other equally important components include an emphasis on classroom management at the beginning of the school year, and as well identifying and implementing classroom rules and operating procedures (Marzano & Marzano, 2003). The teacher's abilities to make efficient use of lesson time, to coordinate classroom resources and space, and to manage student behavior with clear rules that are consistently enforced, are all important for maximizing learning (Coe et al., 2014).

A well designed system of rules and procedures stipulates a code of conduct and guidelines to govern classroom behavior (Kauchak & Eggen, 2012). The code of conduct should be crafted in collaboration with students to gain ownership (Dunbar 2004): The teacher should communicate the consequences for inappropriate behavior, whiles avoiding threats and ultimatums, which can detract from a positive emotional climate. Also, the teacher should continue to remind students on the rules and procedures; and should enforce the rules with consistency when problems occur. Also, involving parents on classroom rules and procedures can gain their support, and thus minimize classroom problems.

Accumulating evidence provides support for the significance of classroom climate in student outcomes. In Maryland in the U.S., Pas et al. (2015) examined teacher classroom behavior in relation to student compliance with classroom norms, engagement, and social disruption. Using observational data and latent profile analysis (LPA), the authors identified specific profiles of student classroom behavior. Students in classrooms demonstrating consistent expectations tended to display very few disruptive behaviors (e.g., off-task conversations, verbal aggression, and bullying). On the other hand, students in classrooms with inconsistent and the noncompliant profile displayed less engagement and more social disruption. The teachers of classrooms with noncompliant students used the most disapproval and reactive strategies in managing student behavior.

Also, Reyes et al. (2012) found a positive relation between classroom emotional climate and grades mediated by engagement. Grades increased by 1.74 points for every unit increase in student engagement. In contrast, classrooms with a negative emotional climate (i.e., low CEC) were ones in which teachers and students share little emotional connection and regularly disregard, disrespect, taunt, humiliate, threaten, or even physically lash out at one another.

Teachers in such classrooms did not design or apply lessons with students' perspectives or cognitive capabilities in mind, nor do these teachers divert from a lesson plan when students' boredom, discomfort, or confusion arises.

Similarly, Stronge et al. (2011) hypothesized that effective teachers have some particular set of attitudes, approaches, strategies, or connections with students (e.g., positive relationships, encouragement of responsibility, classroom management, and organization) that lead to higher achievement. The authors found that the top-quartile teachers scored significantly higher in establishing routines, and monitoring student behavior. Such teachers also scored higher in fairness, respect and positive relationships with students. The authors also determined the number of students visibly disengaged in the lessons and those who initiated disruptive or off-task behaviors. It was found that bottom-quartile teachers had disruptions in their classrooms every 20 minutes, whereas top-quartile teachers had disruptions once an hour.

In England, Kington et al. (2011) found that highly effective teachers were able to balance creativity, task centered progress and fun whiles maintaining discipline in their classrooms more consistently. Such teachers used praise extensively to promote positive relationships and rapport with students. They offered students the opportunity to reflect, self-evaluate, and engage in dialogue about learning, which resulted in confidence in their own learning. Also, the more effective teachers spent more time in developing individual relationships with pupils, and focused students on building self-esteem, engendering trust and maintaining respect. Also, the students in such teachers' lessons appeared more valued and part of the classroom community.

Also, Opdenakker and Van Damme (2006) found that good classroom management skills had a positive impact on student achievement in mathematics. The quality of teacher relationship with students (i.e. trust, clear expectations, care and respect) explained 9% of the variance in achievement. Also, student–student relationship was found to impact on learning, explaining 7% of variance in achievement.

Similarly, in Cyprus, Kyriakides (2005) examined the effect of classroom climate on student achievement in mathematics, Greek Language and the affective aims of schooling. Data on the perceptions of students were collected on the following: 1) the extent to which the classroom environment was businesslike and supportive; 2) teacher positive relationships with students; and 3) teacher expectations. It was found that the variables related to classroom environment and positive interactions had statistically significant positive effects on all the outcome measures (see also Creemers & Kyriakides, 2009; Creemers & Kyriakides, 2010; Kyriakides & Creemers, 2008; Kyriakides, Antoniou & Creemers, 2009).

Thus far, the findings reviewed are mainly derived from the developed country school context. It appears research on teacher classroom behavior as an impact on student learning outcomes has not taken root in sub-Saharan Africa. Given the importance of teaching quality on student learning outcomes, it is surprising how little literature is available from the context of African countries to guide policy decisions. The relative importance of teaching quality might differ in the context of Africa (Filmer, Molina, & Stacy, 2015). First, schools in sub-Saharan Africa draw teachers from different segments of the teacher quality distribution than in developed countries because of labor market conditions, and differences in human capital development. Moreover, the returns to moving up higher the teacher quality distribution differ, and which could generate differences in variation in student achievement explained by quality teaching.

However, although not as comprehensive , a few studies from Africa have used advanced methods (i.e., longitudinal designs, experimental and quasi-experimental designs) in examining the effects of some aspects of teaching quality (e.g., time on task, teacher pedagogical knowledge and practice). In order to put to study in perspective, the next section turns to those studies.

Research in sub-Saharan Africa and Ghana

Using data from the National School Effectiveness Study (NSES) in South African primary schools, Taylor (2011) examined features of teacher practices that have an impact on student achievement. Data on the achievement of 11813 grade 4 and grade 5 students were collected both at the beginning and end two school years. Data was also collected on teaching practices including assessment practices, teacher knowledge and curriculum coverage. In analyzing the data with multilevel modeling techniques (controlling for SES and other background factors), it was found that student learning improved substantially when teacher knowledge is combined with time on task. Also, a statistically significant positive effect was found for curriculum coverage on student achievement for both subject domains and grade level.

Also, using a longitudinal design in South Africa, Carnoy et al. (2008) examined the impact of teaching quality on sixth grade mathematics. Data on student achievement was collected at two time points within an academic year. Also, using classroom observations, data on teacher pedagogical knowledge, classroom pedagogy, and opportunity to learn (OTL) was collected. In using multilevel analytic techniques, the authors found OTL to have a statistically significant positive effect on student achievement. Also, teachers with the highest teaching rating in classroom pedagogy had a statistically significant effect on student achievement. It was also reported that majority (77%) of lessons required students to simply recall rules and definitions or perform algorithms with no connection to the underlying concepts of study.

Similarly, in a study in Kenya, Ngware, Ciera, Musyoka and Oketch (2014) examined the effect of quality teaching on grade sixth grade mathematics. Data on student achievement was collected at two time points within an academic year. Data on teachers' mathematical knowledge and proficiency, and the cognitive demand of the tasks used in the lessons was collected. In using multilevel analytic techniques, the authors found a statistically significant negative effect for teaching quality on student achievement; particularly in schools with high-performing students. The low-performing students gained by 6% when mathematics instruction involved high-level cognitive task demands. In the Kenyan context according to the authors, quality teaching has significant positive effects on mathematics only in schools with low-performing students.

In Ghana, Owen Jr. (2005) examined the impact of a USAID quality improvement program (QUIPS) in primary schools. Achievement tests in mathematics and English language were administered to grade 4 and 6 pupils on three occasions: at baseline, at the end of the first year of intervention, and the second year. Data on teacher instructional practices was also collected. Then, using multilevel modeling techniques, the following teaching practices were found to have statistically significant positive effects on student learning gains in both mathematics and English language: 1) special encouragement of girl participation in class; 2) teacher questioning; 3) facilitation of critical and creative thinking; 4) teacher-student interaction; and 5) encouragement of all students to participate in classroom discourse.

In an experimental study in Nigeria, Onu, Eskay, Igbo, Obiyo, and Agbo (2012) determined the extent to which the use of metacognitive skills by students improves achievement in math fractional computations. A sample of 67 primary six pupils were randomly composed and divided into two equal groups, one assigned to experimental treatment and the other to control conditioning. While the experimental group received math metacognitive strategy training, the control group received conventional teaching. A post-test was administered to the students after the intervention. In analyzing the data, pupils who received math metacognitive training (the treatment group) had a total mean achievement score of 6.75 (*SD*=2.58), while pupils that received conventional teaching (the control group) had total mean achievement score of 4.25 (*SD*=2.52), suggesting that the treatment group had better fractional achievement than the control group. Also, males in the treatment group had a mean achievement score of 7.64 (*SD*= 2.27); while the females in the same group obtained a mean achievement score of 6.06 (*SD*=2.65), suggest that the male pupils perform better in fractional mathematics when trained on the use of metacognitive learning strategy.

Still in Nigeria, Akinsola and Odeyemi (2014) used a quasi-experimental design in investigating the effects of mnemonics and prior knowledge instructional strategies for Senior High Students (Form 2) mathematics achievement in Nigeria. They found mnemonic and prior knowledge instructional strategies as more effective for improving students' achievement mathematics. They also found mnemonic instruction to be more effective for student achievement than prior knowledge instructional strategies.

In Ghana, Sarfo, Eshun, Elen, and Adentwi (2014) in an experimental study compared the design regular method of teaching intervention (DRMTI) and the design concrete representational abstract intervention (DCRAI) for teaching geometry and algebra in Junior High Schools. Eighty students were randomly selected and assigned to the two treatments. Tests were administered to the students both at the beginning and end of the intervention assessing problem solving and application skills. For the DRMTI group, the teacher introduced the lesson, modeled a new procedure, guided students to use the procedures, and then assisted students working independently. On the other hand, with the DCRAI treatment group, the teacher introduced the lesson. Then at each stage, the teacher modeled a new procedure, guided students to use procedures, and then assisted students working independently. The teacher used explanations, demonstrations, and illustrations on the blackboard, examples and non examples to help learners understand and apply abstract concepts. In analyzing the data, a significant difference was found between DRMTI and DCRAI (t (78) = 2.43, $p < 0.05$, Cohen $d = 0.54$). Students in DCRAI condition generally performed better (M = 48.48) than the students in DRMTI condition (39.50) on the post-test.

Similarly, Arhin (2013) studied the use of drawings in student learning in mathematics in primary schools. In a Primary school, a grade six teachers and his students were assigned to experimental group, whiles another was to serve as control. Data on student achievement was collected both at the beginning and end of nine weeks of the intervention. Also, the teacher in treatment group was trained to include in his lessons the use of problem questions, manipulation of tools and materials for art, and identifying drawing relationships between mathematics and art. The teacher was also to encourage the students to use such manipulative drawings in the lessons. In analyzing the data after the intervention, there was an increase in the mean value of the post-test (82.96) for the experimental group over the mean value of the pre-test (57.46) showing that intervention was effective in improving performance. Also, there was a strong, positive correlation between the use of drawings and mathematics achievement (r= .533, n=55, p<.0000) implying that increasing the use of drawings in Mathematics teaching is associated with improvement in pupils' performance in mathematics.

As a further complement to the study, a few cross-sectional studies are also reviewed. Filmer et al. (2015) in a cross-sectional study investigated the effects of teaching on measures of grade 4 students' performance in mathematics and reading in Mozambique, Uganda, Togo, Nigeria, and Kenya. Controlling for student and school characteristics, the authors found an additional hour of effective teaching time per day to increase student achievement by .034 and .054 standard deviation for mathematics and reading respectively. Instilling trust in students also increased achievement by .073 and .069 standard deviations for mathematics and reading respectively. Similarly, challenging students intellectually increased student achievement by .09 and .14 standard deviations for mathematics and reading respectively.

Probably the most documented inhibitor to education quality in Ghana is the issue of low time on task in primary schools (Casely-Hayford, 2011). Researchers have found that even when teachers are present in school, instructional time is misused; and that there is a direct correlation between misuse of learning time and pupil disenchantment, absenteeism and dropout (Alhassan & Adzahlie-Mensah, 2010). Etsy (2005) reported that teacher factors that significantly contributed to low pupil academic achievement were the incidence of lateness to school, absenteeism, and the inability to complete the syllabi. As expected, statistically significant negative effects have been reported for teacher use of classroom time (i.e., time on task) on test scores of grade six students in English language and mathematics (Mereku, 2005).

Also, research has established that teaching in Ghanaian schools is largely through expository methods with little opportunities for learner engagement in practical and problem solving activities which can generate deeper learning and cognitive development (Adu-Yeboah, 2011). For example, in an observational study in primary schools, Arhin (2013) reported that teachers seldom integrate practical activities to explain mathematics concepts, and that the teachers did not consider the different learning abilities of pupils in teaching. Similarly, Agbenyega and Deku (2011) investigated teacher pedagogical practices in grade six classrooms. It was found that teaching practices were prescriptive and inflexible, and did not value variety of the learning styles of pupils. Similarly, Kuyini and Desai (2008) investigated whether teachers adapted their instructional practices to the needs of grade six students. It was found that teachers made very limited use of instructional adaptation, and in some cases, no adaptation at all was made to support children with learning disabilities (p: 10).

Thus far, an attempt was made to review the major findings that have accumulated in TER over time. The findings mostly derived from developed countries indicate that effective teachers through their instruction and classroom management practices can create a learning environment that is motivating for student learning. More specifically, the findings indicate that the quantity, quality and the classroom climate facilitated by teachers are the most critical factors for student learning gains. At the same time, EER at its inception had been criticized on a number of grounds. It is to these criticisms the review next turns to.

Conceptual limitations of educational effectiveness in research

EER had been criticized on a number of grounds (i.e., on theoretical and methodological limitations, a narrow focus on basic skills, and the inability to contribute substantially to school improvement) (Creemers & Kyriakides, 2008; Luyten et al., 2004; Reynolds & Teddlie, 2001). At the inception of EER, there was a shortage of rationale theories for formulating research questions, and for providing an organizational scheme within which to accumulate knowledge (Creemers & Kyriakides, 2008). The “how and why” variables of interest were selected and operationalized in studies lacked clarity (Luyten et al., 2004, p: 259). Moreover, the methods of data analysis did not take into account the complex interrelationships between the variables of interest, nor the inherent nested structure of schooling (Rutter & Maughan, 2002).

Further, the failure of studies in assessing the absolute effect of education on child development was an area of concern (Goldstein, 1997; Coe and Fitz-Gibbon, 1998). School effects had largely been seen as the between-school differences in student achievement not explained by control variables (e.g., student and school characteristics) (Coe & Fitz-Gibbon, 1998). For this reason, the control variables in a statistical model largely determined the effect size of schools (Luyten et al., 2004). According to Luyten and colleagues, "if the control variables account for much of the variation in student achievement, the school effect can be small; and if not, the school effect can be spuriously large" (p: 266). To subsequently assume the remaining variance in student achievement between schools is caused by school characteristics can be misleading if not all relevant factors (e.g., unmeasured student background and school context factors) are included in the statistical model (Goldstein, 1997).

The VAM technique of analyzing school data was seen as a more efficient method for measuring school or teacher effectiveness (Anderman et al., 2014; Goe & Croft, 2009; Lomax & Kuenzi, 2012). However, value added measures of teacher effectiveness are highly unstable, and significantly affected by differences in students assigned to teachers (Darling-Hammond, 2015). According to the author, even after controlling for student background factors (e.g., SES or prior achievement), and school context factors in VAM, teachers are either advantaged or disadvantaged based on the characteristics of their students. Moreover, because teachers are neither randomly assigned to schools, nor students to classrooms; it is difficult to sort out how much achievement growth is attributable solely to teachers, and how much is attributable to other factors that might not have been included in VAM analysis (Goe & Croft, 2009).

Furthermore, based on analytic procedure used in VAM (e.g., covariate adjustment model, gains score model, or an explicit growth model); different results on the magnitude of teacher affects are often attained (Anderman et al., 2015; Rowan et al., 2002). For example, using the covariate adjustment model and adjusting for student prior achievement, SES, and the social composition of schools, Rowan et al. (2002) found the variance in student mathematics achievement of between 6% to 11% to lie among classrooms (i.e., *d*-type effect size of .10 and

.36). On the other hand, with the annual gains score approach, the variance in student achievement among classrooms was found to be between 3% and 11% (i.e., *d*-type effect sizes ranging from .18 to .33). Alternatively, using the crossed random model, a *d*-type effect size of .72 was found for teacher effects. In order to attain stability in teacher effects on student learning gains therefore, Anderman et al. (2014) recommends the use of the growth curve model which requires a minimum of student achievement data spanning a three school year period.

Also, in view of the complexity of measuring the act of teaching, providing an accurate and reliable data on effective teaching can be a challenge (Hiebert & Grouws, 2007). For example, in classroom observations of teaching, establishing and maintaining inter-observer reliability on subtle but potentially important features of teaching often requires the training of raters in the use of observation instruments in standard ways so that results can be comparable (Goe & Croft, 2009; Hill, Charalambos, & Kraft, 2012). More observations can improve the relationship between observations and student progress, but Hill et al. (2012) estimated that using observations of practice to produce ratings of teacher quality with a reliability of 0.9 would require seeing a teacher teaching five different classes and having each lesson observed by six independent observers, which would probably be unmanageable across the system. Also, the use of teacher questionnaires has even more serious problems, especially when administered on a single occasion. Moreover, the validity of teachers self-reports can be invalid since teachers have the tendency to over-report or exaggerate their teaching (Hiebert & Grouws 2007).

EER had also been criticized for not contributing much to school improvement (i.e., not providing the clues on how to attain higher levels of performance) (Luyten et al., 2004; McLaughlin & Black-Hawkins, 2004). For example, when research shows positive effect of a teaching strategy, such as the use of active teaching or cooperative teaching, on student outcomes, it was expected that support could be provided to teachers by educational professionals in order to help them implement this strategy and improve their practice (Creemers & Kyriakides, 2010). Research had focused more on effective schools than the less effective (Reynolds & Teddlie, 2001). The factors that enhance effectiveness may be quite different from those that lead to ineffectiveness (i.e., knowing what constitutes an effective school or teacher and knowing how that translates into improvement are two entirely different issues) (Rutter & Maughan, 2002). As noted by Luyten et al. (2004), being effective and becoming effective are two different things; and being effective is not the same as staying effective (p: 264). Schools differ in the underlying causes of their specific capacity for change, and contextual characteristics (Rutter & Maughan, 2002). As the direct users, schools should have the relevant information about research output; and as well be helped in understanding how it informs their current and specific needs (McLaughlin & Black- Hawkins, 2004).

Additionally, EER had been criticized for focusing too heavily on basic knowledge and skills (Creemers et al. 2010). Researchers had not been able to monitor or study student learning in the full range of the school curriculum, or in relation to new goals of education such as meta-cognitive skills (Creemers & Kyriakides, 2008). Moreover, the correspondence between the officially stated goals of education and the standardized tests typically used in assessing educational effectiveness was an area of concern (Campbell et al., 2003). This is because standardized tests commonly address only the cognitive skills of students, whereas officially stated goals in most countries are much broader, extending to cover the personal development and citizenship in students (Luyten et al., 2004).

Another area of concern was the use of mainly quantitative methods and strategies to the exclusion of qualitative methods. Coe and Fitz-Gibbon (1998) argued that quantitative research is inadequate for explaining how and why internal and external conditions in schools influence student learning outcomes; and that the quantitative method ignores the values and life experiences of research participants, and the meanings they give to events. A combination of both quantitative and qualitative strategies in studies have the advantage of a synergistic breath in which a greater range of data can result in more nuanced and authentic account of learning, and the complex realities in schools (Day, Sammons, & Gu, 2008).

Finally, the limitations of EER at its inception can be summarized as follows (Creemers et al., 2010; Luyten et al., 2004): 1) there was the need for longitudinal studies in order that pre-existing differences between students and schools can be taken into account; 2) the need for multilevel analysis of school data to facilitate the exploration of differential effectiveness of schools ; 3) adequate controls for social selection, prior achievement, and other self-perpetuating effects that may exist in schools; 4) plausible explanations of the processes on how and why schools and teachers become effective; 5) a broader effectiveness criteria to include the cognitive, affective and meta-cognitive goals of education; and 6) the need to synchronize or link research output in ways that can be used by schools and teachers for school improvement.

Based on the criticisms, EER has since shown great development and improvement in both theoretical and methodological grounds (Reynolds et al., 2014). As will be shown in the next section, the dynamic model educational effectiveness was developed by taking into account the limitations of EER (Creemers & Kyriakides, 2006). As stated in chapter one, the conceptual framework of the dynamic model at the classroom level was used in studying the teaching factors that have an impact on student achievement in Ghana. The review next section turns to the conceptual framework of the study.

Conceptual framework of the study

EER is approached from three main perspectives (i.e. economic, educational psychologists and sociological perspectives) (Creemers & Kyriakides, 2008). The economic oriented studies focus on estimating the relationship between school inputs or resources (e.g., student/teacher ratio, teacher experience, class size, per pupil expenditures) and student learning outcomes (Hanushek, 1997). Educational psychologists focus on student background factors such as learning aptitudes, personality and motivation, and as well on variables measuring the learning processes (Creemers, 1994). Educational sociologists focus on student background factors such as SES, gender, and social-capital, and the school context) (Coleman et al., 1966). The predominant effectiveness criterion is student achievement in cognitive skills, knowledge, attitudes and moral development. Equity as a broader criterion of effectiveness is also used (Sammons & Bakkum, 2011).

A second wave of research on school effectiveness was also to emerge running in parallel with instructional effectiveness research (Creemers, 1994; Scheerens & Bosker, 1997). School effectiveness studies focused on effectiveness enhancing conditions at the school level, and instructional effectiveness studies focused on effectiveness enhancing conditions at the classroom level. Then, a third wave of studies introduced an integration of the effective school research, economic and psychological studies, and instructional effectiveness research, and mixtures of antecedent conditions at school; all jointly studied to determine their relative impact on student learning outcomes (Creemers, 1994). Furthermore, these later studies incorporated resource inputs, school organizational factors and instructional characteristics, in which multilevel modeling became a vital methodological requirement (e.g., Creemers, 1994; Scheerens, 1992; Stringfield & Slavin, 1992) (Creemers & Kyriakides, 2008, Riddell, 2008).

The comprehensive model educational effectiveness (Creemers, 1994) was developed at the third phase of EER (Creemers & Kyriakides, 2008). The validity of the model was provided in studies conducted in the Netherlands and Cyprus (e.g., de Jong et al., 2004; Kyriakides & Tsangaridou, 2008). At the same time, the studies also identified some weaknesses for take-up in subsequent models (Creemers & Kyriakides, 2008). For example, at the classroom level, there was the need for a clearer definition of teaching in reference to the most important aspects of effective teaching which refer to both the direct teaching model and new theories of learning. Taking a lead from the weaknesses identified in the comprehensive model, and as well the limitations of EER as reviewed in the previous section, Creemers and Kyriakides (2006) developed the dynamic model of educational effectiveness. In the sections to follow, the dynamic model of educational effectiveness, its main assumptions and essential characteristics are presented. This followed by a more detailed presentation of the model at the classroom level.

The dynamic model of educational effectiveness research

The dynamic model is multilevel in measuring educational effectiveness (Creemers & Kyriakides, 2006): The model is mainly based on the following three assumptions. First, most effectiveness studies had been exclusively focused on language or mathematics rather than on the whole school curriculum aims. This meant that the outcome measures should be defined more broadly to include meta-cognitive and affective aims of education rather than restricting to basic skills. This implied that new theories of teaching and learning are used in order to specify variables associated with the quality of teaching. Second, the dynamic model is established in a way that helps policy makers and practitioners to improve educational practice by taking rational decisions concerning the optimal fit of the factors within the model and the present situation in schools or educational systems. This was to address a major constraint of the earlier theoretical models (i.e., Creemers, 1994; Scheerens, 1992; Stringfield & Slavin, 1992) in not contributing significantly to school improvement. And third, the dynamic model is not only parsimonious but also describes the complex nature of educational effectiveness. The model could be based on specific theory but at the same time, some of the factors included in the major constructs of the model are interrelated within and/or between levels.

The essential characteristics of the dynamic model of educational effectiveness

The dynamic model describes the complex nature of educational effectiveness, and refers to different effectiveness factors situated at the level of the student, classroom, school and educational system (Creemers & Kyriakides, 2006). The teaching and learning situation is emphasized, and the roles of the two main actors (teacher and student) are analyzed. Above the student and classroom levels, the dynamic model refers to school factors which are expected to influence teaching and learning. At the school level, the emphasis is on developing and evaluation of school policy for teaching, and for creating a suitable learning environment at school. At the final level (i.e., educational system), the dynamic model refers to the influence of educational systems in developing and evaluating educational policy for teaching and learning in schools. Figure 1 below presents the main structure of the dynamic model of educational effectiveness.

As can be observed in Figure 1, the dynamic model refers to multiple effectiveness factors that operate at the different levels of the student, classroom, school and educational system (Creemers & Kyriakides, 2006). The essential characteristics of the dynamic model are as follows (Creemers & Kyriakides, 2006). First, the model refers to multiple effectiveness factors which operate at different levels. Second, it is expected that some factors which operate at the same level are related to each other, for which reason, grouping of factors are specified. Third, although there are different effectiveness factors and groupings of factors, it is assumed that each factor can be defined and measured using similar dimensions. This is a way to consider each factor as a multidimensional construct and at the same time to be in line with the parsimonious nature of the model. Finally, the dynamic model is designed in a way that takes into account the possibility that the relationship between the factors of the model and learning outcomes may not be linear. This refers to the possibility of searching for optimal values of the various dimensions of the factors and optimal combinations between the factors of the model.

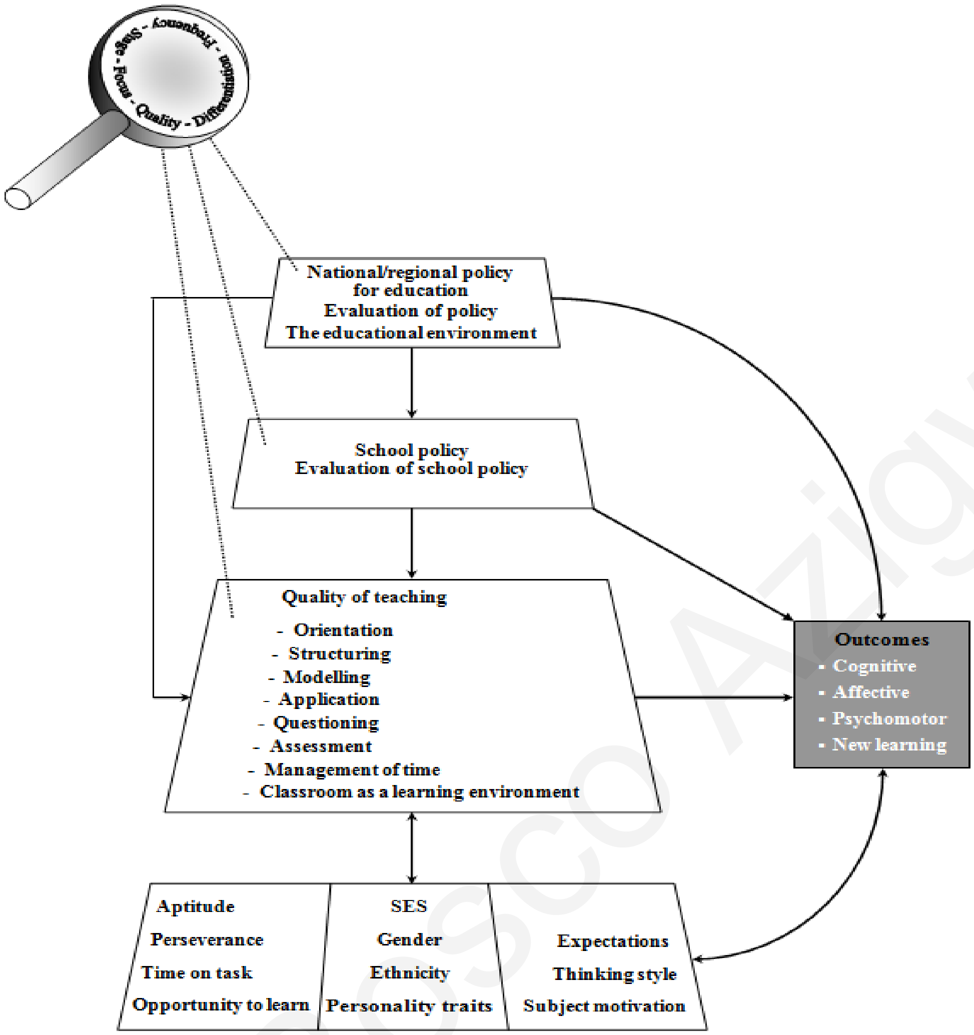

Figure 1. Main structure of the dynamic model of educational effectiveness

The quality of instruction, time on task and opportunity to learn, are key concepts which when optimally manipulated can result in student learning gains (Creemers & Kyriakides, 2006). Thus, the dynamic model puts an emphasis on quality, time and opportunity to learn as overarching factors running through all the levels of the model. At the classroom level, quality, time and opportunity to learn are influenced by factors at school, which is in turn influenced by factors at the educational system. At the student level, the time students actually spend on learning is defined in reference to three variables: opportunity (time allowed for learning); perseverance (the amount of time students are actively engaged in learning; and aptitude (the amount of time needed to learn in optimal instructional conditions).

Studies conducted in many countries show that a higher proportion of the variance in student achievement can be explained by student background factors (Brophy & Good, 1986; Scheerens & Bosker, 1997; Sirin, 2005). Thus, the dynamic model refers to two main categories of background factors operating at the student level. The two categories are: a) student socio-cultural and economical background variables emerging from the sociological perspective of EER (e.g., gender, SES, ethnicity); and b) background variables emerging from the psychological perspective (e.g. aptitude, motivation, expectations, personality, and thinking style) (Creemers & Kyriakides, 2006).

A distinction is made between the student-level factors by referring to factors which are unlikely to change (e.g., gender, SES, ethnicity, personality), and factors that may change over time (e.g., subject motivation and thinking styles) (Creemers & Kyriakides, 2006). The first group of factors (e.g., gender, SES, ethnicity) are known in the literature to explain variation in student learning outcomes for which reason they are not only treated as student level factors, but are also highlighted for investigating their impact on learning, and as well the level of any inequality that may exist in student performance (e.g., Willingham, 2012; Willms, 2002). For example, parental education has an influence on the value placed on education, which in turn can influence child learning outcomes (Eccles & Davis-Kean, 2005). Studies have also shown that academic achievements by student sex tend to depend on the subject domain (e.g., language, math, or science). Whereas male students tend to outperform their females counterparts in mathematics and science, female students tend to outperform their male counterparts in reading and writing (Gustafsson, Hansen, & Rosén, 2013; Voyer & Voyer, 2014).

The second group of student factors (i.e., aptitude, motivation, perseverance, and expectations) also explains variation in student learning outcomes (Brophy & Good, 1986; Ryan & Deci, 2000). For example, the aptitude of a child determines his/her readiness to profit from instruction (Haertel, 2013). Aptitude refers to any relatively stable child characteristics (e.g., cognitive or psychomotor ability, or prior knowledge) that are predictive of learning achievement (Bailey, Watts, Littlefield, & Geary, 2014; Kaufman et al., 2012). Also, prior knowledge provides a clearer and precise predictor of future achievement, and a more useful basis from which instruction and guidance can be based (Walberg, 2003). Furthermore, prior knowledge determines how new information is understood, organized and stored in long-term memory for retrieval when needed (Slavin, 2014).

The dynamic model is not focused on individuals as such but on the effects of the actions which take place at classroom/school/context levels by students, teachers, school principals and policy makers (Creemers & Kyriakides, 2006). School principals or leaders of educational systems have the potential to unleash latent capacities in school organizations (Creemers & Reezigt, 1997). However, studies have shown that leadership characteristics (e.g., leadership style, professionalism or specialization) have negligible effects on student achievement (Anderson, 2004). Also, mixed results have been reported for variables presumed to be indicative of teachers' competence (e.g., academic ability, years of education, teaching experience, and subject matter knowledge) (Darling-Hammond, 2000). For example, teacher subject knowledge is widely perceived as a factor affecting teacher effectiveness, but teachers' subject knowledge, regardless of how it is measured, has rarely correlated strongly with student achievement (Creemers & Kyriakides, 2010).

Thus, at the classroom level of the dynamic model, instead of measuring the teaching style of the teacher, the model focuses on the actual behavior of the teacher in the classroom. At the student level, the focus is on the student and his/her engagement in learning. Similarly, at the school level, instead of measuring the leadership style of a principal, the focus is on the impact of the end result of leadership (e.g., the development of school policy on teaching, and the evaluation of school policy). And at the system level, the model does not refer to the leadership style of policy makers, or to the use of specific approaches in administering the educational system. It refers to the content of national policy which reveals the end result of activities that policy makers undertake that can have an impact on teaching and learning in schools.

A major distinction of the dynamic model as compared to the other integrated models before it (i.e., Creemers, 1994; Schereens & Bosker, 1997; Stringfield & Slavin, 1992), is that it uses a measurement framework that examines not only how frequently each effectiveness factor is present in a school, class or educational system, but also the *qualitative* characteristics of the functioning of each factor (Creemers & Kyriakides, 2006). The model assumes that each factor situated at the classroom, school and educational system can be defined and measured using five dimensions: *frequency, focus, stage, quality, and differentiation*. The dimensions are expected to contribute to the effects that a factor has on student learning outcomes. Moreover, they help in describing in a better way the functioning of the effectiveness factors. In chapter one, the conceptual framework of the dynamic model at the classroom level was briefly presented. The next section presents the classroom level factors in greater detail.

Classroom factors of the dynamic model of educational effectiveness

The dynamic model refers to eight effectiveness factors which were found to be consistently related to student learning outcomes in TER (e.g., Brophy & Good, 1986; Creemers, 1994; Doyle, 1975; Kyriakides et al., 2002; Muijs & Reynolds, 2001; Rosenshine, 1995). The eight factors are: *orientation, structuring, questioning, teaching modeling, applications, management of time, teacher role in making classroom a learning environment, and assessment* (Creemers & Kyriakides, 2006). The factors do not refer to only one approach to teaching (i.e., direct explicit model or constructivism approaches to teaching). The dynamic model adopts an integrated approach in defining quality teaching. The model refers to skills associated with the direct teaching and mastery learning such as structuring and questioning, and orientation and modeling which are in line with the constructivist approach to teaching.

Direct instruction is based on both the theory and evidence that learning can be greatly accelerated if instructional presentations are clear, minimize misinterpretations, and facilitate generalizations (Rosenshine, 1995). Its main principles are that all children can learn, regardless of their intrinsic and context characteristics. The teaching of basic skills and their application in higher-order skills is essential to intelligent behavior and should be the main focus of any instructional program (Rowe, 2006). On the other hand, the constructivist view holds that instruction is generally more effective when learners are actively involved in the learning process (Gordon, 2009; Jonassen, 1991; Prince & Felder, 2007). To this view, when students learn to recognize a problem, draw on own experience and prior knowledge, search relevant information and develop strategies for solving the problems; knowledge construction, discovery and understanding can be achieved at a higher level of cognition (Joolingen, 1999). However, the implicit assumptions underlying such rationale are that intrinsically motivated learners have acquired sufficient prior knowledge and skills to engage effectively and productively for generating new learning in a given subject matter domain (Rowe, 2006).

Other scholars (e.g., Cummins, 2000; Rowe, 2006; Wilson & Peterson, 2006) posit that neither direct instruction nor constructivist methods provide an adequate blueprint insofar as they fail to explicitly address the goals of education. A continuum exist from direct instruction to the constructivist approach to teaching as neither of the two extremes is found in the practical world of education (Joolingen, 1999, p: 1). Effective teachers use an array of teaching methods or strategies as there is no single universal approach that may be suitable to the needs of all learners (Slavin, 2014). A teacher's instructional approach should be based on how much guidance and scaffolding is considered desirable for teaching new skills to learners based on mastery of the subject matter (Archer & Hughes, 2011). Particularly, teachers should apply pedagogical approaches judiciously based on their own inquiry and understanding of the teaching and learning situation at hand (Darling Hammond et al., 2001).

The focus of the dynamic model is on teacher classroom behavior, and interactions with students around the content for learning directed at successful student learning (Creemers & Kyriakides, 2006). This is different from factors such as teacher beliefs, subject matter knowledge, years of experience, and personality traits. The rationale is that the classroom is the primary venue in which students and teachers interact; hence, decisions by teachers as to what to do in this venue will most strongly affect student outcomes (Creemers & Kyriakides, 2006). Teacher inputs will be least likely to influence student academic performance because they do so less directly, through encouraging classroom practices conducive to high student performance (Wenglinsky, 2002). For example, teacher characteristics can have an influence on teaching, but do not necessarily determine teaching i.e. teachers with different characteristics can teach in essentially the same way and vice versa (Hiebert & Grouws, 2007). Whereas decisions by teachers on what to do in classrooms is most strongly expected to affect learning outcomes; teacher characteristics influence student achievement indirectly through the quality of teaching (Creemers, 1994). As noted by Anderson (2004), it is not what teachers are that matters, but what they do in classrooms for successful learning (p: 34).

Thus, the dynamic model refers to various factors related to the key concepts of quality, time on task, and opportunity to learn, which when optimized can lead to student learning gains (Brophy & Good, 1986; Creemers, 1994; Doyle, 1975; Rosenshine, 1995). Opportunity to learn and time on task concern with the quantitative aspects of teacher behavior in providing relevant activities related the content of curricula; and actually spending the allocated time for teaching activities (Brophy & Good, 1986). Students learn more when they spend much of their time being taught directly by their teachers (Muijs & Reynolds, 2001).

The instructional variable of time has two interrelated aspects: how much time is spent teaching and how much time students spend on learning tasks (Archer & Hughes, 2011; Brophy & Good, 1986). Increasing instructional time or opportunity to learn does not always lead to an increase in the time students spend on learning tasks, or in the total amount of learning (Archer & Hughes, 2011). The *quantity* of instruction can be seen as a necessary but insufficient component of teaching and learning. A combination of *quantity* and *quality* of instruction is what leads to students learning success (Archer & Hughes, 2011). The relevant causal agent producing student learning is how teachers use instructional time (Rowan et al., 2002). High-quality instruction is the provision information cues, correctives, and positive reinforcement to students to ensure the fruitfulness of engaged time (Walberg, 2003).

Thus, three main aspects of quality of instruction are distinguished in the dynamic model (i.e., curriculum, grouping procedures and teacher behavior), each of which should contain a set of effectiveness enhancing conditions similar across the three components (Creemers & Kyriakides, 2006). Learning material include the extent to which curricula offer opportunities to learn i.e. quantity of subject matter offered, the degree of overlap between goals and subject matter; explicitness and ordering of goals; structuring and clarity of subject matter; use of advance organizers; and the evaluation of student learning in order to provide extra support or corrective instruction when needed (Creemers, 1994). Also, grouping procedures such as mastery learning, heterogeneous grouping and co-operative learning can induce effectiveness (Creemers, 1994). When students with similar levels of knowledge and skills are grouped together, teaching of what students already know and what they are yet incapable of learning is avoided, and thus enables suitable instruction that is more efficient (Walberg, 2003). Teacher-led group instruction also has a positive impact on achievement as it increases such effective teaching elements as clear explanations, modeling, practice, feedback; and as well increases the opportunity for productive discussion, and peer and cross-age tutoring (Westwood, 2005).

Additionally, the teacher's ability to create a productive classroom environment that is orderly and focused, and where students feel both physically and emotionally safe is critical for learning (Anderson, 2004; Jones & Jones, 2012; Kauchak & Eggen, 2012). Thus, the dynamic model refers teacher management of the classroom for orderliness and quiet atmosphere; high expectations for all students; clear goal setting; and an emphasis on the acquisition of both basic skills, and as well cognitive learning (Creemers & Kyriakides, 2008). As presented above, the teacher effectiveness factors of the dynamic model are as follows (Creemers & Kyriakides, 2008): *orientation, structuring, questioning, teaching modeling, applications, management of time, teacher role in making classroom a learning environment, and assessment.* The next to follow presents brief overviews of the teacher factors of the dynamic model.

1) Orientation. Orientation refers teacher behavior in providing the objectives for which a specific task, lesson or series of lessons take(s) place and/or challenging students to identify the reason for an activity in a lesson (Creemers & Kyriakides, 2006). In the orientation phase of instruction, the teacher is expected to provide to students with what is expected of learning activities, and what they will know or be able to do at the end (Brophy & Good, 1986). This involves a review of previous material and/or prerequisite skills, the specific knowledge or skills to be learned, and explanations of why the particular objective is important (Creemers & Kyriakides, 2006). The use of advance organizers, study questions, and predictions can prepare students for the learning activities (Cotton, 2003); link or bridge new information to existing cognitive structures (Mayer, 2002); and can also serve as a 'mental road map' of what students have accomplished, where they are presently, and where they are going (Walberg & Paik, 2000, p:13). Throughout the lesson, the teacher is expected to monitor the learning tasks to ensure that all the students understand the rationale behind assignments, and on how to complete assignments (Porter & Brophy, 1988).

It is expected that when students are told why the content to be learned is important to their daily lives, their curiosity, interest, and active participation in lessons might be attained (Creemers & Kyriakides, 2008). Similarly, with orientation activities, students might be motivated for lessons, identify with the objectives of the lesson, and spend their time and effort in the lessons; which can ultimately result in their understanding and the desired learning outcomes (Kift & Field, 2009; Ryan & Deci, 2000). Additionally, orientation activities can enable student engagement (both behaviorally and emotionally) in lessons; a result of which can facilitate compliance to classroom rules and norms (Trowler & Trowler, 2010).

2) Structuring. A well designed lesson provides a clear structure and framework which can enable students to identify key points in a lesson linking with their past learning (Creemers & Kyriakides, 2006). Student learning is maximized when teachers not only actively present materials but structure it (Rosenshine, 2012): a) beginning with overviews and/or review of objectives; b) outlining the content to be covered and signaling transitions between lesson parts; c) calling attention to main ideas; and d) reviewing main ideas at the end. Summary reviews in the lessons are also important since they integrate and reinforce the learning of major points (Brophy & Good, 1986). Furthermore, structuring not only facilitate memorizing of information, but also allows for its apprehension as an integrated whole i.e. the recognition of the relationships between lesson parts (Walberg & Paik, 2000). Moreover, achievement is higher when information is presented with a degree of redundancy, particularly in the form of repeating and reviewing general views and key concepts (Creemers & Kyriakides, 2006). Similarly, alerting students to key-points allows them to concentrate on the most important parts of lessons (Rosenshine, 2012).

3) Questioning techniques. Teacher questions are instructional cues or stimuli that convey to students the elements of the content to be learned and directions on what and how to engage in lesson activities (Cotton, 2003). Teacher questioning is the single most effective strategy for promoting student involvement in lessons, and resultantly their learning regardless of grade level, content area or topic (Kauchak & Eggen, 2012). Also, teacher questioning can be used for the following (Cotton, 2003): a) for developing students interest and motivation to be actively involved in lessons; b) for evaluating students' preparation for lessons and checking on homework or seatwork completion; for developing critical thinking and inquiry skills; for reviews and summaries of previous lessons; for assessing the understanding of students in the instructional goals and objectives.

Effective teaching involves careful attention to questioning as asking the right questions is the essence of good teaching (Westwood, 1996). Effective teachers ask questions that reflect an optimal match of the content and learning objectives with questions with to maintain momentum and the interest of student in lessons (Stronge et al., 2011). The use of divergent as well as convergent questions can help students formulate hypotheses, make connections with learning activities, or challenge previously held views (Dillon, 1988). There should be a mix of product questions and process questions in which students are not only required to give answers but to also explain the way at arriving at answers (Creemers & Kyriakides, 2009). Also, classroom norms should be established indicating that every student deserves the opportunity to answer questions, and that all answers are important. This can ensure that the most verbal students monitor their own talking, and allow others opportunities to participate in classroom discourse (Dillon, 1988).

Another way to influence student learning via questioning is through wait-time (Kauchak & Eggen, 2012). According to Westwood (1995), when teachers pause for three to five seconds (both after asking a question and after hearing an answer), more students participate in classroom discussion; their answers are longer and of higher quality; and student cognitive development can improve. Also, correct responses should be acknowledged, while responses that are partly correct require affirmation of the correct part, or rephrasing of the question (Brophy & Good, 1986). Following incorrect answers, the teacher should indicate that the response is not correct, but should avoid personal criticism, and should provide the correct answer by showing why the correct answer is correct (Muijs & Reynolds, 2001).

4) Modeling strategies. Cognitive research on teaching proposes ways to encourage student self-monitoring, self-teaching or meta-cognition that fosters achievement and independence in learning (Chinn, 2011; Ellis & Worthington, 1994; Ertmer & Newby, 2013). Effective teachers are expected to help pupils to use strategies and/or develop their own strategies for solving different types of problems (Kyriakides et al., 2002); particularly for students with learning problems, who commonly exhibit inefficient learning styles (Westwood, 1996). Also, teaching the use of cognitive skills to students transfers part of the direct teaching functions of planning, allocating time and reviews to the students themselves (Walberg & Paik, 2000).

Furthermore, teaching modeling provides students with specific demonstrations of working with the content, which should be introduced and explained clearly in the context of students' everyday lives (Chinn, 2011). In modeling activities, the teacher guide students precisely on how to go about learning tasks for developing cognitive and problem solving skills such as rehearsal, elaboration, organization, and meta-cognition strategies (Ellis & Worthington, 1994)**.** Through explicit modeling, the teacher clearly describes the concept to be leant, and then models the desired outcome (Archer & Hughes, 2011): a) by describing the skill or strategy; b) by describing features of the strategy or steps in performing the skill, and breaking the skill into manageable parts; c) by modeling with the use a variety of techniques such as engaging students with enthusiasm, and keeping a steady pace; asking good questions, and checking for student understanding.

On the other hand, the constructivist view to teaching holds that learners ultimately construct their own knowledge that resides within them, and that each person's knowledge is unique (Gordon, 2009; Jonassen, 1991). This view suggests that learning best occurs when learners reflect on their own experiences and construct their own distinct meanings, rules, and mental models related to content (Prince & Felder, 2007). However, in teaching new concepts especially to novice learners, some amount of guidance is required (Kirschner, Sweller, & Clark, 2006). With adequate guidance and structure, discovery learning can be an effective learning approach in which intuitive or deep conceptual knowledge can be acquired (De Jong & Lazonder, 2014; Mayer, 2004).

5) Application. At this phase of the lesson, the teacher should provide learners numerous opportunities to practice the skills being learned (Rosenshine, 1986; Walberg & Paik, 2000). Walberg (1999) proposes three phases in application activities: In the first phase, students practice newly learned knowledge or skills under the teacher's direct supervision (e.g., on solving math problems, or holding discussions in small groups). At this point, the teacher should actively monitor the activities while providing immediate feedback. At the end, teachers should have precise information regarding each student's knowledge or skill acquired in the lesson. At the second phase, students engage in independent practice by working on their own, with periodic reviews by the teacher. Then finally, students practice the new concepts independently either in the form of class work or homework. In order to maximizing the positive impact of homework, effective teachers not only provide homework, but also provide feedback to reinforce what has been done correctly, and re-teach what has not (Walberg & Paik, 2000).

6) The classroom as a learning environment. The teacher's ability to create a productive classroom environment that is orderly and focused, where students feel both physically and emotionally safe is critical for teaching and learning (Good & Brophy, 1986). Effective teachers are expected to organize and manage the classroom as an efficient learning environment and thereby to maximize engagement rates (Creemers & Kyriakides, 2008). Effective teacher behaviors that can help with classroom management are as follows (Good & Brophy, 1986): a) effective teachers emphasize academic instruction; a) they expect all students to master the curriculum, and as well allocate the most time to curriculum-related activities; and c) they assign seat work for activities related specifically to the objective of the lesson, and as well at the appropriate level of difficulty.

The dynamic model concentrates on measuring teacher contribution in creating an efficient learning environment in his/her classroom (Creemers & Kyriakides, 2006). Five elements of classroom as a learning environment are taken into account: teacher-student interaction; student-student interaction; students' treatment by the teacher; competition between students; and managing classroom disorder. The first two elements are important components of measuring classroom climate. The dynamic model refers to the type of interactions that exist in a classroom rather than the perceptions of students on teacher interpersonal behavior. The other three elements refer to the attempt of teacher to create a businesslike and supportive environment for learning (Brophy & Good, 1986; Walberg, 1986).

7) Management of Time. Management of time is considered as one of the most important indicators of teacher ability to manage classroom in an effective way (Creemers & Kyriakides, 2006). Effective teachers emphasize academic instruction as their main classroom goal; and they have an academic orientation (Muijs & Reynolds, 2000): Such teachers create a businesslike, task-oriented environment and spend classroom time on academic activities rather than on socializing and free time. They avoid digressions, decrease transition times, and increase opportunities for students to learn by requiring frequent responses to increase content coverage (Archer & Hughes, 2011). Teachers can maximize time on task and increase content coverage through the following (Walberg & Paik, 2000): a) decide what is important for learning by examining the curriculum, and selecting critical skills and objectives, whiles discarding or deemphasizing the less critical; and b) the use of a more parsimonious way of delivering instruction by avoiding digressions, decreasing transition times, whiles increasing opportunities for learning with frequent questions and responses from the students.

8) Teacher assessment. Teacher assessment of student understanding of the concepts for learning should be done before, during, and after lessons (Brophy & Good, 1986). Teacher assessment has the potential not only to measure and report learning but also to promote it (McTighe &

O'Connor, 2005). This phase of the lesson involves two instructional events (Huitt et al., 2009): a) data collection on a daily basis to judge student success, and as well over longer intervals such as weekly, biweekly, and monthly; b) formative evaluation about learning to determine if students are making progress. The use quizzes can enable the gathering of additional information on the learning of the students as group or of particular individual students. Finally, providing corrective feedback and reinforcement is done whenever the teacher has made an assessment of student learning at any point in the lesson. The primary function is to make plans for additional teaching on the topic, if necessary.

Additionally, classroom assessment and grading practices that are well designed can provide personalized and timely information to guide both learning and teaching (McTighe & O'Connor, 2005). Frequent assessment of progress informs teachers and students when additional time and corrective remedies are needed (Walberg & Paik, 2000). The information gathered can be used by teachers in identifying the needs of students and as well to evaluate their own practice. Also, the feedback to students should have a positive and emotional tone, be immediate and specific, and should include corrective information where necessary (Jacobsen et al., 2009). Corrective feedback and reinforcement has a strong relationship to student achievement (Walberg, 1986).

Thus far, a review of the conceptual framework of the dynamic model, its features and main assumptions has been presented. Also presented were the classroom level of the model and a summary of the eight teaching factors. As indicated earlier, the dynamic model assumes that each of the eight teaching factors can be measured using five dimensions. The review next turns to the measurement dimensions of the dynamic model.

The measurement dimensions of the dynamic model of educational effectiveness

The dynamic model assumes that each of the teaching factors discussed above can be defined and measured using five dimensions: *frequency, focus, stage, quality, and differentiation* (Creemers & Kyriakides, 2006). Specifically, the frequency dimension is a quantitative way to measure the functioning of each of factor, whereas the other four dimensions measure the qualitative characteristics of the functioning of the factors. The measurement dimensions are not only important from a measurement perspective, but also from a theoretical point of view.

According to Creemers and Kyriakides (2006), the actions of teachers associated with each factor can be understood from different perspectives, and not only by giving emphasis to the number of cases, and/or the actions of teachers. Further, the use of the measurement dimensions in studies may also help in developing strategies for improving teaching since the feedback given to teachers could refer not only to the quantitative aspects of teaching but also the qualitative characteristics of teaching (Creemers & Kyriakides, 2006).

A summary review of the measurement dimensions of the dynamic model can be as follows (Creemers & Kyriakides, 2006): The *frequency* dimension refers to the quantity of an activity associated with each teacher factor. The frequency dimension is probably the easiest way to measure the effect of a factor, and almost all the models before the dynamic model (i.e., Creemers, 1994; Schereens & Bosker, 1997; Stringfield & Slavin, 1992) were concerned with this dimension of effectiveness factors (Creemers & Kyriakides, 2006). However, the frequency dimension of a factor may not always be linearly related to student learning outcomes. It is assumed that after an optimal value of using for example personnel monitoring system is a school, monitoring may not have an additional effect on learning outcomes. On the contrary, this may result in a negative effect on teacher behavior in terms of teaching; and ultimately on student learning outcomes (Creemers & Kyriakides, 2006).

In addition, the quantity of a teaching might not necessarily lead to an increase in the time students spend on learning tasks, or in the total amount of learning (Archer & Hughes, 2011). The *quantity* of instruction can be seen as a necessary but insufficient component of teaching and learning. A combination of *quantity* and *quality* of instruction is what can lead to learning success (Archer & Hughes, 2011). Moreover, the quantitative aspect of teaching is basic to instruction; teachers exercising more advanced skills to do with the qualitative aspect of instruction can have better student learning outcomes (Kyriakides et al. (2009). For these reasons, the dynamic model goes further by considering the qualitative aspects of teacher classroom behavior (*focus, stage, quality, and differentiation of teaching*).

The factors are measured by taking into account the *focus* of the activities which reveals the function of the factor at classroom. Two aspects of focus of each factor are measured. Whereas the first aspect refers to the specificity of activities which can range from specific to general, the second aspect addresses the purpose for which an activity takes place. An activity may be expected to achieve a single or multiple purposes. For example, under the focus dimension of Orientation, the teacher is not only expected to provide the aim of a lesson to students, but to also link the activities in a lesson to a unit or number of lessons as covered in previous lessons. This enables students to gain a complete picture of the learning activities which can result in their understanding of the lessons and consequently successful learning.

Further, teaching activities associated with a factor can be measured by taking into account the *stage* at which they take place. It is expected that teaching factors need to take place over a long period of time to ensure that they have a continuous direct or indirect effect on student learning (Creemers, 1994). Also, the continuity of a factor can be achieved when the teacher is flexible in adapting the activities related to a factor by taking into account the needs of students. For example, based on the teacher' assessment through questioning, if the orientation activities in the lessons appear not to be well understood by the students, there will be the need to repeat the activities so that all students are able to identify with the aims of the lesson.

The dimension *quality* refers to the properties of the specific factor itself. For example, the measurement of quality refers to the properties of an orientation task and especially whether the activities are clear to students. It also refers to the impact that a learning task has on student engagement in learning. For example, a teacher may present the reasons of doing a task simply because they have to do it, or that the activity is part of their teaching routine without having much effect on student participation. On the other hand, other teachers may encourage students to identify the purposes that can be achieved by doing a task which can increase their motivation towards a specific task/lesson/series of lessons (Kift & Field, 2009).

Finally, the dimension *differentiation* refers to the extent to which activities associated with a factor are implemented in the same way for all the students in a class. In a typical classroom, students differ in SES, prior knowledge, and learning style; all of which can affect their learning. Differentiation or adaptive instruction when skillfully implemented can cater for the needs of all learners (Creemer, 1994; Westwood, 1996). This can be through assigning tasks based on the needs of students, or giving more time to slower learners to complete a learning task (Walberg & Paik 2000). However, differentiation of teaching does not necessarily imply that students are not expected to achieve the same purposes (Kyriakides & Creemers, 2006). On the contrary, adopting the policy on the special needs of each group of schools/teachers/students may ensure that all of them will become able to achieve the same purposes. In chapter one, studies conducted to test the validity of the dynamic model were briefly presented. The next section presents in more detailed review of some of the studies relevant to the current study.

Studies testing the validity of the dynamic model of educational effectiveness

As stated in chapter one, the validity of the dynamic model for measuring educational effectiveness has been provided in longitudinal studies conducted in Europe (e.g., Antoniou, Kyriakides, & Creemers, 2011; Creemers & Kyriakides 2010; Demetriou & Kyriakides, 2012; Kyriakides & Creemers, 2008; Kyriakides et al., 2009; Kyriakides et al., 2010; Kyriakides et al., 2013; Panayiotou et al., 2014; Vanlaar et al., 2015). All the said studies provided evidence about the validity of the dynamic model as an integrated and multilevel model. The studies also provided support for the construct validity of the measurement framework of the dynamic model in respect of each of the five dimensions (i.e., frequency, focus, stage, quality and differentiation). Particularly, the eight teacher factors of the dynamic model were found to be positively associated with student learning outcomes.

As an example, using a representative sample of Greek Cypriot primary schools, Kyriakides and Creemers (2009) studied the impact of the teacher factors on grade six students achievement in mathematics, Greek language and religious education. The aim was to determine the extent to which each of the eight factors (i.e., orientation, structuring, questioning, teaching modeling, applications, management of time, classroom management, and assessment) are multi-dimensional constructs; and whether the factors can be defined in reference to the five measurement dimensions of the model. Value added measures of student achievement in the outcome measures were collected. Classroom observational data and as well the perception of the students on quality teaching were also collected.

In analyzing the data using Structural Equation Modeling (SEM) techniques, the authors found support for the construct validity of each of the factors in relation to the five measurement dimensions. For example, the convergent validity for each of the eight factors in relation to the five dimensions was higher than 0.60 in terms of factor loadings. In the next step, using multilevel modeling techniques, statistically significant positive effects were found for the teacher factors on all the outcome measures. Furthermore, the importance of measuring separately each teacher factor with the five dimensions as against treating each factor as unidimensional was also demonstrated. As stated above, the earlier integrated models (i.e., Creemers, 1994; Schereens & Bosker, 1997; Stringfield & Slavin, 1992) were concerned with only the quantitative aspect of an effectiveness factor. The authors demonstrated the need for a measurement framework that incorporates both the quantitative and qualitative dimensions of an effectiveness factor. For example, the frequency dimension of teaching modeling was not found to be associated with student achievement in any of the outcome measures; but the quality dimension of the factor had an impact on student achievement in all the outcome measures. Moreover, the advantage of using the five dimensions to measure teacher factors was also demonstrated as this explained more of the variation in student achievement.

Furthermore, a meta-analysis of 167 studies (between 1980 and 2010) investigating the contribution of teacher classroom behavior to student learning outcomes was conducted using the conceptual framework of the dynamic model (Kyriakides et al., 2013). The study also provided support to the validity of the teacher factors of the model. For each of the teacher factors, the effects on the learning outcomes were as follows: Orientation 0.36; Structuring 0.36; Modeling 0.41; Application 0.18; Questioning 0.34; Assessment 0.34; Management of time 0.35; Classroom as a learning environment 0.45.

Also, a longitudinal study in six European countries (Belgium/Flanders, Cyprus, Germany, Greece, Ireland, and Slovenia) was conducted examining the extent to which the teacher factors of the dynamic model are associated with student achievement in mathematics and science (Panayiotou et al., 2014). The sample comprised of 10,742 grade 4 students in 571 classes in 334 schools. Written test in math and science were administered to the students both at the beginning and end of one school-year. Data on the perceptions of the students on quality teaching were also collected. Then using multilevel modeling techniques, statistically significant positive effects were found for all the teacher factors on student achievement for both outcome measures. Moreover, the variance in achievement explained by the factors was attained at 50% and 45% for mathematics and science respectively.

Using the same European data set and analytic procedures as described above, Vanlaar et al. (2015) examined the differential effects of the teacher factors of dynamic model on student achievement in math and science. In this study also, the teacher factors were found to have differential effects in both math and science, especially for low achieving students. For example, structuring was found to be associated with both math and science achievement, and particularly strongly associated with math achievement for low-achieving classes, explaining 5.7% and 2.2% of the variance in math and science achievement respectively. Also, questioning was found to have an impact on math achievement especially in low-achieving classes. The effect on science achievement was hover not statistically significant. Teacher questioning explained 5.1% and 1.8% of the variance in math and science achievement respectively.

As far as teacher professional development is concerned, the dynamic model promotes a dynamic integrated approach (DIA) in which the value of evidence based and theory-driven approach to improve education and particularly teacher effectiveness (Kyriakides et al., 2012)**.** Whereas the Holistic Approach (HA) approach to teacher professional development is focused on encouraging reflection on teaching practices, experiences, and beliefs; the Dynamic Integrated Approach (DIA) is focused on how to address specific groupings of teacher factors associated with student learning rather than with an isolated teaching factor or with the whole range of teacher factors (as implied by the Holistic Reflective Approach) without considering the professional needs of student teachers and teachers.

Three experimental studies were conducted in Cyprus testing the assumptions of the dynamic model as regards teacher professional development (i.e., Antoniou, Kyriakides, & Creemers, 2011; Demetriou & Kyriakides, 2012; Kyriakides et al., 2009). For example, using a representative sample of 130 teachers and their students (N=2356), Antoniou et al. (2011) examined the impact of the two approaches (referred to above) on teacher professional development on mathematics. The teaching skills and perceptions of teachers and as well the student achievement were measured at the beginning and at the end of the intervention. Teachers found to be at a certain developmental stage were randomly allocated to two groups. The first team employed the DIA and the second the HA. The teachers of the experimental group (DIA) were given training on the teacher factors of the dynamic model. Supporting material related to the teaching skills corresponding to their developmental stage was also provided. On the other hand, teachers in the control group (HA) were allowed to critically evaluate their own beliefs and practice and how to transform their past experiences in order to improve their teaching practice.

In measuring the impact of the two professional development programmes on teaching skills, it was found that the final scores of teachers employing the DIA (Mean=0.36, SD=1.05) was higher than their initial score (Mean=-0.28, SD=1.01), and that this difference was statistically significant. On the other hand, the final score of teachers employing the HA (Mean=-0.25, SD=1.04) was not higher than their initial score (Mean=-0.26, SD=1.05). Also, in multilevel analysis of the data, the effect of DIA on student achievement was found to be bigger (i.e., 0.24 (0.08) than the effect of HA indicating that the students of teachers employing the DIA had better results. Moreover, the perceptions and attitudes of teachers who used the HA was not been modified due to their participation in the interventions. The results also revealed that the developmental stage at which a teacher is situated has a considerably large and statistically significant effect on student achievement (i.e., 0.31 (.10).

Based on the results of the validation studies, it can be claimed that the dynamic model is plausible for measuring educational effectiveness. At the same time, since all the validation studies were conducted in the European educational environment where schools share similar characteristics of a uniform material and economic infrastructure (Scheerens, 2004), further studies in other contexts radically different are needed to further test the model. The factors determining educational effectiveness are complex, interwoven and dependent on local context (Heneveld & Craig, 1996). In this perspective, the Ghanaian educational environment provided a unique context (e.g., school characteristics, resources, quality of teaching, students' SES) to further test the generic nature of the dynamic model.

Research Agenda

As discussed in the literature review, four decades of educational effectiveness research reveal the significance of teaching factors as the most important predictor of student learning outcomes (Scheerens & Bosker, 1997). Also, the factors determining student learning were found to be complex and interwoven, spanning between student, school, and community support for learning (Carlson & Cowen, 2015; Heneveld & Craig, 1996). Therefore, researchers from developed countries have taken advantage of new methodological developments (e.g., longitudinal designs and multilevel modeling) in measuring teaching effectiveness more efficiently (Creemers &

Kyriakides, 2008). As was shown in the literature review, very little of this strand of research has been conducted in sub-Saharan Africa, and particularly in Ghana.

It was shown in the literature review that the quantity of an academic activity (e.g., time on task and OTL) do have an impact on student learning outcomes. The form and quality of a teacher's organized lessons (e.g., structuring, questioning, feedback, and application) also have an impact. However, the effectiveness factors as reviewed are mostly derived from the direct teaching model. It has been argued that the direct teaching model is useful for the development of skills through reinforcement and practice, but tasks requiring more complex thinking and higher mental processes are not generally well-learned under the model (Darling Hammond et al., 2001). For learners to process information more actively, it is argued, they need to move from the acquisition of lower cognitive skills to higher levels of cognition through activities of knowledge construction (Darling Hammond et al., 2001; Chinn, 2011).

The dynamic model adopts an integrated approach by incorporating effective teaching skills associated with both the direct instruction model and the constructivist approach (Creemers & Kyriakides, 2006). For example, the dynamic model refers to skills associated with direct teaching and mastery learning (e.g., structuring and questioning), and orientation and modeling strategies which are in line with the constructivist approach to teaching.

As indicated in chapter one, teaching and learning in African countries and for that Ghana is comparatively very low. Therefore, as part of the larger effort to improve the situation, the conceptual framework of the dynamic model was used in studying the teaching factors most relevant for student learning gains in Ghanaian primary schools. The study was envisaged to help in determining the degree to which teaching processes identified as effective in developed countries are equally in developing countries, and more importantly, the teaching factors that are effective in impoverished educational context. Among other aims, it was envisaged that the findings might serve as a basis for policy on teacher initial training or further professional development for not only Ghana, but other countries of similar characteristics.

As a recap, the teacher factors of the dynamic model are: *orientation, structuring, questioning, teaching modeling, applications, management of time, teacher role in making classroom a learning environment, and assessment*. The model assumes that each of the factors can be measured using five dimensions: *frequency, focus, stage, quality, and differentiation.* The specific questions addressed in the study are as follows:1) whether there is variation in the functioning of each of the eight teacher factors, and the measurement dimensions of the dynamic model in the teaching practice in Ghanaian schools; 2) whether the eight factors are multi-dimensional constructs, and if they can be defined in reference to each of the five dimensions (i.e., frequency, focus, stage, quality and differentiation); 3) whether each of the eight factors and measurement dimensions can explain variation in student learning gains in mathematics. In chapter three to follow, the methods and strategies through which data was collected and analyzed to illuminate the research questions are presented.

CHAPTER 3

METHODOLOGY

Theories, methodology and methods are the processes that inform an approach to research (Cohen et al., 2007). Research in teaching is commonly viewed from the lenses of the quantitative and qualitative paradigms (Bracken, 2010; Cohen et al., 2007; Gage, 1989). Researchers of the quantitative paradigm hold the view that reality can be dissected into variables that represent theoretical constructs underlying an observable phenomenon. On the other hand, those of the qualitative hold the view that reality is not out there to be objectively observed or constructed; and thus employ data gathering methods considered to be sensitive to context, and the subjective meanings that people bring to research situations (Cohen et al., 2007).

However, both the quantitative and qualitative paradigms to research have their place depending on the research questions in a study (Muijs, 2004; Wolf, 2004). As indicated earlier, the study sought to determine whether the teacher factors of the dynamic model function in explaining student achievement in Ghanaian primary schools, and if so, to generalize to other countries of similar characteristics. The quantitative research method involving the use numerical measures of correlations and factor-analytic techniques can test the generalizability of the findings as envisaged (Cohen et al., 2007).

The chapter is arranged as follows: the first to follow is the research design setting out the logical structure of the study. Experimental and surveys as the quantitative methods to research are discussed. Also, the issues of reliability and validity of data, and ethical considerations as critical elements of research are briefly discussed. This is followed by the procedures used in gaining access to the schools to conduct the research. Then the methods and strategies through which data was collected and analyzed to illuminate the research questions. In the concluding part of the chapter, the limitations of the study are also discussed.

Research design and methods

Experimental and surveys (i.e., cross-sectional and longitudinal studies) are regarded as quantitative studies as they involve the collection of information that is quantifiable and can be subjected to statistical analysis (Wolf, 2004). Cross-sectional studies provide a static snapshot of how variables of interest happen to correlate with student learning outcomes at a particular point in time; and do not take into account the prior educational experience of students or their further development from the time of measurement (Creemers et al., 2010). Also, the problem with cross-sectional studies is how to differentiate between cause and effect from simple association (Goldstein, 1999). On the other hand, longitudinal designs involve observations of the same students at more than one point in time. The benefit of longitudinal studies is that they allow the investigation of stability and change in the outcome variable over time; and thus provide a better basis for inferences about causality than do cross-sectional designs (Gustafsson, 2010).

However, randomized experimental studies provide greater assurance or the standards for making causal inferences (Slavin 2010). For example, in an experimental design, a group of students are randomly assigned, one group to an effective teaching method whiles the other group does not receive the effective method to serve as control. In analyzing the resulting data, if any significant difference between the two groups is found in favor of the treatment group, one comes closer to a causal effect for the effective method (Wolf, 2004). The challenge however in experimental studies is how to hold all variables constant except the treatment variable (Slavin, 2010). Also, ethical considerations involved in conducting experimental studies make their use in the practical world of schooling problematic (Cohen et al. 2007). For example, it is unethical to administer a proven valid teaching method to a group of students whiles withholding it to a control group simply because the aim is to measure the effect size of the valid method (Creemers et al., 2010). Moreover, in education, experimental studies are usually brief or artificial on topics of theoretical more than of practical relevance (Slavin, 2010).

As stated earlier, the current study used a longitudinal design in studying the value added to student learning gains by teachers. The data on quality teaching was collected through classroom observations as teachers and students engaged each other in natural classrooms settings. The perceptions of the students on quality of teaching provided by their teachers were also collected. Direct classroom observations can enable the collection of rich information about teacher classroom behaviors, activities and subtle routines (e.g., teacher student interactions, student/student interactions) (Hiebert & Grouws, 2007). Similarly, the perception of students on quality teaching is important since they have the most contact with teachers, and as well the direct consumers of teacher service (Goe, Bell, & Little, 2008). It was envisaged that when the teacher factors of the dynamic model are found to be relevant in Ghana, experimental designs could then be used to determine the effect sizes of the teacher factors of the model.

Finally, two desirable properties of any empirical study are high levels of reliability and validity (Cohen et al., 2007; Kline, 2011). Whereas validity involves careful sampling, appropriate instrumentation and statistical treatment of data; reliability involves choosing measures that demonstrate consistency and reliability over time (Cohen et al., 2007). Ethical considerations concerning the right and good of research for the individuals involved and society in general is also important (Mertens, 2010). In this respect, an attempt was made to attain valid and reliable data on the variables of interest (e.g., student achievement in mathematics, and quality teaching). Particularly, confirmatory factor analysis was conducted testing the construct validity of the instruments used in collecting data on quality teaching. Also, I was mindful of the need to guard against any potential harmful effects of the study in terms of intellectual dishonesty, suppression of personal bias, and the accuracy in reporting of the results.

Participants

The primary school population in Ghana is (N=19,854) made of public schools (N=14,112) and private schools (N=5,742). Gender parity ratio is almost 1:1, whiles teacher/pupil ratio is 1: 45 (MOE, 2012). The study was conducted in the Upper East Region, one of the ten regions of Ghana, which has a total school population of (N=701). Using the stage sampling procedure, three out of the ten districts of the region were randomly selected. Thereafter, schools (N=73) representing 10% of the school population in the region were randomly selected. Then, all grade six classes/teachers (N=99) and their students (N=4386) served as participants. Out of this sample, 55 schools were public whereas 18 were private. The chi-square test did not reveal any statistically significant difference between the research sample and the population in terms of school type (X^2=1.03, d.f. =1, p=0.09). In regard to the student sample, 49% were male and 51% female and the chi-square test did not reveal any statistically significant difference between the research sample and the population in terms of pupils' sex (X^2=0.95, d.f.=1, p=0.43). The sample is representative of primary schools in Ghana in terms of the background characteristics for which statistical data of this region are available.

Procedures

A formal letter was first written to the head of the Ministry of Education in Ghana for permission to conduct the research. Upon approval, the concerned schools were formally informed to grant permission for the study. In subsequent steps, meetings were held with the head teachers and teachers to explain the rationale of the study. Through these meetings, the data collection procedures and time lines (especially the classroom observations) were discussed and agreed upon. The participants were informed the research findings might be useful for improving teaching and learning in schools. Thus, the consent of the study participants was attained. Confidentiality in the use and dissemination of the findings was also assured. In this respect, the names of the students, teachers and schools are assigned codes in the data.

It is important to note that studies deploying research designs as used in the current study (e.g., testing over 4,500 students at two time points, classroom observations, and student ratings of quality teaching) are rare in Ghana. Thus, the commitment of the teachers and students for their time and contribution to the study had to be appreciated. To this end, workshops were again held with the schools to provide feedback in the form of general trends in the findings (not the performance of the individual schools, teachers or students). This way, the schools were encouraged to use the teacher factors of the dynamic model in developing policies and action plans for improving teaching and learning.

Instruments

The study draws from data on student achievement in mathematics, student and school background characteristics, and classroom observations and student ratings on quality teaching. In this respect, the supervisory team provided technical support in developing two sets of tests for measuring student learning in mathematics based on the prescribed curriculum and textbooks for teaching in Ghana. Also, student and teacher questionnaires were designed for the purpose of collecting data on background characteristics. As far as the data on quality teaching is concerned, the instruments and student questionnaire of the dynamic model were used. As indicated in chapter two, the instruments and questionnaire have been validated in longitudinal studies conducted in Europe (e.g., Creemers & Kyriakides 2009). It is important to note that I was provided training on the use of instruments. Also, the student questionnaire and the test measures for mathematics were piloted in Ghana to determine their applicability and/or suitability.

Dependent variable: Student achievement in mathematics. Mathematics introduces children to concepts, skills and thinking strategies that are essential for everyday life, and as well supports learning across school curricula (Mullis et al., 2012). Also, grade six as the terminal point of primary education provides the essential building blocks to the rest of the levels of education and/or work related skills to those who do not continue in their education from that level. Furthermore, at the primary school level, students are at a lower level of cognitive development which makes measurement plausible (Boissiere, 2004).

Ghana operates a centralized curriculum system with standard mathematics text books for use in all primary schools (MOE, 2007). The aim of the curriculum is to develop in children, cognitive, affective and psychomotor skills for analytical thinking and problem solving in real life situations (MOE, 2007). The assessment of learning is however the responsibility of the individual schools and teachers. For this reason, two common sets of tests (pre-test and post-test) were developed based on the prescribed curriculum and text books for grade five and six respectively. The first step was to develop specification tables capturing the major content areas of the curriculum. This was to ensure that the teaching and learning activities within each major content area of the curriculum are fairly addressed. In so doing, it turned out that the specified teaching and learning activities in the text books were more of the algorithmic type with a relatively few on problem solving activities. The challenge then was how to achieve in the tests a balance between the intended curriculum (e.g., analytical thinking and problem solving) and the teaching and learning activities as specified in the textbooks.

In the end, the tests covered tasks on basic operations, numbers and numerals, measurement, handling money, data collection and analysis, and a few problems solving activities. The tests items were reviewed on all aspects of content, grammar, spelling, and distracters. The construction of the tests was subject to controls for reliability and validity (i.e. Kline, 2010). The completed tests were pilot-tested in schools (N=4) with primary six students (N=120) in Ghana to determine their suitability. Based on the results of the pilot study, minor changes were made to finalize the tests for implementation. Specifically, items that appeared ambiguities, complex in language or not at the appropriate level of difficulty were spotted and removed to finalize the tests for implementation (sees Appendix A1, A2 for the tests).

The Pre-test measure was implemented towards the beginning of the school year in September 2013, and the Post-test at the end in July 2014. The Extended Logistic Model of Rasch (Andrich, 1988) was used to analyze the emerging data. The analysis revealed that the scales in both measures had satisfactory psychometric properties. Specifically, the indices of cases and item separation were higher than 0.80. Moreover, the infit mean squares and the outfit mean squares were near 1.0, and the values of the infit t-scores and the outfit t-scores were approximately zero. Furthermore, each analysis revealed that all items had item infit with the range 0.99 to 1.01. Based on the satisfactory results, Rasch person scores were generated for each student for each of the two measures for further analysis.

Explanatory variables: Student level. The grade six students completed the questionnaires on their background characteristics during the school year in September 2013 (see Appendix, B). The response rate was recorded at 89%. An attempt was made to include in the questionnaires culturally valid indicators of social and material assets relevant to Ghana (i.e., Lockheed, Fuller, & Nyirongo, 1988). Section a) of the questionnaires elicited each student demographic profile and SES. Section b) elicited information about parental support for learning, learning materials at home, parental attitudes for learning, and economic assets. The following categorical variables were examined and readers can also see which categories were taken into account in measuring the background variables:

a) Age (11 years or below =1; 12 years =2; and above 12 years =3).
b) Gender (boys=1; girls=1).
c) Educational level of the fathers (no education=1; Middle/Secondary School=2; Diploma/University degree and above=3)
d) Educational level of mothers (No Education=1; Middle school/Secondary School=2; Diploma/university degree and above=3)
e) Occupational status of fathers (Not Employed, Peasant farmer, laborer=1, Commercial farmer, Small scale business owner, public servant=2).
f) Occupational status of mothers (not employed, peasant farmer, laborer 1; Commercial farmer, Small scale business owner, Public servant=2). It is important to note that the

variables dealing with occupational status had to be combined in two categories because the data collected had few respondents in each category.

Aptitude. Aptitude refers to any relatively stable child characteristic (i.e., cognitive or psychomotor ability, prior knowledge) that may be a predictor of achievement (Bailey et al., 2014; Kaufman et al., 2012; Walberg, 2003). For this study, prior knowledge of the students in mathematics (i.e., the pre-test scores) served as a proxy for aptitude.

Household economic assets. As well as conventional household economic assets, culturally valid indicators of social and material assets such as access to water and electricity, land and live stock ownership were taken into account (Lockheed et al., 1988). The categories were as follows: conventional household possessions (e.g. radio, electric or gas stove, kerosene stove, electric iron, box iron, refrigerator, television, cellular phone); livestock ownership (e.g., cattle, donkey); transportation-related (e.g., bicycle, motorcycle, donkey cart). Principal Component Analysis was conducted on the emerging data to determine the weighting of each item. Items such as house type, animal ownership, donkey cart did not attain satisfactory results, and were thus removed. An index was then created for the remaining items for each student. A satisfactory Cronbach's reliability index for this variable was attained at the level of 0.82. A high index value indicates a high level of this variable.

Home learning environment. The questionnaires also asked students to indicate if they have a quiet place at home for learning or not; and the language usually spoken at home (e.g., I speak my local dialect almost always at home, or I speak English language almost always at home). Also, a Likert scale type items were provided for the students to indicate parental support for homework and private tuition (i.e., never =1, rarely= 2, sometime =3, often= 4, almost always =5). In addition, a list of learning materials were also provided for the students indicate those available in their homes for learning (e.g., I have a desk, math books, or a computer at home for studies). The emerging data was analyzed with Principal Component Analysis to determine the weight for each item. A satisfactory Cronbach's reliability index was attained at the level of 0.78. Based on the satisfactory results, an index was created for each student for the following variables:

a) Learning materials at home. A high index value indicates a high level of this variable.
b) Homework. A high index value indicates a high level of this variable.

c) Private tuition. A high index value indicates a high level of this variable.

Another aspect of the Likert scale items also elicited data on the perceptions of the students on parental attitudes towards learning. In analyzing the emerging data using Principal Component Analysis, three factors with eigenvalues greater than 1 emerged following extraction and oblique rotation. In the second step, Confirmatory Factor Analysis was carried out building on a three factor solution. The goodness-of-fit indices for the three factors were as follows: X^2 (274.48) = 24, p-value < .01, CFI = .96, RMSEA = .05, Alpha = .77. Based on the satisfactory result, the following variables were created. A high index indicates a high value.

d) Parental attitude for mathematics (e.g., my parents believe it is important to study mathematics, my parents like mathematics)

e) Monitor children's progress (e.g., my parents inspect my books; make sure I learn at home, study my terminal reports to check my performance).

f) Parental care after school time (i.e., my parents know where I go after school; when I leave the house my parents ask me where I am going).

Explanatory variables: School level. The structural characteristics of schools such as school location (urban, rural), and type of school control (public, private) can contribute to student performance (Raudenbush & Bryk, 2002). Also, school neighborhood conditions such as resources and the values of the community for learning can have an impact on student learning outcomes (Carlson & Cowen, 2015). Similarly, the skill level, attitudes and behavior of children in schools are partly based on their exposure to different neighborhood conditions (Burke & Sass, 2013; Downey, von Hippel, & Broh, 2004).

In addition, teachers with better training and experience are expected to be able to use their expertise to enhance student learning (Michaelowa, 2001). Also, for developing countries where school resources can be inadequate, physical resources such as classrooms conditions, furniture, and textbooks, blackboards, libraries and the availability of electricity can have an impact on student learning outcomes (MOE, 2014).

In this respect, the teacher questionnaires elicited data on the characteristics of the schools, teachers, and teaching and learning resources (see Appendix, C). The teachers of grade six completed the questionnaires during the school year in September 2013. The response rate was 96%. Section a) elicited data on teacher age, gender, educational attainment, and other school characteristics such as school location, and school type. Section b) elicited data on school resources (e.g., library, math books, computers, free school uniforms, school feeding, toilet and electricity facilities). The following categorical variables were examined and readers can also see which categories were taken into account in measuring these school context variables.

a) School type (Public =1;Private = 2)
b) School location (Urban= 1; Rural= 2)
c) School feeding (Yes =1; No = 0)
d) Access to electricity (Yes =1; No =0)
e) Access to water (Yes =1; No =0)
f) Library (Yes =1; No =0)
g) Age of teacher (under 25 years = 1; between 26 and 35=2; between 36 and 45=3; between 46 and above =4)
h) Gender (Male=1; Female =2)
i) Highest qualification: School Certificate (e.g. SSCE, GCEA Level) =1; Diploma from Training College=2; Bachelor of Education or Degree awarded by a university) = 3
j) Teaching experience: 0-3 years=1; 4-7 years=2; 4-7 years=3; 14 years and above=4)

Teaching and learning materials. This aspect of the questionnaires used Likert scale type items (i.e., not available=1, available but inadequate =2, adequate=3). An estimate of the internal consistency of the data was attained at a satisfactory Cronbach's alpha of 0.83. Thus, the following variables were generated. A high index value indicates a high level of the variables in the schools.

a) Teacher stationery (chalk, notebook, and cardboard)
b) Pupils' math textbook(s)
c) Reading materials (newspapers, story books)
d) Mathematical drawing instruments (ruler, compasses and protractor),
e) Teaching equipment (i.e., meter, tape measure, liter, weighing scale)
f) Classroom conditions (furniture and space)**.** It is important to note that although the dynamic model does not put an emphasis on school resources, an advantage was taken to

also collect data on some of the variables listed above to in order to determine their impact on student learning.

Class size. The number of students in a classroom can affect how much is learned in a number of different ways (Ehrenberg et al., 2001). The interactions and social engagement of students in a classroom can result in for example, more or less noise and disruptive behavior, which in turn can affect the kinds of activities the teacher is able to promote. It can also affect how much time the teacher is able to use in focusing on individual students and their specific needs rather than on the group as a whole. For this study, the mean class size was 43 (SD =15).

Class composition. The composition of students in a classroom can be a source of motivation, aspiration and direct interactions and learning for all students (Hanushek, Kain, Markman, & Rivkin, 2003). Peer groups can positively affect the learning process within a classroom through questions and answers, and contribution to the pace of instruction; but can also hinder learning through disruptive behavior (Hanushek et al., 2003). For this study, the classroom compositional variable was created based on an average of the educational level of mothers.

Explanatory variables at classroom level: Quality of teaching. The dynamic model specifies one high-inference observation instrument, two low-inference observation instruments, and a student questionnaire for the purpose of data collection on quality teaching. Used in the current study were the High-inference observation instrument, the Second-low inference observation instrument, and the Student questionnaire. It was assumed that using the two instruments which are comparable, together with the Student questionnaire would enable an exploration of whether similar dimensions of teaching behaviors can be identified as effective classroom practices.

The High-inference observation instrument uses a Likert scale type of items in measuring all the eight teacher factors and the five dimensions of the dynamic model. In part a) of the instrument, the observer indicates how often each teacher behavior is observed (e.g., the teacher spent time to explain the objectives of the lesson). Part (b) enables the search for curvilinear relations between the factors and students' learning outcomes. The Second low-inference observation instrument refers to the following five factors: orientation, structuring, teaching modeling, questioning techniques, and application. The instrument is designed in a way that enables the collection of more information in relation to the quality dimension of the five factors. Similarly, the student questionnaire uses a Likert scale type items in measuring the eight factors and dimensions and the dynamic model. Specifically, students are asked to indicate the extent to which their teacher behaves in a certain way in their classroom (e.g., at the beginning of the lesson the teacher explains how the new lesson is related to previous ones).

As indicated earlier, the original student questionnaire was piloted in schools (N=4) with students (N=120) in Ghana to determine the applicability and/or relevance of each of the items. This was also to assess whether the questionnaires could be answered by young children. Based on the feedback, a number of items especially those related to the dimensions of the factors were not well understood by the students, and were thus dropped. For example, an item such as the teacher gives more exercises to some pupils than the rest of the students was not understood by the students. The changes meant that the dimensions of the factors could not be measured with the student questionnaire. However, the revised version of student questionnaires was still able to measure all the eight effectiveness factors (See Appendix C, D, and E for the instruments).

Between May and July of the 2014 school year, the researcher visited each of the schools and observed mathematics lessons of each of the teachers for an average of 40 minutes. The Second-low inference observation instrument was first used in recording data on teaching and learning activities. After each lesson, the Student questionnaire was also administered. Then, the High-inference observation instrument was also used in rating each teacher's lessons. It is important to note data was collected for each of the teachers (N=99). Also, the response of the student questionnaire was attained at a satisfactory rate of 83%.

Data analysis

The analysis is based on students who have scores in both the pre-test and post-test measure (N=3,585). The data is hierarchically structured (i.e., students nested in classrooms, classrooms in schools, and schools in turn nested in districts). The score gains of the students are linked to their teachers (N=99), schools (N=73), and school location (rural, urban). The hierarchical structure of the data makes multilevel modeling the appropriate technique for analyzing the data (Goldstein, 2003). Moreover, multilevel modeling enables an efficient identification of variables at the student, teacher, and school level that are associated with student learning outcomes (Snijders, 2005; Steele, 2008).

The random intercept model was used in conducting five different two-level models (i.e., students in level 1, teachers in level 2) where the intercepts represent random differences between groups (Goldstein, 2003). In a two-level model, the residuals in student achievement are split into two components, corresponding to the two levels of the data structure (Leckie & Charlton, 2012). The first model is an unconditional or null model with no predictor variables. The model is referred to as a variance components model, as it decomposes the variation in the dependent variable into separate level-specific variance components (see equation 0 below). In the second step, student background factors were added to the null model to determine their impact on achievement (equation 1). In the next step, variables relating to the home learning environment were introduced in model 2 (equation 2). This is followed in model 3 by school context factors (equation 3). Then, the teacher factors of the dynamic model were introduced in model 4 (equation 4). The models can be represented in following equations:

$$\mathrm{Posttestscore}_{ij}=\beta_0 + u_j + e_{ij} \qquad (0)$$

$$u_j \sim N(0, \sigma_u^2)$$

$$e_{ij} \sim N(0, \sigma_e^2)$$

$$\mathrm{Posttestscore}_{ij}= \beta_0+ \beta_1\mathrm{Pretestscore}_{ij}+ \beta_2\mathrm{StudAge}_{1j} +,\ldots.., u_j + e_{ij} \qquad (1)$$

$$\mathrm{Posttestscore}_{ij}=\beta_0+\beta_1\mathrm{Pretestscore}_{ij}+ \beta_2\mathrm{StudAge}_{1j}+\beta_2\mathrm{Homework}_{1j}+ u_j + e_{ij} \qquad (2)$$

$$\mathrm{Posttestscore}_{ij}= \beta_0+ \beta_1\mathrm{Pretestscore}_{ij} + \beta_2\mathrm{StudAge}_{ij}+ \beta_3\mathrm{Schtype}_j +, \ldots, u_j +e_{ij} \qquad (3)$$

$$\mathrm{Posttestscore}_{ij}= \beta_0+ \beta_1\mathrm{Pretestscore}_{ij}+ \beta_2\mathrm{StudAge}_{ij} +\beta_3\mathrm{Schtype}_j + \beta_4\mathrm{Orientation}_j+, \ldots., u_j + e_{ij} \qquad (4)$$

Where $posttestscore_{ij}$ is the score for student i in classroom j for mathematics achievement at the end the school year in 2014. β_0 is the intercept measuring the mean score across all classrooms, u_j is a classroom level random effect, and e_{ij} is a student level residual error term. Also, β_1 to β_4 represent the coefficients of the factors at student, school, and the teacher factors of the dynamic model on the dependent variable. The residuals u_j and e_{ij} are assumed independent of one another and normally distributed with zero means and constant variances of σ_u^2 and σ_e^2. The degree of clustering in the data can be summarized by the intraclass correlation coefficient (ICC), and the variance partition coefficient (VPC) (Leckie & Charlton, 2012). The ICC measures the proportion of the total variance in the dependent variable at the classroom level, while the VPC measures the proportion of total variance between classrooms. The formulas for these two coefficients can be written as follow:

$$\frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}$$

Limitations of the study

As stated earlier, one high inference observation instrument, two second-low inference observation instruments and a student questionnaire are prescribed by the dynamic model for measuring quality teaching. In this study however, the First-low inference observation instrument was not used. This can be a source of limitation since the instrument enables the collection of additional data about teacher-student and student-student interactions, and classroom management. Also, cross validation of the data was not possible since the classroom observations were carried out by only one observer (i.e., the researcher) (Hill et al., 2012).

Furthermore, a high level of opportunity to learn is required for an accurate estimate of teacher effectiveness (Anderson, 2004). As indicated in chapter one, the quantity of instruction in Ghana often falls far short of curricular aims (MOE, 2012). Therefore, the effects on student achievement by the teacher factors of the dynamic model might be entangled with inadequate quantity and quality of instruction. Also, mathematics is generally more learned in schools; and thus may be more directly influenced by teachers (Nye, Konstantopoulos**,** & Hedges, 2004; Willms, 2003). In this view, the fact that study was for only mathematics limits the ability to understand how the findings might be if other subject domains such as language were explored.

Summary

In this chapter, the methods through which data was collected and analyzed to illuminate the research questions have been presented. As indicated, a longitudinal design was used in order to determine the value added to student learning by teachers. And in so doing, to also determine whether the teacher factors of the dynamic model function in explaining student achievement. In longitudinal designs, a minimum of student achievement data spanning a period of three school years is required in order to determine change and development in student learning gains (Anderman et al., 2014). For practical reasons of cost and time however, the achievement data used in the current study covers only one school year.

The main aim of the study was not about change and development in learning per say, although change was a bi-product. Longitudinal studies are expensive, time consuming, and labor-intensive (Cohen et al., 2007). Furthermore, longitudinal designs are vulnerable to many threats including participant attrition (Gustafsson, 2010). One could not predict whether the same teachers at the start of the study would be available throughout the live span of the study. As a result of perceived low prestige of the teaching profession in Ghana, teachers generally move on for further studies or abandon the profession altogether to other professions (Akyeampong, 2003). Thus, to avoid the threat of participant attrition, one school year period was seen as adequate. Moreover, there is a general agreement among methodologists that a design with observations at two time points still qualifies as longitudinal research (Gustafsson, 2010).

Also, although the use of one observer (in this case the researcher) for collecting the data on teaching can be a limiting factor, this was mainly due to time and resource constraints. The use of multiple observers would have involved much more costs in terms of training and remuneration. I had neither personal relationship nor any prior knowledge of the teachers. Therefore, the issue of familiarity as a source of bias was not an issue. Moreover, the study was purely as an academic exercise. The intention was not to judge the performance of the schools or the teachers per say.

As indicated earlier, an attempt was made to attain valid and reliable data on the variables of interest (e.g., data on student achievement, and the quality of teaching). As part of this effort, confirmatory factor analysis was conducted to determine the construct validity of the instruments used in measuring the quality of teaching. Based on these controls, the study had the potential to achieve its objectives. Among others aims, the study had the potential to provide data on effective teaching practices from the context of Ghana that can be used for teaching and learning in schools in Ghana and other countries of similar characteristics. Chapter four to follow presents the results.

CHAPTER 4

RESULTS

The following steps are used in presenting the results. The first to follow is results on confirmatory factor analysis of the construct validity of the High-inference observation instrument, and the Student questionnaire. Descriptive statistics are also provided to inform the reader on the general patterns of the teachers' classroom behaviors as observed in the lessons. This is followed by multilevel analysis of the effects on student achievement by multiple of factors at the level of students and schools. Haven controlled for background factors, the effects on achievement by the teacher factors of the dynamic model are also presented

Using Confirmatory Factor Analysis to test the construct validity of the measurement framework of the dynamic model of educational effectiveness

One of the routes to construct validation of a scale is predicting its' factor structure based on the theory that guided its construction (Kline, 2011; Raykov & Marcoulides, 2011). In this respect, confirmatory factor analysis (CFA) was conducted examining the construct validity of the high-inference observation instrument and the student questionnaire of the dynamic model. In CFA, the predicted factor structure of a number of observed variables is translated into a covariance matrix. Next, this matrix is adjusted to the population covariance matrix, and subsequently compared with it. The discrepancy between the two matrixes is expressed by a number of goodness-of-fit indices. An assessment of how well the predicted factor structure is corroborated by the sample data, and whether it could be generalized to the population, is often based on the values of these indices (Raykov & Marcoulides, 2011).

Thus, in reference to the specifications of the dynamic model (Creemers & Kyriakides, 2006); covariance matrixes were created for each teacher factor under the instrument and the questionnaire. Then using EQS software (Bentler, 1995), first-order CFA models were conducted to determine the fit of the models to the data. Each model was estimated using the maximum likelihood methods (ML) since the ML method does not require an excessively large sample size (Bentler, 1995). The goodness-of-fit indices used for evaluating the models were scaled chi-square test (X^2), comparative fit index (CFI), and root mean-square error of approximation (RMSEA). The sections to follow present the results.

The construct validity of the Student questionnaire

The Student questionnaire used descriptive statements about teaching behaviors hypothesized to measure each of the teacher factors and their dimensions. Part A used 49 Likert type scale items (i.e., 1= never; 2= rarely; 3= sometimes; 4= often; 5=almost always) for the students to indicate what usually happens in their mathematics lessons. For example, the first item reads as follows: in mathematics, we start lessons with things that are easy to understand; as the lesson goes on what we cover is more difficult. Part B provided four statements for the students to indicate what usually happens in their lessons. For example, the teacher explains to us what s/he expects us to learn from mathematics lessons: (1= in every lesson; 2=in most lessons; 3= only sometimes; 4= very rarely; 5= never). The scores of the students for each of the scale items is an indication of a teacher's strength or weaknesses in relation to each of the teacher factors. Table 1 below presents the specification table of the Student questionnaire.

Table 1. Specification table: Scale items of the Student questionnaire and their respective hypothesized factor loadings.

	Measurement Dimensions					**Items excluded**
Teacher Factors	**Frequency**	**Focus**	**Stage**	**Quality**	**Differentiation**	
Orientation				8		
Structuring	3	10	2, 34, 38	1, 4, 7		1, 34
Application			11, 12	26	13, 14, 15, 32	12, 32
Management of time	31, 35, 36	NA	NA	NA	NA	NA
Questioning	25, 39			24, 37, 40, 41,42	43	
Modeling strategies	44, 47			45, 46		
Teacher-student interactions	16, 17			19, 20, 21, 22		22
Dealing with misbehavior	29, 18	28		23, 27, 33, 30		23, 28
Assessments	50, 51			5, 6, 9, 48, 49		49

*NA=Not applicable

As can be observed in Table 1 above, specific scale items are hypothesized as indicators of the dimensions of the teacher factors of the dynamic model. The first step was an analysis of variance (ANOVA) for the emerging data to determine whether the items could be generalizable at the classroom level. The analysis revealed that each item was generalizable at the level of the classroom and the variance found to be situated at the classroom level was relatively high (i.e., higher than 10%). In the second step, for each of the teacher factors, first-order CFA models were conducted examining the fit of the data to the models. For example, as can be observed in Table 1 above, Item 3 measures the frequency dimension of structuring; Item 10, the focus dimension; Items 2, 34, and 38, the stage dimension; and Items 1, 4, and 7, the quality dimension. The factor loadings for Item 1 and Item 34 (i.e., .32, and.38) were unsatisfactory, and thus were removed to improve the model. For the rest of the Items, the factor loadings were between 0.51 and .54 which is satisfactory (Kline, 2011).

As indicated earlier, the goodness-of-fit indices used for evaluating the models were the scaled chi-square test (x^2), comparative fit index (CFI), and the root mean-square error of approximation (RMSEA). According to scholars (e.g., Gustafsson et al., 2013; Kline, 2011; Hu & Bentler, 1999), a chi-square test close to zero indicates little difference between the expected and observed covariance matrices. The probability level must be greater than 0.05 when x^2 is close to zero. CFI range from 0 to 1 with a larger value indicating a better model fit. Acceptable model fit is indicated by a CFI value of 0.90 or greater. RMSEA values range from 0 to 1 with a smaller RMSEA value indicating better model fit. RMSEA values in the range of 0.00 to 0.05 indicate close fit, those between 0.05 and 0.08 indicate fair fit, and those between 0.08 and 0.10 indicate mediocre fit.

In this respect, the first-order CFA model conducted for Structuring produced reasonable goodness-of-fit indices (i.e., X^2=96.37; df=19, < 0.001; CFI=0.98; RMSEA=.03) (Gustafsson et al., 2013). The x^2 result was statistically significant indicating a poor fit of the data to the model. However, x^2 is too stringent for model testing, for which reason, the CFI and RMSEA are also consulted (Kline, 2011). The CFI (i.e., .98) and RMSEA (.03) values fell within the acceptable range. Moreover, all freely estimated unstandardised parameters were statistically significant (p<0.01) (Gustafsson et al., 2013). A similar procedure as described above was used in conducting first-order CFA models for the rest of the teacher factors with satisfactory results.

Table 2 below presents CFA results for all the teacher factors under the questionnaire. The analysis excludes Orientation as it has only one item loading on it (see Table 1).

Table 2. Goodness-of-Fit indices: First-order CFA models testing the validity of the Student questionnaire.

Teacher factors	**X^2**	**df**	**P**	**CFI**	**RMSEA**	**C/ALPHA**
Structuring	96.3	19	.001	.98	.03	.68
Application	243.9	12	.000	.91	.07	.69
Questioning	83.1	18	.001	.98	.03	.56
Modeling strategies	17.9	2	.001	.98	.05	.55
Teacher-Student Interactions	71.5	9	.001	.98	.04	.66
Dealing with Misbehavior	91.6	13	.001	.95	.03	.55
Assessment	95.5	10	.001	.93	.04	.65

Note: All x^2values have *p* values ≤ 0.001; RMSEA values ≤ 0.05 indicate close fit, and values between 0.05 and 0.08 indicate reasonable fit, CFI values ≥ 0.95 indicates good fit (Hu & Bentler, 1999).

As can be observed in Table 2, the chi-square (x^2) values for all the teacher factors under the questionnaire are statistically significant suggesting a lack of fit of the models to the data. However, due to the sensitivity of x^2 in large samples, in this case students (N=3,585), the CFI and RMSEA were consulted (Barrett, 2007). As can be observed in the table, with the exception of Application and Assessment whose CFA values were attained at the level of 0.91 and 0.93, for the rest of the factors, the CFI values fell within a satisfactory range of 0.95 to 0.98. Particularly, the RMSEA values for all the factors fell between .03 and .07, which is a good result (Gustafsson et al., 2013). Also, the Cronbach's alpha coefficients obtained for all the teacher factors ranged from 0.55 to 0.69 which is moderate. Moreover, it was found that the values of Cronbach alpha are increased by removing any of the items of each scale.

The construct validity of the High-inference observation instrument

The High-inference observation instrument used a total of 55 Likert type descriptive statements about teaching behaviors hypothesized as indicators of the teacher factors of the dynamic model. For example, from a 5 point scale, the observer is to indicate if an orientation activity or activities in the lessons of teachers helped students to understand new content in the lessons.

Table 3 below presents the specification table of the instrument with details of the specific scale items hypothesized to measure either the quantitative or the qualitative aspect of the teacher factors of the dynamic model.

Table 3. Specification table: Scale items of the High-inference observation instrument and their respective hypothesized factor loadings.

Teaching factors	**Measurement dimensions**	
	Qualitative aspects	Quantitative aspects
Orientation	1, 5, 41	2, 40
Structuring	3, 6, 9	4 , 7, 8
Application	10, 11, 12, 13, 14, 15,16,	
Time management	42, 43	17, 39
Questioning	44, 45, 46, 47, 48, 49	
Modeling strategies	50, 51, 52, 54, 55	53
Teacher-Student interactions		18, 19, 24
Student-Student interactions	25, 26, 27, 28	20, 21, 22, 23,
Managing classroom disorder	35, 36, 37, 38	29, 30, 31, 32, 33, 34,

For all the teacher factors under the instrument, first-order CFA models were conducted examining the fit of the data to the models. For example, as can be observed in Table 3, Items 1, 5, 41, 2, and 40 are hypothesized to load on Orientation. The factor loadings obtained for the first-order CFA model for each of the items (i.e. 0.65, 0.84, 0.86, 0.85, and 0.92) were very high and satisfactory (Kline, 2011). Also, the model produced satisfactory goodness-of-fit indices (X^2=5.8; df=3, < 0.12; CFI=0.99; RMSEA=.08) (Gustafsson et al., 2013). Similarly, first-order CFA models conducted for the rest of the teacher factors under the instrument attained satisfactory results in terms of factor loadings and goodness-of-fit indices. Table 4 below presents the results. As can be observed in the table, with the exception Application and Student-Student interactions, the scaled chi-square (X^2) indices for the rest of the factors are non-significant. A non-significant X^2 is an indication of a good result (Kline, 2011). Also, the RMSEA values for all the teacher factors fell between (0.05-0.8). Similarly, the CFI values for all the teacher factors were above 0.95 indicating a good fit of the models to the data (Kline, 2011; Gustafsson et al., 2013). Moreover, the standardized factor loadings (not shown in the table) were all positive and moderately high, with standardized values ranging from 0.58 to 0.84.

As can be observed in the table also, the Cronbach's alpha reliability coefficients for all the factors fell in the range of 0.70 to 0.97 which is a good result (Gustafsson et al., 2013).

Table 4. Goodness-of-Fit indices: First-order CFA models testing the validity of the High-inference observation instrument.

Teacher factors	**X^2**	**DF**	**p**	**CFI**	**RMSEA**	**C/ALPHA**
Orientation	5.8	3	.12	.99	.08	.90
Structuring	10.9	7	.14	.99	.07	.97
Application	22.7	10	.01	.98	.06	.96
Time Management	3.28	2	.19	.97	.08	.83
Questioning	11.5	5	.04	.99	.06	.91
Teaching Modeling	6.9	5	.20	.99	.06	.92
Student-Student interactions	38.6	20	.01	.97	.08	.71
Managing classroom disorder	7.2	4	.12	.99	.08	.60

Note: All x^2values have p values ≤ 0.001; RMSEA values ≤ 0.05 indicate close fit, and values between 0.05 and 0.08 indicate reasonable fit; CFI values ≥ 0.95 indicates good fit (Hu & Bentler, 1999).

As far as Teacher-Student interaction is concerned, the first-order CFA model was just identified as it has three scale items loading on it (see table 3 above). Thus, exploratory factor analysis was conducted for the factor with satisfactory results. The eigenvalue for the first factor was equal to 2.56, explaining 85% of the total variance, while the second eigenvalue was less than 1 (i.e., 0.26). This implied that the three items could be treated as belonging to one factor since all the three items had relatively big factor loadings ranging between 0.82 and 0.89. It was also necessary to conduct descriptive statistics of the data in order to identify any variability that may exist in the teachers' classroom behaviors**.** The sections to follow present the results**.**

Descriptive statistics: Data emanating from the Student questionnaire

Table 5 below presents descriptive statistics of the data emanating from the Student Questionnaire. As can be observed in Table 5, the means attained for all the teacher factors fell between 2.65 and 3.97. Teacher-Student Interactions and Structuring had comparatively high means (i.e., 3.97 and 3. 91). High mean scores indicate a greater incidence of effective teacher behaviors for the two factors. Management of time however attained the lowest mean value which is an indication that the students believe the teachers did not pay much attention to that factor as compared with the rest of the factors.

Table 5. Descriptive statistics: Data emanating from the Student questionnaire.

Teacher factors	**Mean**	**SD**	**Min**	**Max**
Orientation	3.84	.48	1.63	4.60
Structuring	3.91	.37	2.78	4.67
Application	3.58	.43	2.46	4.93
Management of time	2.65	.48	1.40	4.30
Questioning	3.41	.36	2.55	4.56
Modeling strategies	3.58	.44	2.58	4.66
Teacher -Student interactions	3.97	.53	2.82	5.62
Dealing with misbehavior	3.19	.42	1.83	4.36
Assessment	3.82	.45	2.71	5.44

Also, as can be observed in the table, the standard deviations of the means for all the factors fell within the range of 0.36 to 0.74 which is an indication that the teachers did not vary a great deal in their teaching behavior according to the views of students. The very small values of standard deviations reveal that the statistical power for detecting effects of teacher factors based on the questionnaires was very small. Results emerged from student questionnaire are also compared with those emerged from the observation instruments in the next sections.

Descriptive statistics: Data emanating from the High-inference observation instrument.

Table 6 below presents descriptive statistics of the data emanating from the High-inference Observation Instrument. A different picture emerges as compared with the data from the questionnaire. As can be observed from the table, the standard deviations from the means range from 0.57 to 0.85 which is comparatively higher than what is reported above on the data from the student questionnaire. Also, as can be observed from the table, Teacher-Student interaction and Structuring recorded the highest standard deviations (i.e., 0.85 and 0.83) respectively indicating a higher variability for those two factors between the teachers. A closer inspection of the minimum and maximum values also reveals another pattern. For Application, while the minimum value is 1.83, the maximum value is 4.17 which is an indication of a considerable variation between the teachers' behaviors in respect to the factor. Also, a similar pattern can be observed for

Questioning and Modeling which reveals a considerable variation in the teachers' behaviors for those factors. Of all the factors, Orientation and Structuring recorded the lowest mean values of 2.25 and 2.91 respectively, which is an indication that the teachers did not vary a great deal with respect to those two factors as compared to the rest of the factors.

Table 6. Descriptive statistics: Data emanating from the High-inference observation instrument.

Teacher factors	**Mean**	**SD**	**Min**	**Max**
Orientation	2.25	0.64	1.00	3.40
Structuring	2.91	0.83	1.50	4.33
Application	3.23	0.75	1.83	4.17
Management of time	3.69	0.61	2.50	4.75
Questioning	3.30	0.66	2.00	4.67
Modeling strategies	3.13	0.64	1.67	4.50
Teacher-Student interactions	3.47	0.85	1.67	4.67
Student-Student interactions	3.51	0.63	2.25	4.50
Managing classroom Disorder	3.95	0.57	2.86	4.86

Descriptive statistics: Data from the Second low-inference observation instrument

The Second low-inference observation instrument refers to the following five factors of the dynamic model: orientation, structuring, teaching modeling, questioning, and application. The measurement dimensions are as follows: frequency, stage, focus, quality, differentiation. Whereas the frequency dimension measures the quantitative aspect of teaching, the rest of the dimensions measure the qualitative aspect. Specific teaching activities for each of the five factors are indicated in the instrument. The observer is to record the number and sequence of the teaching activities related to each of the five factors under each of the measurement dimensions for each teacher. The time used in minutes for each teaching activity is also recorded (Creemers & Kyriakides, 2006).

The frequency dimension is determined by the number of teaching activities for each factor, and the time in minutes used by each teacher for each teaching activity. This takes into account the number of tasks that take place in a typical lesson for a teaching factor as well as how long each task takes place. It also helps in determining the importance teachers attach to each of the five factors in their teaching practice. The stage dimension is determined by assigning a weight for each teacher based on the number of teaching activities undertaken for each factor. Under the focus and qualitative dimensions, specific teaching activities with codes are specified. For example, under the focus dimension of orientation, the observer is to indicate if an orientation activity was related to a specific task, code=1, the whole lesson, code =2, or unit or unit of lessons, code=3. Based on the number of activities recorded under these codes, weights are calculated for each teacher for the focus and quality dimensions. Also, for each of the five factors, the observer is to indicate the number of differentiation activities provided by the teachers. For example, in posing a question, the teacher may strategically call on a girl, a boy or a weaker student. Based on a count of the number of differentiation activities provided by each teacher under each of the teacher factors, a score is calculated for each teacher for differentiation. A satisfactory Cronbach's alpha coefficient of 0.84 was attained for the data emerging from the instrument.

Table 7 below presents descriptive statistics of the data from the instrument. As can be observed in Table 7, the rows for the frequency dimension for all the teacher factors, it appears the teachers allocated a greater proportion of time for Application activities. For example, whereas for the frequency dimension of Application, the mean was 12 minutes, the frequency dimensions of Orientation, Structuring, Modeling, and Questioning recorded mean values of 3, 4, 5 and 6 minutes respectively. Also, a closer inspection of the means and standard deviations for the dimensions of the five factors gives an indication that the teachers emphasized very much more on the quantitative aspect of teaching as compared the qualitative. For example, for the frequency dimensions of Application, the mean is 11.60 (SD=1.58); for Orientation, the mean 2.98 (SD=0.70); for Structuring the mean is 3.81 (SD=0.78); for Modeling strategies, the mean is 6.11(SD=1.26); and for Questioning, the mean is 5.08 (SD=0.92). On the other hand, the means and standard deviations under the rest of the dimensions (stage, focus, quality and differentiation) are comparatively very low. This is an indication that the teachers did not pay much attention to those dimensions in their teaching. For example, under Orientation, the stage dimension recorded a mean value of 0.11 (SD=0.30); under focus, a mean value of 0.35(SD=0.05); under quality, a mean value of 0.34 (0.03); under differentiation, a mean value of 0.04 (SD=0.13). Particularly, of all the dimensions, differentiation recorded the lowest mean values. This is an indication that differentiation of teaching in which the needs of varied students (i.e., ability level and learning styles) was relatively not catered for by the teachers.

Table 7. Descriptive statistics: Data on quality teaching emerging from the Second low-inference observation instrument.

Teacher factors	Measurement dimension	Mean	SD	Min	Max
Orientation	Frequency	2.98	.70	2.0	4.0
	Stage	.11	.30	.0	1.0
	Focus	.35	.05	.33	.50
	Quality	.34	.03	.33	.50
	Differentiation	.04	.13	.0	.5
Structuring	Frequency	3.81	.78	.0	6.0
	Stage	.65	.65	.0	2.0
	Focus	.46	.12	.00	.66
	Quality	.47	.34	.00	1.00
	Differentiation	.03	.09	.00	.33
Application	Frequency	11.60	1.58	8.0	16.0
	Stage	.79	.71	.0	2.0
	Focus	.44	.09	.33	.66
	Quality	.45	.09	.33	.66
	Differentiation	.23	.24	.00	.66
Modeling strategies	Frequency	6.11	1.26	4.0	9.0
	Stage	1.28	.69	.0	2.0
	Focus	.46	.09	.33	.66
	Quality	.46	.06	.33	.66
	Differentiation	.26	.19	.00	.66
Questioning	Frequency	5.08	.92	4.0	7.0
	Stage	1.15	.65	.0	2.0
	Focus	.46	.08	.33	.66
	Quality	.50	.08	.33	.70
	Differentiation	.29	.14	.00	.66

Overall, it can be inferred that the teachers' varied very little in their classroom behaviors in relation to the qualitative dimensions (i.e., focus, stage, quality and differentiation). Also, the very small values of standard deviations for those dimensions reveal that the statistical power for detecting effects of teacher factors under the dimensions is very small. The Second-low observation instrument also enabled the collection of additional information about the teachers' practice. In next to follow, further details of the teachers' behaviors in respect of the five factors (orientation, structuring, application, modeling and questioning) are presented. The reader can refer to Appendix F.

1) Orientation. As presented in Table 7, the teachers used an average of 3 minutes ranging from 2 to 4 minutes for a total number of 112 orientation activities. For the stage dimension, the average weighting obtained for orientation activities was 0=78.8, 1=21.2. This implies that very few orientation activities used in the lessons. Under the focus dimension, whereas in 79 or 70.5 % of the orientation activities, the teachers merely stated the aim of the lesson as a routine in their practice, for 33 or 29.5 % of the activities, the teachers provided to the students the aim of the lesson, and as well the link of the lesson to previous lessons. Under the quality dimension, whereas 92 or 82.1% of the orientation activities were typical or routine; 20 or 17.9% related to learning (i.e., the teachers attempted to link the orientation activities with the past experiences of the students). Also, whereas in 23 or 21.6% of the orientation activities, the teachers differentiated their teaching, in 89 or 79.4% of the activities, the teachers did not.

2) Structuring. The teachers used an average of 4 minutes ranging from of 0 to 6 minutes for a total number of 170 activities related to structuring. Under the stage dimension, the weighting obtained for the activities was 0= 59.1; 1=34.6; 2=6.3. Under the focus dimension, out of the total number of activities, whereas 69 or 40.6% were related to the structure previous lessons; 78 or 45.9% were related to the structure of the day's lesson; and 23 or 13.5% to a unit or a number of lessons. Under the qualitative dimension, 114 or 67.2% of the activities appeared to be clear to the students; whiles 56 or 32.9% appeared not to be clear to the students. Also, in 37 or 21.8% of the activities, the teachers provided differentiation opportunities to the students, whiles in 133 or 78.2 % of the activities, the teachers did not.

3) Application. The teachers used an average of 12 minutes ranging from 8 to 16 minutes for a total of 268 application activities. Under the stage dimension, the weightings obtained for the activities were 0=17.7, 1=74.1 and 2=8.2. This implies that although much of the teaching time was allocated to application activities, the activities did not vary a great deal. Under the focus dimension, whereas 146 or 54.5% of the activities concerned with only a part of the lesson; 103 or 38.4% concerned with the whole lesson; and 19 or 7.1% concerned a unit or a number of lessons. Under the qualitative dimension, 187 or 69% of the activities required students to simply recall rules and definitions, or perform algorithms with no relation to the underlying concepts; 81 or 31% required the activation of cognitive strategies to solve the problems which can develop deeper levels of understanding concepts or ideas. Also, in 119 or 34.4% of the activities, the teachers provided differentiation opportunities to the students, whiles in 149 or 65.6%, the teachers did not.

4) Modeling strategies. The teachers used an average of 6 minutes ranging from 4 to 9 minutes for a total of 361 modeling activities. Under the stage dimension, the weightings obtained for the modeling activities were 0 =2.3, 1=39 and 2=58.7. Under focus, 203 or 56.2% of the modeling activities could be used in the lesson only; 121 or 33.5% could be used in a unit of the lessons; and 37 or 10.2% could be used across units of lessons. The quality dimension measures the teachers' role in the modeling activities. Out of the total number of the modeling activities, 212 or 58.7% were given by the teacher; 78 or 21.6% through guided discovery; and 71 or 19.6% through self-discovery. Also, whereas in 111 or 30.8% of the modeling activities, the teachers provided differentiation opportunities to the students, in 249 or 69.2% of the activities, the teachers did not.

5) Questioning. The teachers used an average of 5 minutes ranging from 4 to 7 minutes for a total number of 443 questions. Under the stage dimension, the weightings obtained for the activities were 0=11.9, 1=57.4, and 2=30.7. Under the focus dimension, 279 of the questions were for a specific task; 131 for the whole lesson; and 33 covered a unit or a number of lessons, representing 63%, 29.6% and 7.4% respectively. The quality dimension measures the type of questions posed (i.e., product or process questions). Out of the total number of questions, 291 or 65.6% were product questions which did not require higher level thinking (i.e., the students were not asked to assign the reasoning behind their answers); 152 or 34.4% were process questions requiring the students to provide the reasoning behind their answers to the questions. Also, whereas in 130 or 29.3% of the questioning activities, the teachers provided differentiation opportunities to the students, in 313 or 70.6% of the activities, the teachers did not.

Having established the construct validity of the measurement instruments of the dynamic model, the next step was to conduct multilevel analysis to examine whether the teacher factors function in explaining student achievement. Factor scores were thus generated for each teacher based on the CFA models of the data from the Student questionnaire and the High-inference observation instrument. Scale scores were also generated from the data from the Second low-inference observation instrument for each teacher. The sections to follow presents results of multilevel analysis of the impact on student achievement by factors at the level of students, and school context factors, and the teacher factors of the dynamic model.

Using multilevel analysis to search for the impact on student achievement in mathematics by the teacher factors of the Dynamic model

As indicated in chapter three, MLwiN software (Goldstein et al., 1998) was used for the multilevel analysis. Five different two-level models were examined (i.e., students in level 1, classrooms/teachers in level 2). The first model (model 0) is an unconditional model without explanatory variables describing how much variation in achievement is between classrooms and how much between students. The importance of factors determining student learning outcomes is often judged in reference to the percentage of variance in achievement accounted for by the factors in a simple variable decomposition lying between schools/classrooms and within students (Scheerens & Bosker, 1997). Sufficient variance has been interpreted as 10% or more (Raudenbush & Bryk, 2002).

The standard practice is to adjust student achievement scores for background conditions (e.g., prior learning or SES), and school context factors only after which the effects of schools or teachers can be determined (Scheerens, 2013). In this respect, in model 1 and 2, student background factors were added to the empty model to determine their joint impact on student achievement. In the next step in model 3, school context variables were added to model 2. Having controlled for the impact of student and school context variables, the effects of the teacher factors of the dynamic model were then determined in model 4. The section to follow presents results.

Results of multilevel analysis: The effects on student achievement in mathematics by student and school background factors

Table 8 below presents results of multilevel analysis of the effects on student achievement in mathematics by factors at the level of the students, schools, and as well the teacher factors of the dynamic model under the Student questionnaire. As can be observed in the first column of the table (model 0), 55% of the variance in achievement is at the level of the classroom (teachers), and 45% at the level students. This is an indication that an extremely high proportion of the variance in achievement lies at the classroom level. This finding seems to reveal that teachers matter more in Ghana than in other developed countries. Also, having established a significant variation in student achievement between the classrooms (teachers) justifies the need for a further examination of the factors accounting for this variation (Raudenbush & Bryk, 2002).

In this respect, in model 1, student background variables were added to the empty model. As can be observed in Table 8 (model 1), the pretest measure (a proxy for prior learning), educational level of mothers, occupational status of fathers, and student sex (in favor of male students) had statistically significant effects on students' achievement in mathematics ($p < .05$). On the other hand, student age, educational level of fathers, and occupational status of mothers were not statistically significant. Also, as can be observed at the bottom end of the table for model 1, 31.5% of the variance in student achievement was explained by the student background factors, whiles 30.8% and 37.4% of the variance remained unexplained at the classroom and student levels respectively. The likelihood statistic (X^2) shows a significant change between the empty model and model 1 ($p<.001$) which justifies the selection of model 1.

In the next step in model 2, variables related to the home learning environment were added to model 1. As can be observed in Table 8, the column for model 2, learning materials at home, and parental care for the child had statistically significant effects on student achievement. On the other hand, quiet place to learn at home, language at home, household economic goods, home work, parental attitude towards math, monitoring of child learning were not significant. Also, as can be observed at the bottom end of the table for model 2, 31.7% of the variance in achievement is now explained, whiles 30.7% and 37.4% of the variance remained unexplained at the classroom and student levels respectively. The likelihood statistic (X^2) shows a significant change between model 1 and model 2 ($p<.001$) which justifies the selection of model 2.

In the next step in model 3, school context variables were added to model 2. As can be observed in Table 8, the column under model 3, classroom composition (i.e., aggregate of mothers' educational level) had a statistically significant effect on student achievement ($p<.05$). On the other hand, school location, class size and school type were not significant. Among all the background variables examined, the classroom compositional variable had the biggest effect on achievement (Hanushek et al., 2003; Walberg 2003). Also, with the addition of school context variables to model 2, 39.8% of the variance in achievement was explained whiles 22.8% and 37.4% of variance remained unexplained at the classroom and the student levels respectively. The likelihood statistic (X^2) also shows a significant change between mode 2 and model 3 ($p<.001$) which justifies the selection of model 3.

Results of multilevel analysis: The effects on student achievement in mathematics by the teacher factors of the Dynamic model - Student questionnaire

Having controlled for the impact on student achievement in mathematics by the background factors, the next step was to determine the effects of the teacher factors of the dynamic model. This section presents results of the analysis concerning the student questionnaire. Nine different versions of model 4 (i.e., models 4A-4I) were conducted for each of the factors. In each version of model 4, the factor scores of the CFA models were added one by one to model 3. As can be observed in Table 8 above (the columns for models 4A to 4I), none of the teacher factors under the questionnaire was found to have a statistically significant on achievement. The effects of Teacher assessments and Teacher-student interaction were however statistically significant at the 10% level. As was indicated in the descriptive statistics section (section, 4.3.1), the very small values of the standard deviations of the teacher factors in respect of the data from the questionnaire revealed that the statistical power for detecting effects of teacher factors was very small and this needs to be taken into account in interpreting the results of this section.

Table 8. Parameter estimates (and standard errors) for the analysis of student achievement in mathematics (students within classes)

	Model 0	Model 1	Model 2	Model 3	Model 4A	Model 4B	Model 4C	Model 4D	Model 4E	Model 4F	Model 4G	Model 4H	Model 4I
Fixed Part	-0.994	-1.014	-1.219	-2.118	-2.093	-2.128	-2.182	-2.070	-2.103	-2.100	2.203	-2.007	-2.232
(Intercept)	(0.080)	(0.086)	(0.117)	(0.471)	(0.473)	(0.473)	(0.313)	(0.473)	(0.310)	(0.476)	(0.472	(0.470)	(0.423)
Students' context													
		0.369*	0.360*	0.359*	0.359*	0.359*	0.359*	0.359*	0.359*	0.358*	0.358*	0.359*	0.358*
Prior knowledge (Pre-test measure)		(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
		-0.055*	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051
Student sex (male reference category)		(0.024)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
		-0.014	-0.002	0.008	0.008	0.008	0.008	0.008	0.007	0.008	0.007	0.008	0.009
Age of student		(0.020)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
		0.039*	0.046*	0.038*	0.036*	0.036*	0.036*	0.038*	0.039*	0.039*	0.038*	0.039*	0.039*
Educational level of mothers		(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
		0.008	0.004	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Educational level of fathers		(0.011)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
		-0.062	-0.066	-0.065	-0.065	-0.064	-0.064	-0.064	-0.064	-0.065	-0.064	-0.064	-0.065
Occupational status of mothers		(0.036)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
		0.071*	0.084*	0.083*	0.083*	0.083*	0.083*	0.083*	0.083*	0.083*	0.083*	0.083*	0.082*
Occupational status of fathers		(0.030)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Home learning environment													
			0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.042
Quiet place to learn at home			(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
			0.002	-0.005	-0.005	-0.005	-0.005	-0.005	-0.004	-0.004	-0.004	-0.005	-0.006
Language at home			(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
			0.000	-0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Economic household goods			(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Learning Materials			0.042*	0.040*	0.040*	0.040*	0.041*	0.041*	0.040*	0.040*	0.040*	0.040*	0.041*
			(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Homework			-0.015	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014
			(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Private tuition			-0.022*	-0.022*	-0.022*	-0.022*	-0.022*	-0.022*	-0.022*	-0.022*	-0.023*	-0.022*	-0.022*
			(0.10)	(0.11)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Attitude towards math			-0.002	-0.005	-0.005	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	-0.005	-0.004
			(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Check on performance			-0.001	0.000	-0.000	-0.000	-0.001	-0.001	0.000	0.000	0.000	0.000	-0.001
			(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Children are offered learning			0.050*	0.049*	0.049*	0.049*	0.049*	0.049*	0.049*	0.049*	0.049*	0.049*	0.049*
opportunities after school time			(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
School Context													
				-0.197	-0.203	-0.195	-0.188	-0.237	-0.195	-0.179	-0.151	-0.197	-0.088
School type				(0.147)	(0.147)	(0.147)	(0.147)	(0.149)	(0.145)	(0.147)	(0.149)	(0.147)	(0.146)
				0.206	0.202	0.210	0.214	0.194	0.188	0.196	0.234	0.204	0.241*
School location				(0.114)	(0.114)	(0.114)	(0.114)	(0.114)	(0.114)	(0.114)	(0.115)	(0.115)	(0.112)
				0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001	0.000
Class size				(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)

Aggregate of educational level of mothers				0.502*	0.502*	0.502*	0.510*	0.498*	0.494*	0.495*	0.480*	0.501*	0.498*
				(0.111)	(0.111)	(0.111)	(0.111)	(0.110)	(0.110)	(0.111)	(0.111)	(0.111)	(0.107)
Teacher factors : Student questionnaire													
Orientation					-0.055 (0.112)								
Structuring						0.033 (0.146)							
Application							0.109 (0.128)						
Management of time								0.069 (0.121)					
Questioning									0.058 (0.152)				
Modeling strategies										0.004 (0.131)			
Teacher-student interactions											0.161 (0.114)		
Dealing with misbehavior												-0.113 (0.127)	
Assessment													0.189 (0.124)
Random Part													
Classroom	54.9%	30.8%	30.7%	22.8%	22.7%	22.8%	22.5%	22.6%	22.7%	22.8%	22.3%	22.5%	21.4%
Students	45.1%	37.7%	37.4%	37.4%	37.4%	37.4%	37.4%	36.9%	36.9%	36.9%	36.9%	36.9%	37.4%
Explained		31.5%	31.7%	39.8%	39.9%	39.8%	40.1%	40.5%	40.4%	40.3%	40.8%	40.6%	41.2%
Significance test													
X2	8131	6737	5791	5758	5758	5758	5758	5662	5662	5662	5756	5662	5659
Reduction		1394	2340	2373	2373	2373	2373	2469	2469	2469	2375	2469	2472
Degrees of freedom		3	2	1									
p value		0.001	0.001	0.001							0.010		0.010

* = statistically significant effect at level .05

Results of multilevel analysis: The effects on student achievement in mathematics by the teacher factors of the Dynamic model - the High-inference observation instrument

Nine different versions of model 4 were conducted for each of the factors under the instrument. In each version of model 4(i.e., models 4A-4I), the factor scores of the CFA models were added one by one to model 3. Table 9 below presents the results. As can be observed in the columns for models 4A to 4I of the table, unlike the findings reported above on the data from the student questionnaire, all the teacher factors of the dynamic model measured with the high-inference observation instrument had statistically significant effects on student achievement ($p<.05$). The total variance in achievement explained by entering each of these factors was found to be at least 42%. Also, the fit of each model was tested against model 3. As can be observed in Table 9, the likelihood statistic (X^2) shows a significant change between model 3 and each version of model 4 ($p<0.001$), which implies that the teacher factors of the dynamic model had significant effects on student achievement. It was also possible to create a model 5 containing all the teacher factors of the dynamic model and this model was found to explain more than 45% of the total variance in student achievement. Model 5 was also found to fit the data better than any version of model 4.

Table 9. Parameter estimates (and standard errors) for the analysis of student achievement in mathematics (students within classes)

	Model 0	Model 1	Model 2	Model 3	Model 4A	Model 4B	Model 4C	Model 4D	Model 4E	Model 4F	Model 4G	Model 4H	Model 4I
Fixed Part	-0.994	-1.014	-1.219	-2.118	-1.738	-1.775	-1.805	-1.882	-1.736	-1.785	-1.751	-1.847	-1.879
(Intercept)	(0.080)	(0.086)	(0.117)	(0.471)	(0.458)	(0.461)	(0.458)	(0.316)	(0.471)	(0.445)	(0.448)	(0.456)	(0.455)
Teacher factors: High inference observation instrument													
Orientation					0.295* (0.083)								
Structuring						0.215* (0.065)							
Application							0.245* (0.072)						
Management of time								0.264* (0.083)					
Questioning									0.231* (0.078)				
Modeling strategies										0.281* (0.077)			
Teacher-student Interactions											0.253* (0.061)		
Student-student Interactions												0.277* (0.083)	
Dealing with classroom Disorder													0.302* (0.090)
Random Part													
Classroom	54.9%	30.8%	30.7%	22.8%	19.9%	20.3%	20.2%	20.7%	20.8%	19.9%	19.3%	20.3%	20.4%
Students	45.1%	37.7%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%.
Explained		31.5%	31.7%	39.8%	42.7%	42.3%	42.4%	41.9%	41.8%	42.7%	43.3%	42.3%	42.2%
Significance test													
X2	8131	6737	5791	5758	5746	5748	5747	5749	5750	5746	5743	5748	5748
Reduction		1394	2340	2373	2385	2383	2384	2382	2381	2385	2388	2383	2383
Degrees of freedom		3	2	1	1	1	1	1	1	1	1	1	1
p value		0.001	0.001	0.001	.001	.001	.001	0.001	0.001	0.001	0.001	0.001	0.001

* = statistically significant effect at level .05

Results of multilevel analysis: The effects on student achievement in mathematics by the teacher factors of the Dynamic model - the Second low-inference observation instrument

A similar procedure as described above was used in conducting different versions for each of the measurement dimensions (frequency, stage, focus, quality and differentiation) of the five factors of the dynamic model (orientation, structuring, application, modeling and questioning) in model 4 (i.e., models 4A-4E). In each version of model 4, the scale scores under each of the dimensions of the teacher factors were added as a group to model 3. Table 10 below presents the results. In model 4A, the data for the frequency dimensions of the five teacher factors were added to model 3. As can be observed in the column of the table for model 4A, the frequency dimension of Application had a statistically significant on student achievement ($p<.05$). However, the frequency dimension of Orientation, Structuring, Modeling, and Questioning were not significant. That the frequency dimension of Application was the only dimension significant comes as no surprise. As was shown in the descriptive statistics section (4.3.3), the frequency dimension of Application had the biggest standard deviation as compared to the rest of the teacher factors under the instrument. Also, as can be observed towards the bottom end of the table for model 4A, 46.2% of the variance in student achievement was explained by the frequency dimensions of all the five teacher factors, whiles 16.4% and 37.4% of the variance at the classroom and student levels respectively remained unexplained. The likelihood statistic (X^2) also shows a significant change between model 3 and model 4A ($p<.001$) which justifies the selection of model 4A.

In model 4B, the stage dimensions of the five teacher factors were added to model 3. As can be observed in column 4B of Table 10, the stage dimension of Structuring had a statistically significant effect on achievement ($p<.005$). However, the stage dimensions of Orientation, Application, Modeling and Questioning were not statistically significant. Also, as can be observed in the same column, 45.4% of the variance in student achievement was explained by the stage dimension of the five teacher factors whiles 17.2% and 37.4% of the variance at the classroom and the student levels respectively remained unexplained. The likelihood statistic (X^2) also shows a significant change between model 3 and model 4B ($p<.001$) which justifies the selection of model 4B.

Table 10. Parameter estimates (and standard errors) for the analysis of student achievement in mathematics (students within classes).

	Model 0	Model 1	Model 2	Model 3	Model 4A	Model 4B	Model 4C	Model 4D	Model 4E
Fixed Part	-0.994	-1.014	-1.219	-2.118	-2.055	-2.031	-1.822	-2.091	-1.932
(Intercept)	(0.080)	(0.086)	(0.117)	(0.471)	(0.427)	(0.447)	(0.432)	(0.465)	(0.445)
Frequency									
Orientation					0.077				
					(0.076)				
Structuring					0.126				
					(0.074)				
Application					0.130*				
					(0.055)				
Modeling					0.002				
					(0.062)				
Questioning					0.010				
					(0.083)				
Stage									
Orientation						0.045			
						(0.156)			
Structuring						0.206*			
						(0.096)			
Application						0.163			
						(0.094)			
Modeling						0.002			
						(0.082)			
Questioning						0.085			
						(0.092)			
Focus									
Orientation							0.302		
							(0.978)		
Structuring							0.004		
							(0.456)		
Application							0.857		
							(0.834)		
Modeling							2.085*		
							(0.981)		
Questioning							-0.037		
							(0.897)		
Quality									
Orientation								-0.064	
								(1.400)	
Structuring								0.086	
								(0.149)	
Application								0.676	
								(1.043)	
Modeling								3.563*	
								(1.019)	
Questioning								1.991*	
								(0.869)	
Differentiation									
Orientation									0.245
									(0.356)
Structuring									-0.172
									(0.598)
Application									0.903*
									(0.273)
Modeling									-0.033

									(0.368)
Questioning									0.215
									(0.476)
Random Part									
Classroom level	54.9%	30.8%	30.7%	22.8%	16..4%	17.2%	17.3%	12.1%	18.1%
Student level	45.1%	37.7%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%
Explained		31.5%	31.7%	39.8%	46.2%	45.4%	45.3%	50.5%	44.5%
Significance test									
X2	8131	6737	5791	5758	5727	5733	5733	5702	5737
Reduction		1394	2340	2373	2404	2398	2398	2429	2394
Degrees of freedom		3	2	1	1	1	1	2	1
p value		0.001	0.001	0.001	.001	.001	.001	.001	.001

*=statistically significant at the 0.05 level

In model 4C, the focus dimensions of the five teacher factors were added to model 3. As can be observed in column 4C of Table 10, the focus dimension of Modeling strategies had a statistically significant effect on student achievement ($p<.05$). However, the focus dimension of Orientation, Structuring, Application and Questioning were not significant. Also, as can be observed in the same column, 45.3% of the variance in student achievement was explained by the focus dimension of all the five teacher factors whiles 17.3% and 37.4% of the variance at the classroom and the student levels respectively remained unexplained. The likelihood statistic (X^2) also shows a significant change between model 3 and model 4C ($p<.001$) which justifies the selection of model 4C.

In model 4D, the quality dimensions of the five teacher factors were added to model 3. As can be observed in model 4D of Table 10, the quality dimensions of Modeling, and Questioning had statistically significant effects on achievement ($p<.05$). However, the quality dimension of Application, Orientation and Structuring were not significant. It can also be observed in the same column that 50.5% of the variance in student achievement was explained by the quality dimension of the five teacher factors whiles 12.1% and 37.4% of the variance at the classroom and the student levels respectively remained unexplained. The likelihood statistic (X^2) also shows a significant change between model 3 and model 4D ($p<.001$) which justifies the selection of model 4D.

In model 4E, the differentiation dimensions of the five teacher factors were added to model 3. As can be observed in column 4E of Table 10, the differentiation dimension of Application had a statistically significant effect on student achievement ($p<.05$). However, the differentiation dimensions of Orientation, Structuring, Modeling and Questioning were not statistically significant. Also, as can be observed in the same column, 44.5% of the variance in student achievement was explained whiles 18.1% and 37.4% of the variance at the classroom and the student levels respectively remained unexplained. The likelihood statistic (X^2) also shows a significant change between model 3 and model 4E ($p<.001$) which justifies the selection of model 4E. In the final step, all the dimensions of the five factors were entered in one model to determine their joint effects on student achievement. This model explained 53% of the variance in achievement at the classroom level and was found to fit the data better than any version of model 4.

Having established that the teacher factors of the dynamic model had an impact on student achievement, an analysis of the effects of the factors on achievement by class size was also conducted to determine whether a significant difference would emerge. To do this, the total sample was split by class size (i.e., from 15-34, 34-43, and 45-88). As regards the data from the high-inference observation instrument, all the teacher factors had statistically significant effects on student achievement irrespective of class size. No interaction with class size was also observed by comparing the data that emerged from the low-inference observation instrument.

Finally, Table 11 below presents the effect sizes which emerged by calculating Cohen's d of the teacher factors and their dimensions as emerged from using the observation instruments. One can see from Table 11 that the effect sizes of all the factors and their dimensions are higher than 0.30, and in three cases (i.e., Application under the high-inference instrument, the frequency dimension of Application, and the quality dimension of Modeling) their effect sizes are much higher than 0.35). This is a finding that has not emerged in earlier studies conducted in other European countries where the effect sizes of these factors were much smaller.

Table 11. Effect sizes of the teacher factors and their dimensions on student achievement gains in mathematics.

Teacher factors/Dimensions	High-inference observation instrument	Second-low observation instrument
Orientation	0.32	
Structuring	0.34	
Stage		0.33
Application	0.38	
Frequency		0.39
Differentiation		0.31
Time management	0.31	
Questioning	0.33	
Quality		0.35
Modeling	0.32	
Focus		0.34
Quality		0.38
Teacher-student interactions	0.30	
Student-student interactions	0.33	
Managing classroom Disorder	0.34	

Results of multilevel analysis: The effects on student achievement in mathematics - school inputs

Table 12 below presents multilevel analysis of the effects on students' achievement in mathematics by school inputs. As can be observed in the table, with the exception of mathematics books for teaching and learning, all other school inputs examined (e.g., Teacher Gender, Experience, Qualifications, School feeding) were not statistically significant for student achievement. One can see that mathematics books found to be related with achievement have direct impact on teaching.

Table 12. Parameter estimates (and standard errors) for the analysis of student achievement in mathematics (students within classes)**:** School Resources

	Model 0	Model 1	Model 2	Model 3	Model 4A	Model 4B	Model 4C	Model 4D	Model 4E	Model 4F	Model 4G	Model 4H	Model 4I	Model 4J	Model 4K
Fixed Part	-0.994	-1.014	-1.219	-2.118	-2.119	-2.120	-2.130	-2.096	-2.447	-2.452	-2.705	-2.415	-2.304	-2.454	-2.497
(Intercept)	(0.080)	(0.086)	(0.117)	(0.471)	(0.470)	(0.471)	(0.469)	(0.470)	(0.556)	(0.571)	(0.552)	(0.559)	(0.570)	(0.554)	(0.570)
School resources															
Teacher Sex					0.117 (0.148)										
Teacher Age						0.022 (0.080)									
Teaching experience							- 0.061 (0.064)								
Teacher Highest Certificate								0.110 (0.108)							
School feeding									-0.063 (0.131)						
School library										-0.012 (0.191)					
Math books											0.372* (0.148)				
Computers												-0.053 (0.123)			
Math teaching equipment													-0.112 (0.108)		
Electricity														0.133 (0.127)	
Teacher stationery															0.046 (0.105)
Classroom	54.9%	30.8%	30.7%	22.8%	22.7%	22.8%	22.5%	22.5%	23.3%	23.4%	21.8%	23.4%	23.4%	23.2%	23.3%
Students	45.1%	37.7%	37.4%	37.4%	37.4%	37.4%	37.4%	37.4%	36.7%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
Explained		31.5%	31.7%	39.8%	39.9%	39.8%	40.1%	40.1%	40 %	40%	41.6%	40%	40%	40.2%	40.1%
Significance test															
X2	8131	6737	5791	5758	5758	5758	5758	5758	4943	4943	4937	4944	4942	4943	4943
Reduction		1394	2340	2373	2373	2373	2373	2373	3188	3188	3194	3187	3189	3188	3188
Degrees of freedom		3	2	1							1				
p value		0.001	0.001	0.001							0.001				

*=statistically significant at the 0.05 level

Summary

In this chapter, the CFA models examining the construct validity of the High-inference observation instrument, and the Student questionnaire of the dynamic model attained satisfactory results. It can therefore be claimed the study also provided further support to the construct validity of the measurement framework of the dynamic model. Also, based on the descriptive statistics of the data from the Second-low inference observation instrument, it was clear the teachers emphasized very much more on the quantitative aspect of teaching than the qualitative.

Turning to the substantive questions of the study (i.e., whether the teacher factors of the dynamic model function in explaining variation in student achievement in Ghana), in the analyses of the data emanating from the Student questionnaire, all the teacher factors were found not to have statistically significant effects on student achievement. The effects of Teacher assessment and Teacher-student interactions were however significant at the level of 10%. As was indicated earlier, the very small values of standard deviations of data from the questionnaire revealed that our statistical power for detecting effects of teacher factors based on the questionnaire was very small.

As far as the data from the High-inference observation instrument is concerned, all the teacher factors had statistically significant effects on student achievement. Also, under the second-low observation instrument, whereas the frequency dimension of Application had a statistically significant effect on student achievement, the rest of the frequency dimensions of the factors (i.e., Orientation, Structuring, Teaching Modeling and Questioning) were not significant. Under the stage dimension, whereas Structuring had a significant effect, the rest of the factors were not. Under the focus dimension, whereas Teaching Modeling had a significant effect, the rest of the factors were not. Under the quality dimension, whereas Teaching modeling and Questioning had significant effects, the rest of the factors were not. Under differentiation, whereas Application had a significant effect, the rest of the factors were not significant.

Finally, the findings have implications for theory and research in Ghana. Particularly, policy initiatives can be recommended for improving teaching and learning in schools in Ghana. In chapter five to follow, we discuss the results. The implication for teacher effectiveness research in Ghana and other African countries is also drawn.

CHAPTER 5

DISCUSSION

As indicated in chapter one, the study used the conceptual framework of the dynamic model at the classroom in studying the degree to which teaching processes identified as effective in the developed countries are equally effective in developing countries. And more importantly, the teaching processes which are effective in a relatively resource constraint educational context. Multilevel modeling techniques were used in examining the joint effects of multiple factors at the student, school and the community level that interconnect to impact on students' learning gains in mathematics. The sections to follow present a discussion the key findings. The implications for policy and school effectiveness research in Ghana and the sub-Saharan African region are also drawn.

Summary of key findings

The first step was to determine the construct validity of the high-inference observation instrument and the student questionnaire. Similar to the earlier studies (e.g., Creemers & Kyriakides 2010; Kyriakides et al., 2010; Creemers & Kyriakides, 2010; Kyriakides et al., 2009; Panayiotou et al., 2014), the study also provided support for the construct validity of the high-inference observation instrument and questionnaire. Significantly, the variance component in student achievement in mathematics was found at the null model to be 55% at the classroom level. This implies that teachers are more important for student learning in mathematics in Ghana. Mathematics is generally more learned in schools; and thus may be more directly influenced by teachers (Nye at al., 2004; Willms, 2003). Moreover, school and teachers might even be more important for student learning in mathematics in a developing country such as Ghana where the educational levels of parents and other care givers is comparatively low.

Studies in developed countries usually find a larger proportion of the variance component in student achievement to lie at the student level (e.g., Creemers & Kyriakides 2010; Panayiotou et al., 2014, Scheerens & Bosker, 1997). Similar to the current study, other studies using samples from developing countries (e.g., Cho, Schermanm & Gaigher, 2014; van der Berg, 2008; Zhao et al., 2012) have reported a larger proportion of the variance component in achievement to lie at the school or classroom level. For example, in analyzing TIMSS 2003 data for the science achievement of South African students, Cho et al. (2014) found 41% of the variance component in achievement to lie at the student level, whereas 59% was at the class/school level.

Turning to the substantive questions as whether the eight teacher factors and measurement dimensions of the dynamic model function in explaining variation in student achievement in Ghana. As was shown in chapter four, all the teacher factors *(i.e., orientation, structuring, questioning, teaching modeling, applications, management of time, classroom management, and teacher assessment)* under the data emanating from the High-inference observation instrument had statistically significant effects on student achievement. Similarly, the measurement dimensions (frequency, stage, focus, quality, and differentiation) of the five teacher factors under the second-low inference observation instrument also had statistically significant effects on student achievement.

Based on the findings, it appears that the teacher factors of the dynamic model are probably more important for student learning in Ghana and for that the developing school context. As compared to the earlier studies (e.g., Kyriakides & Creemers 2010; Creemers & Kyriakides 2010; Kyriakides et al., 2010; Creemers & Kyriakides, 2010; Panayiotou et al., 2014), the teacher factors explained much more of the variance in achievement. For example, the additional variance in achievement explained by the teacher factors under the High-inference observation instrument was in the range of 2.5% to 3.5%. However, in a longitudinal study in six European countries examining the effects of the teacher factors on student achievement in mathematics, the additional variance explained by the teacher factors was in the range of 0.75 and 1.7% (Panayiotou et al., 2014).

Also, based on the data from the Second-low inference instrument, it was clear that the teachers emphasized very much more on the quantitative aspect of teaching than the qualitative. For example, even though the teachers allocated a greater proportion of time for application activities, the qualitative dimensions of application activities recorded comparatively low mean values (see Chapter four, Section 4.3.3: Table 7). The quantity of instruction can be seen as necessary but insufficient for student learning gains. A combination of the quantity and quality of instruction in the right proportion is what can lead to successful learning (Archer & Hughes, 2011). Teachers are expected to allocate adequate time for each teacher factor and as well pay attention to the qualitative aspects of each factor (Creemers & Kyriakides, 2006). Particularly, 69% of the activities under Application required students to simply recall rules and definitions, or perform algorithms with no relation to the underlying concepts for learning; whereas 31% of the activities required the activation of cognitive strategies to solve problems. Similar findings were reported in a South African study (Carnoy et al., 2008). Teaching students to activate cognitive strategies in solving problems has the potential to develop in students independent or self-reliant learning skills (Walberg, 2003).

Also, based on the standard deviations reported for all the measurement dimensions of the five teacher factors under the Second-low observation inference instrument, it appears the teachers did not vary a great deal in their teaching behaviors. Particularly, the teachers' behaviors with respect to the stage, focus, quality and differentiation dimensions of Orientation, Structuring, Modeling and Questioning recoded very low means. For example, for Orientation, under the stage dimension, the mean recorded was 0.11 (SD=0.30); under the focus dimension, the mean was 0.35 (SD=0.05), under the quality dimension, the mean was 0.34 (SD=0.03); and under differentiation, the mean was 0.04 (SD=0.13) (see Chapter four, Section 4.3.3: Table 7).

Effective teachers promote learning by communicating to students what is expected of a learning activity and why (Porter & Brophy, 1988). In so doing, students might identify with the objectives of the lesson, spend their time and effort in the lessons, which ultimately can lead to desired learning outcomes (Creemers & Kyriakides, 2006). As indicated earlier, the qualitative aspects of the orientation activities of the teachers were largely typical, and did not require critical thinking. Effective teachers are expected to not only state the aim of a lesson, but to also involve students in finding the reasons for activities in lessons (Creemers & Kyriakides, 2006).

Similarly, under the qualitative aspects of structuring, 67.2% of the activities appeared not to have been understood by the students. Students learn more efficiently when teachers actively structure new information and relate new content to what they already know (Brophy & Good, 1986). Also, a total of 268 activities were recorded under modeling strategies. Out of this number, 58.7% were given by the teachers; 21.6% through guided discovery; and 19.6% through self-discovery (see chapter four: section 4.4.3). Although teachers are expected to provide students strategies for solving problems, they are also expected to offer a balance between the activities in order that students can develop their own strategies for problem solving (Kyriakides et al., 2002).

Also, in teacher questioning there should be a mix of product questions and process questions (Creemers & Kyriakides, 2009). Out of a total of 443 questions posed by the teachers, 65.6% were product questions which did not require higher order cognitive thinking. Similarly, it was only in 22.1% of the questions that the students were invited to comment on the answers provided by their colleagues. The findings are in line with studies in Ghana indicating that students' classroom discourse is very limited due to the command and inflexible nature of teaching (i.e., Agbenyega & Deku, 2011; Mereku, 2003; Opoku-Asare, et al., 2014).

In a typical classroom, students differ in terms of their learning style, ability and SES. Differentiation or adaptive instruction geared to the characteristics and needs of individual students when skillfully implemented can improve the learning of all students (Creemers, 1994). The differentiation dimensions of the five teacher factors under the Second-low inference observation instrument recorded the lowest mean values. It can therefore be inferred that differentiation of teaching was very limited with this sample of teachers. Similar findings were reported in other cross-sectional studies in Ghana (e.g., Agbenyega & Deku, 2011; Kuyini & Desai, 2008).

Overall, the findings suggest that the teachers emphasized more on the basic elements of direct teaching, with very little on the qualitative aspects (i.e., stage, focus, quality and differentiation dimensions). According to Kyriakides and Creemers (2006), the more effective teachers are those who also incorporate in their teaching more advanced skills such differentiation of teaching. Teachers exercising more advanced types of behavior have better student learning outcomes (Kyriakides et al., 2009).

The importance of conducting effectiveness studies in developing countries

As discussed in chapter one, decades of research has revealed the significance of teaching factors as the most important predictor of student learning outcomes (Muijs & Reynolds, 2000; Scheerens & Bosker, 1997). Unfortunately, little of this strand of research has been conducted in developing countries, particularly in sub-Saharan African countries. As it stands now, research output on school and teacher effectiveness has been derived predominantly from the western and industrial school context (Riddell, 2008). The current study contributes in filling the gap with data on effective teaching from the perspective of Ghana.

As discussed above, the variance component of 55% in student achievement in mathematics found at the classroom level suggest that the classroom/teacher effect is much bigger in Ghana than in all other developed countries where effectiveness studies have been conducted during the last four decades (see Creemers, Kyriakides & Sammons, 2010; Scheerens & Bosker, 1997; Teddlie & Reynolds, 2000). Even after controlling for multiple background factors (e.g., SES and school context), the variance component at the classroom level was still much higher (i.e., 30.7%) than those reported in other effectiveness studies conducted in developed countries (e.g., Panayiotou et al, 2015; Creemers & Kyriakides, 2010).

The finding raises the importance of conducting school effectiveness studies in Ghana and other African countries. Heyneman and Loxley (1982) found that SES was more important than school factors in determining children's academic performance in economically developed countries, while the opposite pattern was found in developing countries. Similar results were reported by Park (2008), who discussed how the association of the home literacy environment on reading achievement varies from country to country. The current study provides new evidence that teaching quality might be important than SES in the developing school context. Further studies in Ghana (or other context of similar characteristics) using advanced research methods are obviously needed to determine whether the finding can be replicated.

Particularly, the relatively big variance component in achievement found at the classroom level suggest between school inequalities. Moreover, SES (i.e., the educational level of mothers and occupational status of fathers) were found to be statistically significant for student achievement. Although family SES is less amenable to policy in the short term, it is possible to understand how family SES affects school conditions and to use school conditions to compensate for differences in family SES (Hoff, 2003). Therefore, researchers can take advantage of the big differences between schools in Ghana as found in the current study and probably other African countries in studying differential school effectiveness.

Also, the finding (i.e., big variance component at the classroom level) suggest very much more room for further studies in Ghana to determine the factors that might explain the big variance component in achievement. If the statistical power as determined in the current study can be replicated in Ghana and other African countries, researchers can more easily investigate issues related with differential teacher and school effectiveness in the African countries. For example, using random slope models, researchers can take advantage to search for the extent to which teachers are equally effective for different groups of students since the variance component was higher in this study (i.e., Campbell et al., 2004; Kyriakides, 2005).

The impact of teacher factors on student achievement gains in mathematics

As was shown in chapter four, all the teacher factors and measurement dimensions of the dynamic model were found to have statistically significant effects on student achievement. For example, under the data from the high-inference instrument, Orientation had a statistically significant effect on achievement i.e. a coefficient value of 0.293 (0.083), explaining an additional variance in achievement of 2.8%; Structuring 0.214 (0.066), explaining an additional variance of 2.4%; Application 0.247 (0.072), explaining an additional variance of 2% (see Chapter four, Section 4.4.3: Table 9). Also, under the data emanating from the second-low inference instrument, the frequency dimensions of the five teacher factors (i.e., Orientation, Structuring, Application, and Questioning) explained an additional variance of 6.4%; the stage dimension 5.2%; the focus dimension 5.1%; the quality dimension 10.6%; and the differentiation dimension 4.7% (see Chapter four, Section 4.4.4:Table 10).

Particularly, the teacher factors were able to explain much more of the variance in achievement than the previous studies testing the dynamic model. For example, in a longitudinal study in six European countries (Belgium/Flanders, Cyprus, Germany, Greece, Ireland, and Slovenia), the additional variance in student achievement in mathematics explained by each of the eight teacher factors was attained at the range of 0.7% to 1.7% (Panayiotou et al., 2014). In the current study, the additional variance explained by each of the eight teacher factors was in the range of 2.0% to 3.5%. Moreover, the effect sizes (i.e., Cohen's d) of the teacher factors and their dimensions as emerged from using the observation instruments were also much bigger (i.e., .30 to .35) than those emerged in all earlier studies testing the validity of the dynamic model. Similarly, the meta-analyses of Seidel and Shavelson (2007) also found small effects sizes for teaching variables ranging from .01 to .04.

Another significant finding was that the factors related to direct instruction (e.g., time management, structuring) or constructivism (e.g., orientation, modeling strategies) all had statistically significant effects on student achievement. This finding empirically corroborates the theoretical underpinnings of the dynamic model which, by pursuing an integrated approach, incorporates factors from both instructional perspectives at the teacher/classroom level (kyriakides, 2008).

Based on the findings, it can be claimed that the teacher factors of the dynamic model are probably more important in the developing school context at least as found in the current study. Further studies in Ghana and other African countries are needed to determine whether the findings can be replicated. This can be done through longitudinal studies which could use the conceptual framework of the dynamic model. Randomized experimental studies can also be conducted to determine the effect sizes of the teacher factors. Other theoretical frameworks can also be tested to determine their generalizability. Similarly, domain specific strategies (e.g., use of representations, cognitive activation) can also be tested to determine whether effects on student learning outcomes can be found.

Measuring both quantitative and qualitative characteristics of teacher factors

As discussed in chapter three, the earlier theoretical and integrated models of educational effectiveness models developed in 1990s (i.e., Creemers, 1994; Schereens & Bosker, 1997; Stringfield & Slavin, 1992) were only concerned with the quantitative aspects of effectiveness factors. Kyriakides and Creemers (2009) demonstrated the need for the use of a measurement framework that incorporates both the quantitative and qualitative dimensions of the teaching. The current study also demonstrated the advantage of using both the quantitative and qualitative dimensions for measuring teaching quality. For example, under the second-low inference instrument, whereas the frequency dimensions of the five teacher factors (i.e., Orientation, Structuring, Application, Modeling and Questioning) explained an additional variance of 6.4%; the qualitative dimensions explained much more of the variance in achievement than the frequency dimension (i.e., 10.6%). Moreover, adding all the dimensions of the five teacher factors in one model explained an addition variance of 13.2%. The findings provide further support for the need for effectiveness studies to incorporate in their measurement framework both the quantitative and qualitative aspects of teaching. Particularly that the validity of the measurement instruments for measuring quality teaching in a developing country school context has been provided, future studies, especially in Ghana and other African countries can consider using the instruments for measuring quality teaching.

Using different approaches to measure quality of teaching

In view of the complexity of measuring the act of teaching, a triangulation of sources of evidence (e.g., classroom observation and the ratings of students on quality) is often needed in order to attain a valid and reliable data on teacher effectiveness (Berks, 2005; Hiebert & Grouws 2007; Hill et al., 2012). As indicated earlier, three instruments (i.e., High-inference, Second-low inference observation instruments, and a Student questionnaire) were used in measuring the quality teaching. It was assumed that using the two instruments which are comparable, together with the questionnaire would enable an exploration of whether similar dimensions of teaching behaviors can be identified as effective teacher classroom practices.

As was shown in chapter four, the CFAs for the data emanating from the high-inference instrument and the questionnaire fitted a one factor structure. With these two measurement tools therefore, it was not possible to determine the quantitative or qualitative aspect of teaching. Fortunately, with the data from the second-low inference instrument, it was possible to identify both the quantitative and qualitative aspects of the teachers' classroom behaviors. It was particularly possible with this instrument to measure subtle teacher behaviors in relation to the stage, focus, quality and differentiation dimensions of the teacher factors.

As far as the multilevel analysis is concerned, all the teacher factors under the High-inference observation instrument were found to have statistically significant effects on student achievement. Also, all the dimensions of the five teacher factors under the Second low-inference observation instrument were also significant for student achievement. However, under the data emanating from the Student questionnaire, with the exception Teacher assessment, and Teacher-student interactions that were significant at the 10% level, the rest of the teacher factors were not significant. This is in contrast with the earlier studies (e.g., Creemers & Kyriakides 2010; Panayiotou et al., 2014). The assumption was that students as the direct beneficiaries of the quality of teaching provided by their teachers should be able to identify effective classroom teacher behaviors (Kyriakides, 2005). However, a major disadvantage of using student questionnaires in measuring quality teaching is that students might not be capable of providing information on aspects of teaching such as a teacher's content knowledge and professional classroom practices (Goe & Croft, 2009).

As indicated in chapter three, the questionnaire was adapted and subsequently pilot-tested in Ghana to determine whether the items and factorial structure of the questionnaire were equivalent across different cultural groups (in this case Ghana). Moreover, the construct validity of the Student questionnaire was attained in the confirmatory factor analysis as discussed in chapter four. As discussed in chapter four also, the teacher factors under the questionnaire recorded very low standard deviations (i.e., 0.36 to 0.54). The very small values of standard deviations revealed that the statistical power for detecting effects of the teacher factors based on the questionnaire was very small.

Berks, (2005) posits that the use of multiple sources of measures on quality teaching build on the strengths of all sources, while compensating for the weaknesses in any single source. As it turned out, if not for the other two instruments (i.e., the high-inference, and second-low inference observation instruments), the effects of the teacher factors would not have been determined; for which a wrongful conclusion would have drawn that the teacher factors of the dynamic model are not relevant for student learning in Ghana.

A cultural factor may explain the fact that students were not in a position to distinguish between the most and least effective teachers since they may see teachers as authorities and are therefore less critical in reporting the behavior of their teacher. Prior studies in Ghana found that teacher practices "seems to be couched in authoritarian terms" (Pryor & Ampiah, 2003:40). Therefore, future effectiveness studies investigating the impact of teaching factors should consider essential to use observation instruments to measure teacher behavior. Future studies might also have to adapt the questionnaire to different types of scales (i.e., ranking scales rather than rating) which can make it easier for students to locate their teachers' teaching practices.

Implications for educational effectiveness theory

In using the conceptual framework of the dynamic model, the study contributes to the literature from the perspective of Ghana and sub-Saharan Africa. The study extends the evidence on the effects of quality teaching on student learning gains in mathematics. More specifically, further empirical support to the generic nature of the teacher factors of the dynamic model has been provided. It was particularly revealing that the teacher factors of the dynamic model are equally effective in an educational context such as Ghana where teaching and learning resources are relatively inadequate for education provision. Moreover, there were no interaction effects for class size. As reported earlier, the class size in the current study was 43 (SD =15), with as many as 88 students in some of the classrooms.

The findings have implications for theory. Based on the effect sizes attained for the teacher factors, it can be claimed the teacher factors are probably more important for teaching and learning in the developing school context. Further studies at the school level might also further help but here the effect of context might be stronger. Other researchers can take advantage to test the generic nature of their models. In so doing, the models that work in the context of developed countries can be tested to determine if they equally work in the developing school context. The Africa context, cultures and local school conditions can present both challenges and benefits. Partnerships agreements between researchers, and policy makers, educational leaders and schools can be easily reached for the mutual benefit of all parties. At the same time, this will require an investment of financial resources and the commitment of time on the part of researchers who intend to conduct such studies in Ghana.

Also significant is that the study reveals the limitations of the economic approach to research in which school inputs are the main focus. The commitment to improving quality primary education in sub-Saharan Africa has focused primarily on infrastructure (e.g. classrooms, equipment, learning materials), and less on how teacher education which can promote teacher competencies for meeting the learning needs of students (Moon, 2007). Studies of production function model can be useful for judging the effectiveness of schools and teachers and for policy alternatives, but they do not provide a complete or accurate picture of the determinant of learning outcomes (Hanushek, 2010). The production function model over-simplifies and misinterprets the complex nature of education, the teaching-learning processes and the overriding importance of teaching quality (Bennell & Akyeampong 2007). For example, cross-sectional studies in Ghana (e.g., National Educational Assessment, NEA) has consistently found school resources (i.e., electricity, teacher qualifications, teacher experience) to have statistically significant effects on student achievement in mathematics (MOE, 2014). However, of all the school input variables examined in the current study (e.g., school feeding, classroom furniture, teacher age, gender, and experience), only mathematics books available at school for teaching and learning turned out to be statistically significant for student achievement.

It is important to point out that the findings cannot be interpreted to mean that school resources are irrelevant for teaching and learning. There are many reasons why this inference should not be drawn. For a developing country such as Ghana where a considerable number of schools are still held under trees for lack of infrastructure, such a recommendation will be unwarranted. In Ghana, the teacher/student ratio at pre-schools and primary schools stands at 52:1 and 45:1 respectively (MOE, 2012). Class size in the current study was 43 (SD =15), with as many as 88 students in some of the classrooms. As indicated above, there were no interaction effects for class size in the current study. This finding cannot be interpreted to mean that the Government of Ghana should not invest in more school infrastructure to accommodate the many students in schools.

The fact that Government spending on resources does not seem to guarantee improved outcomes leads to a focus on policies that address the internal efficiency of schools (Taylor & Yu, 2009). More or better resources do not improve student achievement unless they change children's daily experiences at school (Murnane & Ganimian, 2014). Van der Berg (2008: 153) argues that school resources do not *necessarily* make a difference but that the ability of schools to convert resources into outcomes is the crucial factor, and that this is where the policy attention is required. Interventions that focus on improved pedagogy (especially supplemental instruction to children lagging behind grade level competencies) are particularly effective, and so are interventions that improve school governance and teacher accountability (Hanushek, 2010).

Also, the educational process is cumulative, in way that both historical and contemporaneous inputs influence current performance (Ehrenberg et al., 2001). Therefore, for policy decisions on school and teacher performance, researchers in Ghana should deploy more advanced research methods (e.g., longitudinal designs, VAM) in studying school and teacher effects on learning outcomes (i.e., Anderman et al., 2014; Creemers et al., 2010; Reynolds, 2014).

Also, as indicated in chapter one, efficiency problems within many African schools include student and teacher absenteeism, the ineffective use or the non-use of resources such as textbooks, low work ethic. Therefore, interventions that aim to sharpen the monitoring and accountability of schools is worthy of consideration by educational leaders in Ghana. More specifically, incentive structures and relevant teacher professional development programs that encourage better teaching and learning at the classroom level can supplement school resources for better student performance (Ehrenberg et al., 2001). Well-designed incentives for teachers can increase their effort and improve the achievement of students in very low performance settings, but low-skilled teachers need specific guidance to reach minimally acceptable levels of instruction (Murnane & Ganimian, 2014).

Implications for teacher professional development in Ghana

The concern about teacher quality in many parts of Africa and the role teacher education should play in its improvement has become an important subject on the continent (Lauwerier & Akkari, 2015). This has partly resulted from increasing evidence that despite gains in basic school enrolment, gains in student achievement have been more difficult to attain (Akyeampong, Pryor, Westbrook, & Lussier 2011). Poor instructional quality and lack of professional commitment by teachers have been recognized as particularly problematic, and thus raising the prospect that teacher education programme structure and content might be lacking in producing teachers capable of improving quality of basic schools (Akyeampong & Lewin 2002). Moreover, both pre-service and in-service training for teachers are superficial and inadequate with little impact on teacher classroom practices (Lauwerier & Akkari, 2015).

In Ghana, various policy recommendations (e.g., Colleges of Education, Act 2012, Act 847; Educational Review Committee Report, 2002) have highlighted the need for policy on teacher professional development (MOE, 2012). Currently teacher training is provided in forty one (41) teacher training colleges and two (2) universities (Institute of Education, 2013). The minimum qualification of teachers at the basic school level is Diploma in Basic Education awarded by the Colleges of Education. Teachers at the Senior High School levels are required to be holders of bachelor degrees awarded by the two universities. However, the number of qualified teachers in schools falls far short of the requirement. For example, data for the 2011/12 academic year suggested that only 44.8%, 66.3% and 82.9% of teachers at the kindergarten, primary school and junior high school levels respectively were qualified as professional teachers with requisite training (Asare, Mereku, Anamua-Mensah, & Oduro, 2012).

In this respect, the Ministry of Education recognizes that preparing teachers for quality education requires policies and practices which can make teaching an attractive profession (MOE, 2012). For example, the Education Sector Plan (ESP 2010–2020) emphasizes the need for in-service training (INSET) for teachers. The act established the National Teaching Council (NTC) with responsibility for setting and ensuring professional standards and a code of practice for professional development, registration and licensing of teachers. In addition, the ESP (2010–2020) captures the importance of continuous professional development for teachers and makes management of INSET obligatory for stakeholders at the community, school, district and national levels (Asare et al. 2012). Furthermore, a national policy has recently been developed with the principal aim to develop in teachers the ability to adopt reflective teaching approaches to enhance quality delivery in schools (MOE, 2012).

However, even for professional teachers, there is often a profound mismatch between the key competencies required of them to function adequately in the classroom, and the teaching skills they attain in their initial training (Akyeampong et al., 2011; Anamua-Mensah, 2008). Teacher training programmes places more emphasis on subject content knowledge than on the pedagogical knowledge and skills required for teaching (Adu-Yeboah, 2011). To achieve the ultimate aim of teacher education in Ghana (i.e., student learning) will require the adoption of a pedagogy that utilizes cohorts, applied knowledge, reflective practices, and field-based research (Amakyi & Ampah-Mensah, 2014). In addition, increasing opportunities for teacher continuing professional development can upgrade the skills and academic competences of practicing teachers to be effective in their practice (Akyeampong et al., 2011; Asare & Nti, 2014).

At the same time, budgetary allocations of the Ministry of Education mostly goes into paying teacher salaries with very little left for other investments including teacher in-service training (Nyavor, 2014). As a result, the state of in-service training in Ghana lacks the money, material and manpower which are imperatives for running any functional and sustainable in-service training programme that will equip teachers with current and best practices in teaching (Zimmerman, 2011). The few that exist mostly sponsored by Non-Governmental organizations

(NGOs) are often of a short duration which does not permit an evaluation of the impact of the programs on teacher professional development, and resultantly on student learning outcomes (Allsop et al., 2010). Also, the programs are often based more on the specific objectives of the sponsors than the specific needs of teachers (Amakyi & Ampah-Mensah, 2014**;** Asare & Nti, 2014). Moreover, there is often no strong synergistic relationship between the programs and the practical experiences of teachers or the theory of teaching (Anamua-Mensah, 2008).

In the light of the above observations, it can be recommended that teacher in-service programs in Ghana be reconsidered and possibly modified to make them more relevant to needs of teachers. Two dominant approaches to teacher professional are the Competency-Based Approach (CBA) and the Holistic Approach (HA) (Kyriakides et al., 2012): The CBA promotes teacher professional development that is concerned with specific and explicit teaching skills and strategies developed by experts, and teachers are expected to master each skill separately. According to the authors, the rather mechanistic procedure of providing training to teachers for each skill separately does not allow critical and creative thinking. On the other hand, the HA is focused on encouraging reflection of teaching practices, experiences, and beliefs. Emphasis is also given to approaches involving teacher reflective capabilities, analysis, interpretation, and decision-making, which can enable teachers to review critically their teaching practices.

However, research has shown that significant improvement in teacher instructional practice can take place when training programs are school driven, and based on the knowledge base of teacher effectiveness research (Antoniou, Kyriakides, Creemers, 2011; Demetriou & Kyriakides, 2012). According to Walter and Briggs (2012), professional development that makes the most difference to teachers are: 1) concrete and classroom-based; 2) brings in expertise from outside the school; 3) involves teachers in the choice of areas to develop, and activities to undertake; 4) enables teachers to work collaboratively with peers; 5) provides opportunities for mentoring and coaching; and 6) is sustained over time, and supported by effective school leadership.

School heads and teachers as the basic unit of change in schools should also be the initiators, designers, and directors of the change efforts in schools (Smith & O’Day, 1991). The traditional pattern in which teacher professional development is organized around discrete units of knowledge or skills, is given by experts, takes place outside the school, and has a limited duration, with little follow-up and practical application, has no chance of changing teacher beliefs or teaching habits (Marcelo, 2005, p:23). Field-based models of school-based training supported by learning materials has been strongly advocated as a way of closing the gap between theory and practice, and for raising the quality of teaching and learning in basic education (Mattson, 2006).

In this context, teacher professional development should draw from validated theoretical models of EER in order to develop teacher professional development programmes that will not only have an impact on improving teacher knowledge and skills but will ultimately raise educational standards (Antoniou et al., 2011): Teacher professional development should be focused on how to address specific groupings of teacher factors associated with student learning rather than with an isolated teaching factor or with the whole range of teacher factors without considering the professional needs of student teachers and teachers.

The dynamic model of educational effectiveness was developed in order to establish links between EER and improvement practices (Creemers & Kyriakides, 2006). The dynamic model promotes a dynamic approach to school improvement (DASI) in which the value of evidence based and theory-driven approach to school improvement is stressed. Specifically, the dynamic model gives emphasis to the development of school-based programmes that are aiming to improve the quality of teaching at classroom and the school learning environemt (SLE) that can contribute directly and/or indirectly to the improvement of teaching practice. Particularly, DASI is school and teacher driven. Its main features are as follows: 1) a participatory school self-evaluation (SSE) in which data is collected on school policy for teaching and for creating a school learning environment (SLE); 2) strategies for school improvement that places emphasis on the evidence stemming from theory and research; and 3) the collection of multiple data about student learning outcomes. Support for DASI as a valid approach to teacher professional development has been provided in longitudinal studies conducted in Cyprus (e.g., Antoniou, Kyriakides, Creemers, 2011; Demetriou & Kyriakides, 2012).

Therefore, since the teacher factors of the dynamic model were found to be important for student learning in Ghana, using the DASI approach, teacher professional development programs can be developed on the use of the teacher factors of the model for teaching in schools. Also, the programs when implemented should be evaluated to determine their impact on teacher professional development, and as well on how teacher professional development also impacts on student learning outcomes. Particularly, since it was found in the study that the qualitative aspect of teaching (i.e., focus, stage, quality and differentiation) is relatively low; the training should incorporate both the quantitative and qualitative aspect of teaching. A synergy between the quantitative and as well the qualitative dimensions of teaching can result in improved teaching and learning in schools.

It must however be emphasized that whiles training of this nature can be beneficial; its implementation has greater financial implications. Therefore, implementing such programs will require the commitment of the Ministry of Education, schools, and other collaborators in terms of budgetary allocations. Another major problem associated with school-based INSET initiatives is the apparent lack of capacity and infrastructural support structures in most schools (Asare et al. 2012). Therefore, in implementing the programs as suggested, an emphasis should also be placed on training school leaders on how to sustain the programs for sustainability. More importantly, the programs should be evaluated to determine their impact on teacher professional development, and how that impacts on student learning outcomes.

Suggestions for further research

In using the conceptual framework of the dynamic model, the study sought to determine the degree to which teaching processes identified as effective in the developed countries are equally effective in Ghana. In so doing, a contribution can be made for improving teaching and learning in schools. Overall, it can be concluded that the objectives of the study have been achieved. However, the study is not without limitations. As discussed earlier, not using the First-low inference observation instrument in the current study is a limitation since the instrument enables the collection of additional data on teacher-student, student-student interactions, and classroom management. Furthermore, cross-validation of the data on teaching quality was not possible since the classroom observations were carried out by only one observer (Hill et al., 2012).

Also, the fact that the study was for only mathematics limits the ability to understand how the findings might be if other subject domains such as language were explored (i.e., teaching quality might vary with the subject domain). Moreover, the long term effects of the teacher factors could not be determined since the study was for only one school year. Further studies in Ghana and other African countries are therefore needed to determine whether the findings can be replicated. This can be through the use of longitudinal designs using the conceptual framework of the dynamic model. Other subject domain areas such as language or other meta-cognitive and affective aims of education can also be explored to determine their effects on learning.

Furthermore, the most important decisions concerning the quantity and quality of teaching are taken at the school level by head teachers and not by individual teachers (van de Grift, 2007). As indicated in chapter one, teacher absenteeism is a major challenge in Ghanaian primary schools (Abadzi, 2007). The fact that in the current study the school level factors of the dynamic model (e.g., policy for teaching and learning) were not explored is another weakness of the study. The quantity of teaching (e.g., time on task and opportunity to learn) can therefore be an area of further research, but this will require some investment in resources since it can be more of a challenge to measure the quantity of teaching. Particularly that the teacher factors of the dynamic model have been found to be relevant for student learning in Ghana, further research exploring the effects on learning outcomes by the school level factors of the model can be an area of further exploration. It will however be important to take into account the African context, cultures and local school conditions under which teachers ply their trade. Also, when the suggested teacher professional programs as presented in the previous section are successfully implemented, randomized experimental studies can also be conducted to search for ways of using the knowledge base for school improvement purposes.

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Appendixes

Appendix A1: The Pre-test items

Dear student,

The study is for an academic purpose only**. Confidentiality in the use of the results is assured.**

We assure that your identity and the use of the results will be protected.

Name			**Student ID**	
Name of school		**Private**	**Public**	
Gender			F	M
District				

NOTE: The test is for one hour thirty minutes (**1 hour, 30 minutes)**

Instruction: There are 27 questions grouped in three sections.

Section A: In Section A, multiple choice answers are provided. Answer all questions by circling the right answer.

For example: Kofi has only one sister and one brother. He also has two cousins, one boy and a girl. How many sisters does Kofi have?

A. 1
B. 2
C. 3
D. 4

Section B: In Section B, you are required to put your answers in the spaces or empty boxes provided.

For example:

What is the name of your sister?

………………………..

Section A: Answer all questions by circling the right answer.

1) Round off 9,875,567 to the nearest hundred

A. 9,875,500

B. 9,875,570

C. 9,875,600

D. 9,876,000

2) Find the underlined placed digit value of 3 **<u>2</u>** 5 1 8

A. 2

B. 20

C. 200

D. 2,000

3) Find what 6 stand for in 461 753

A. 60

B. 600

C. 6,000

D. 60,000

4) Find an approximate estimate of 254 x 16

A. 2,500

B. 4,000

C. 4,600

D. 5,200

5) Find the Least Common Multiples (LCM) of 12 and 18

A. 2

B. 6

C. 36

D. 72

<u>Section B</u>: **Answer all questions by putting your answer in the space provided after each question. Show workings of how you arrive at your answers.**

6) Arrange the following numbers

a) From the biggest to the smallest number

38,446 38,357 48,338 18,325 58,456

..………. ……….. ……….. ………… ………….

b) From the smallest to the biggest number

445,651 135,662, 145,461 335,156 245,615

………… ……….. ………… ………… …………

7) a) What is the difference of the following ?

(i) 5, 050
$-$ 2,160

(ii) 546,356
$-$ 497,357

b) Find the following sums

(i) $5{,}548 + 2{,}865 + 3{,}432$ =…………………

(ii) $7{,}097 + 856 + 5{,}635$ = ……………….

8) List the following:

a) The factors of 16

………… ……………

b) Factors of 29 that are greater than 3

………………………

c) Multiples of 3 which are less than 18

………………………..

d) The set of prime numbers between 10 and 20

…………………………

9) Write the following as decimals

a) $\frac{1}{5}$ = …………

b) $\frac{5}{5}$ = …………

10) Write the following decimals as fractions

a) 0.7 = ……………..

b) 0.05 = …………..

11) Complete the following

a) $\frac{4}{5} = \frac{\quad}{15}$

b) $\frac{\quad}{10} = \frac{9}{30}$

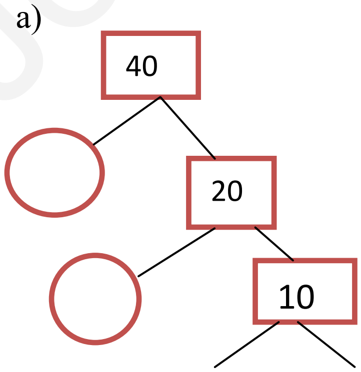
12) Multiply the following

a) 0. 005
$\times$ 14

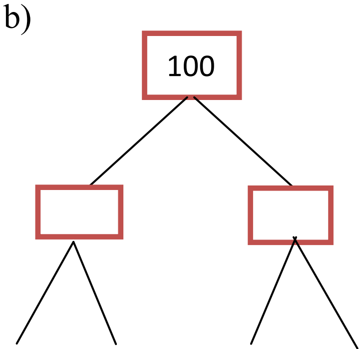
b) 42
$\times$ 9

13) Find the missing numbers in the factor trees below **(Put your answer in the empty boxes or circles)**

a)



b)



14) Find the missing numbers to complete the patterns below

a) $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, ------, ----- –, ----- – , -----–,

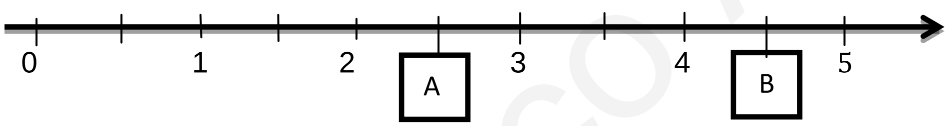
b) 2, 5, 3, 6, 4, 7, -------, -------, -------,

c) 10, 20, 10, 20, ------, -------, 10, 20, 10, 20, ------, -------,

d) 100, 200, 300, --------, --------, --------, 700, ------ -------, -------,

e) 650, 600, 550, --------, ---------, --------, 350, --------, --------, --------, 150

15) find the values to A and B in the numeric line below



A = ... B = ...

16) Convert the following from meters (m) to kilometers (km)

a) 2,500 meters (m) = …………………kilometers (km)

b) 5,000 meters (m) = …………………kilometers (km)

17) Convert the following from millimeters (mm) to meters (m)

a) 3,500 centimeters (mm) = ……............meters (m)

b) 1,500 centimeters (mm) = ……............meters (m)

18) Convert the following from milliliters (ml) to liters (l)

a) 6000 milliliters (ml) = ……………………liters (l)

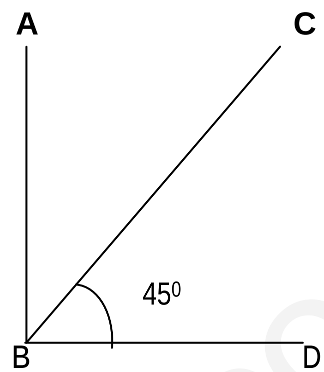
b) 3,000 milliliters (ml) = ……………………liters (l)

19) Convert the following from grams (g) to kilograms (kg)

a) 7, 900 grams (g) = ……………………….kilograms (kg)

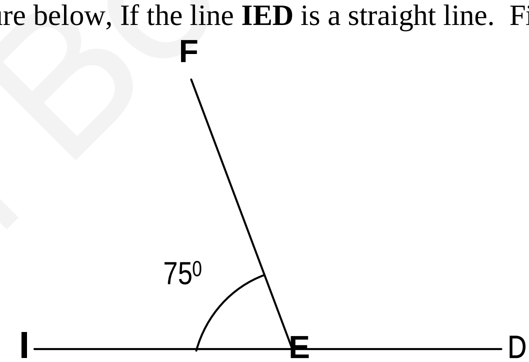
b) 6,500 grams (g) = ……………………….kilograms (kg)

20) a) In the figure below, If the line **AB** is vertical to line **BD**. Find the angle **ABC**



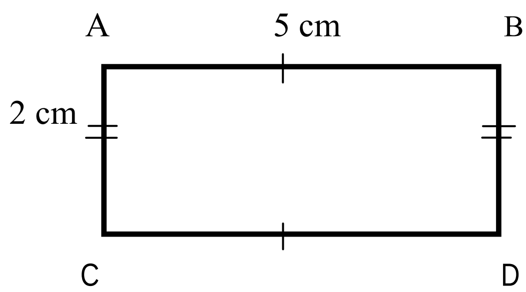
………………

(b) In the figure below, If the line **IED** is a straight line. Find the angle **EDF**



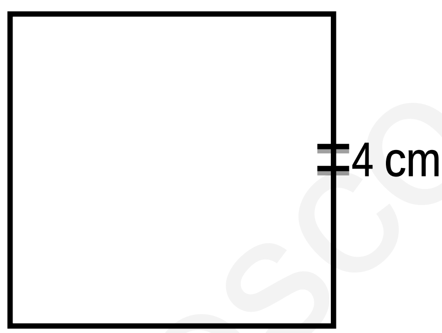
……………..

21) a) Find the perimeter of the rectangle ABCD below



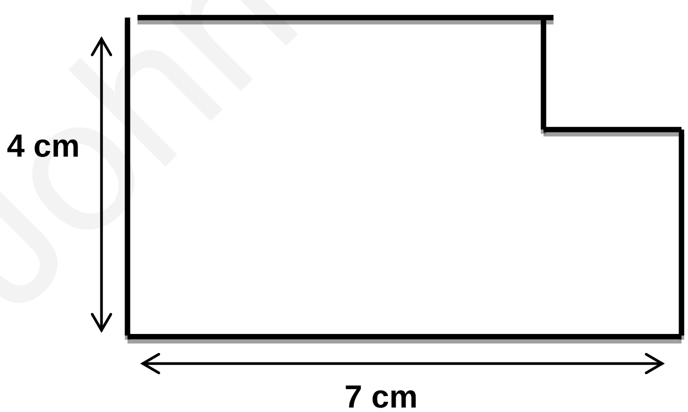
……………......

b) The figure below is a square. Find its perimeter



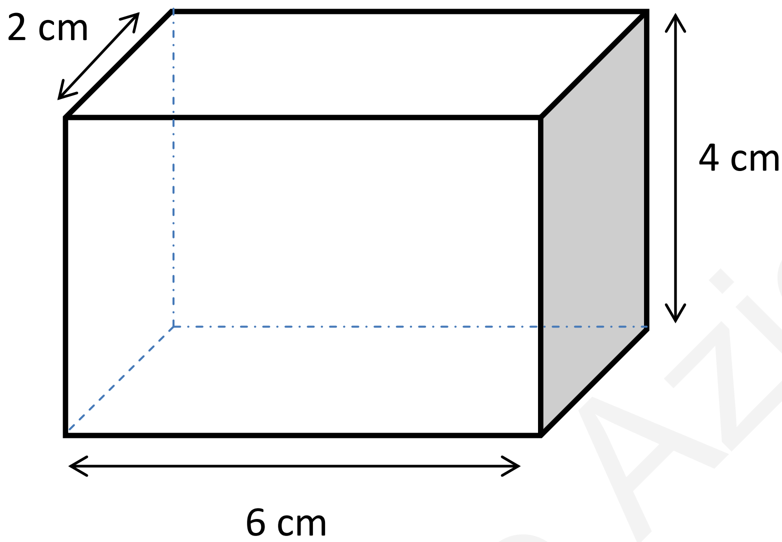
……………….

c) Find the perimeter of the figure below



………………………………

22) a) What is the volume of the rectangular prism below?



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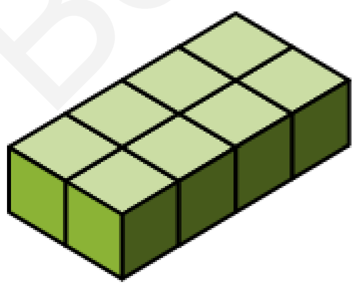
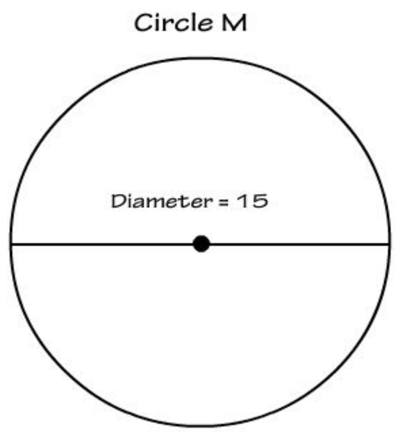
b) In the object below, each one of the cubes is 1 cm^3. Find the volume of the object?



………………………………………………

c) What is the radius of the cycle M in Centimeters?



…………………………CM

23) Library A has a stock of 1,356,501 books and Library B has 1,451,212 books.

What is the difference in the number of books between Library B and Library A?

……………

24) A shop keeper bought 250 school bags for sale at a total cost of GH¢ 1,000.00. What is the **cost price** of each school bag?

…………….

25) If Ama's exercise book contains 30 pages with 22 lines in each page, what is the total number of lines in Ama's exercise book?

……….......

26) A School Assembly Hall has a total number of 450 chairs arranged in **rows and columns**. If each row contains 25 chairs, how many chairs are in each column?

……….......

27) A boy in your class walked a distance of two (2) kilometers (km) in one (1) hour, and thirty (30) minutes. How many kilometers can he cover in 3 hours at the same pace?

…………

Read the table below and answer the questions that follow. Show workings of how you arrive at your answer.

No of pupils	Name	Age (years)	Height (cm)
1	Azure	15	115
2	Alhassan	13	102
3	Azumporka	12	110
4	Kofi	14	108
5	Ama	13	104
6	Nyaamah	11	103

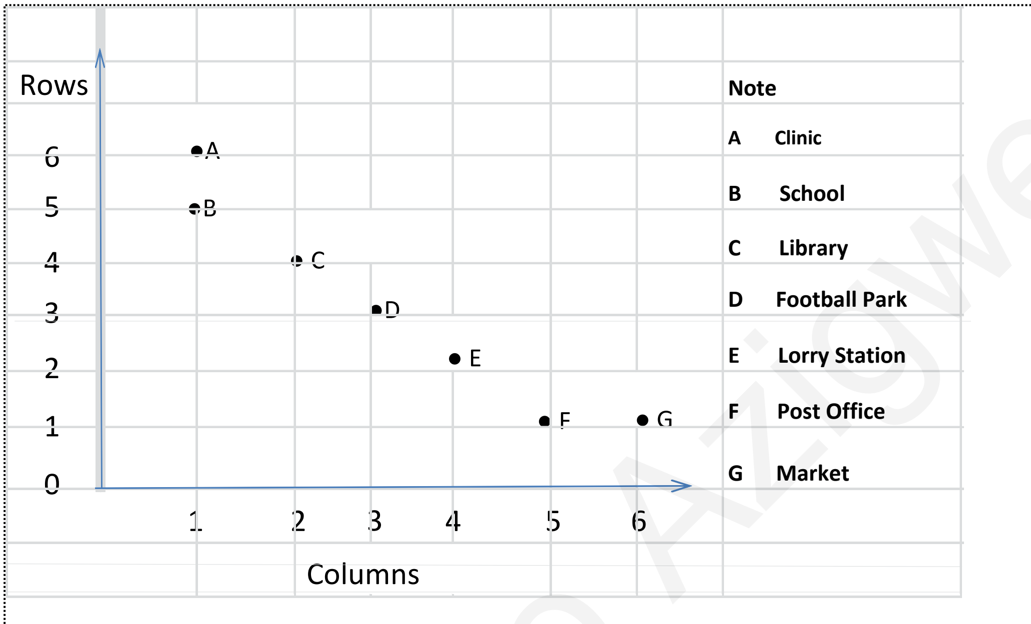
28) a) What is the mean age of the pupils in years?

……………

b) What is median height of the pupils in centimeters (cm)?

……………

Read the grid below and answer questions that follow.



29) a) What is the ordered pair that gives the location of the **Post office?**

....

b) What is the ordered pair that gives the location of the **School?**

....

Appendix A2. The Post-test items

This research is for an academic purpose only**. Confidentiality in the use of the results is assured.**

Name			**Student ID**	
School		**Private**	**Public**	
Gender			F	M
District				

NOTE: The test is for one hour twenty minutes (**1 hour, 20 minutes)**

Instructions

This test comprises of 25 questions grouped in three sections.

Section A: In section A, multiple choice answers are provided. Answer all questions by circling the right answer.

For example: Kofi has only one sister and one brother. He also has two cousins, one boy and a girl.

How many sisters does Kofi have?

A. 1
B. 2
C. 3
D. 4

Section B

In section B, put your answers in the spaces or empty boxes provided.

For example:

What is the name of your sister?

………………………..

Section C: In section C, graphs, tables or figures are provided. You are required to read them carefully and answer the questions that follow.

NOTE: Answer all questions

<u>Section A</u>: Answer all questions by circling the right answer.

1) Which of the following is closest to 8?

   A. 7.091

   B. 7.908

   C. 8.009

   D. 8.132

2) Find the Highest Common Factor (HCF) of 9 and 27

   A. 3

   B. 9

   C. 27

   D. 243

3) If the cost of postage stamp at the Post Office is 50p and an envelope is 25p. How much will it cost to post two (2) letters?

   A. GH¢ 1.00

   B. GH¢ 1.25

   C. GH¢ 1. 50

   D. GH¢ 150.00

4) What is the rule for the ordered pairs of (1, 2) (2, 5) (3, 10)

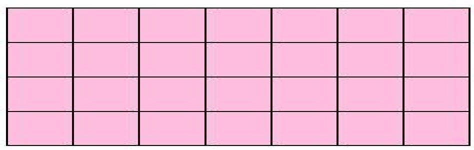
   A. X+1

   B. X^2 +1

   C. 2X+1

   D. X^3+1

5) Which expression shows the area of the rectangle?



A. 4 + 7

B. 4 + 7 + 4 + 7

C. 4 X 7

D. 4 X 7 X 4 X 7

<u>Section B</u>: Answer all questions by putting your answers in the spaces provided after each question

6) Analyze 63 into prime factors

…………………………………

7) Find the composite numbers which are greater than 26 but less than 34

……………………………….

8) Find the highest Common factor (HCF) of the following

64, 180, 30

………………………………

9) a) What is the difference of the following ?

(i) 546,356 – 47,357 = ……………………

(ii) 5,125, 050 $-$ 2,013,160 = ……………………

b) Find the following sums

(i) 5,548 + 2,865 + 3,432 =………………

(ii) 7,097 + 856 + 5,635 = ……………….

10) a) Add

(i) $\frac{2}{5} + \frac{1}{5} =$ ………

(ii) $\frac{1}{3} + \frac{2}{5} =$ ………….

b) Subtract

(i) $\frac{3}{9} - \frac{1}{9} =$ ………..

(ii) $1 - \frac{2}{5} =$ ………..

11) Change the following fractions to decimals

a) $\frac{3}{5} =$ ……. b) $\frac{1}{25} =$ ……..

c) $\frac{3}{10} =$ ……… d) $\frac{1}{4} =$ ……..

12) Compare the fractions below and put the appropriate sign $<$, $>$ **or** $=$ in the boxes.

a) $\frac{1}{4} \; \square \; \frac{3}{4}$ b) $\frac{5}{5} \; \square \; 1$

c) $\frac{1}{4} \; \square \; \frac{1}{3}$ d) $\frac{2}{4} \; \square \; \frac{1}{2}$

e) $\frac{5}{1} \; \square \; \frac{1}{5}$ f) $\frac{2}{4} \; \square \; \frac{1}{5}$

13) Multiply the following.

a) $\begin{array}{r} 23 \\ \times\ 0.5 \\ \hline \end{array}$

b) $\begin{array}{r} 0.005 \\ \times\ 9 \\ \hline \end{array}$

c) $\begin{array}{r} 0.0023 \\ \times\ 51 \\ \hline \end{array}$

d) $\begin{array}{r} 42 \\ \times\ 14 \\ \hline \end{array}$

14) a) Divide the following :

i) $137 \div 3 =$ ………….

ii) $1{,}550 \div 5 =$ ………….

b) Estimate and then, divide the following

i) $352 \div 2 =$……………

ii) $234 \div 5 =$……………

15) Change the following to percentages

a) $\frac{1}{2} =$ … … … … …

b) $\frac{1}{5} =$ ……………

16) Find the following:

a) 20% of 1,500 books = ………………..

b) 15% of 1,000 chairs = ………………..

17) A piece of wood was divided into two pieces of $2\frac{1}{6}$ m and $3\frac{1}{6}$ m long. What was the length of the wood before it was divided?

…………………………….

18) Kwame ate $\frac{4}{5}$ of a cake and Agyei ate $\frac{6}{15}$ of the same cake. How much of the cake was eaten in total?

………………………………

19) A farmer produced 345,000 bags of maize from his farm in 2010, and 250,000 bags in 2011 and 235,000 bags in 2012.

a) How much more maize was produced in the year 2011 than in the year 2012?

…………………

b) Calculate the total number of bags of maize produced within the three years?

………………..

20) A boy in your class walked a distance of two (2) kilometers (km) in one (1) hour, and thirty (30) minutes. How many kilometers can he cover in 3 hours at the same pace?

…………………………….

21) Add together the following:

a) 5 millimeters (mm) + 2 centimeters (cm) = ……………mm

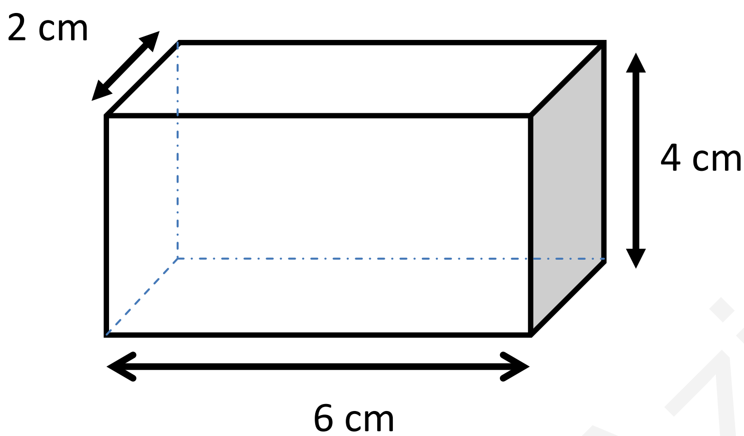
b) 10 meters (m) + 200 centimeters (cm) = ……………….m

22) Subtract the following:

a) 3.5 kilometers (km) − 1,200 meters (m) = …………………. m

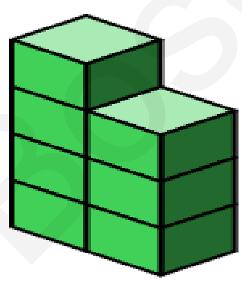
b) 15 kilometers (km) − 1,500 meters (m) = …………………...m

23) a) What is the volume of the rectangular prism below?



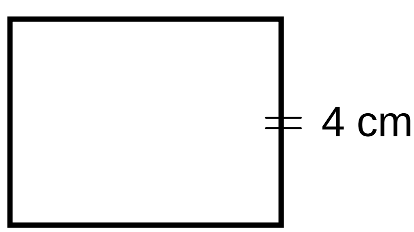
....

b) What is the volume of this object?



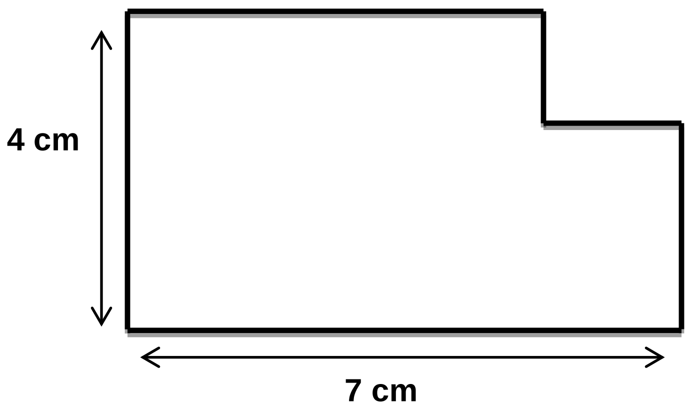
....

24) a) Find the perimeter of the figure below?



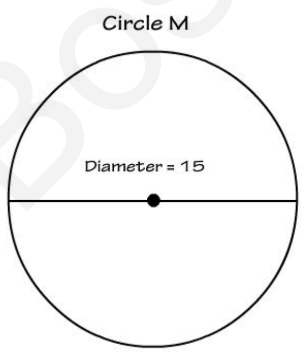
....

b) Find the perimeter of the figure below.



……………………………

c) What is the radius of the cycle M in Centimeters?



…………………………

<u>Section C</u>: **Answer all questions by putting your answers in the spaces provided after each question.**

Read the table below and answer questions 25.

No of pupils	Name	Age (years)	Height (cm)
1	Azure	15	115
2	Adongo	13	102
3	Azumporka	12	110
4	Kofi	14	108
5	Ama	13	104
6	Nyaamah	11	103

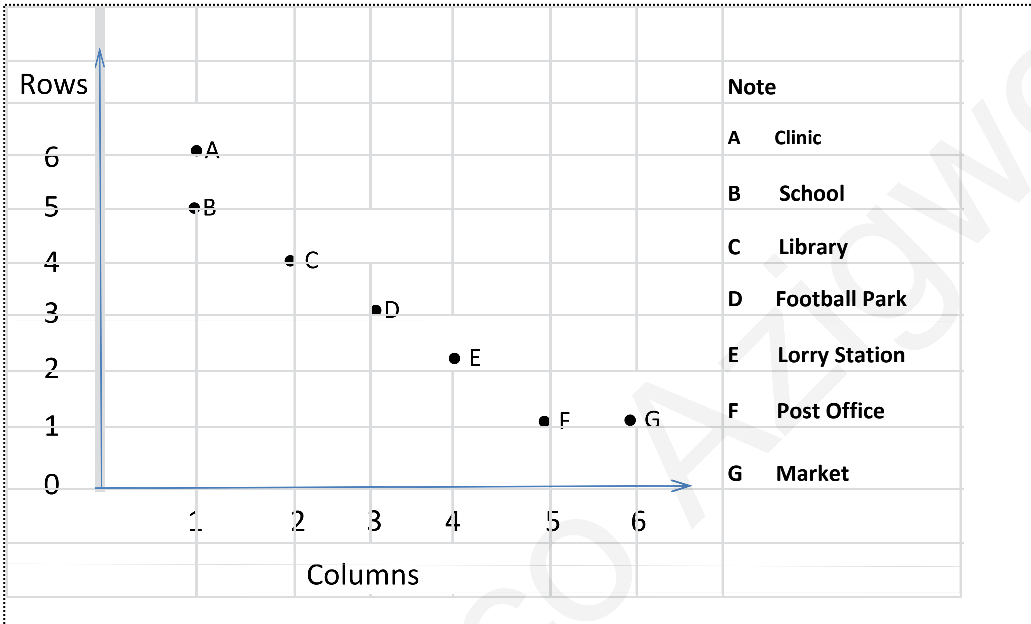
a) What is the mean age of the pupils in years?

....

b) What is median height of the pupils in centimeters (cm)?

....

Read the grid below and answer the questions that follow



26) a) What is the ordered pair that gives the location of the **Post office?**

....

b) What is the ordered pair that gives the location of the **School?**

....

Appendix B: Questionnaires: Student background characteristics

Dear student,

We are conducting a study on the quality of teaching in Mathematics. We would like to know your opinion about your family**. Confidentiality in the use of the information you provide is assured.**

Name of student ………………………………… School ……………………………………

Section A: Parental education and status

For each question tick only one box if applicable

1) **Gender** Male ☐ Female ☐

2) **Age** 11 years or below ☐ 12 years ☐ Above 12 years ☐

3) What is the **highest** level of schooling of your mother?
- No education ☐
- Middle school /Junior High School (JSS) ☐
- Secondary School/Senior High (SSS) /Vocational/technical/commercial ☐
- Post secondary education/Nursing Certificate, Agric Certificate ☐
- Tertiary education (Polytechnic, University) ☐

4) What is the **highest** level of schooling of your father?
- No education ☐
- Middle school /Junior High School (JSS) ☐
- Secondary School/Senior High (SSS) /Vocational/technical/commercial ☐
- Post secondary education/Nursing Certificate, Agric Certificate ☐
- Tertiary education (Polytechnic, University) ☐

5) My mother is a
- Trader in the market ☐
- Peasant farmer ☐
- Commercial farmer ☐
- Laborer ☐
- Contractor ☐
- Public servant (e.g. teacher, nurse, civil servant etc) ☐
- My mother is not employed ☐
- Others: Specify ☐

6) My father is a

- Trader in the market
- Peasant farmer
- Commercial farmer
- Laborer
- Contractor
- Public servant (teacher, nurse, civil servant etc)
- Driver
- My father is not employed
- Others: Specify

7) **My family house is located in** a village The town

8) **Type of family house: My family house is**

a) A bungalow
b) A local house shared with the extended family
c) Compound house shared with other families

My family house is built with

a) Cement blocks
b) Local material (bricks/mud /sand)
c) Local material (bricks/mud /sand

9) What is the **main** source of drinking water in your household? **(Tick only one box)**

a) Taps, tankers or hawkers
b) A standing pipe in our household
c) A well in our household
d) A borehole in our household
e) A borehole in the community
f) the damp/river/stream in the community
g) rain water

10) What is the **main** source of lighting in your household? **(Tick only one box)**

a) Kerosene lamps
b) Electricity from VRA
c) Solar
d) Other (specify)

11) What is the **main** source of cooking fuel in your household?

a) Kerosene stove
b) Electric cooker
c) Charcoal
d) Firewood

12) What type of toilet facility is used in your household?

a) Own Flush toilet
b) Shared flush toilet
c) Own pit latrine toilet
d) Shared pit latrine toilet
e) Bucket toilet
f) No toilet, we use the bush

13) **Durable household goods: (tick as many as applicable) Which of these items are in your household?**

A Car/truck	☐	Electric Iron	☐
A motorcycle/tricycle	☐	Box Iron (Charcoal)	☐
A Bicycle	☐	Fan (ceiling or standing)	☐
Electricity	☐	Telephone	☐
Solar power/energy	☐	Cellular telephone	☐
Refrigerator	☐	An electric or Gas cooker	☐
Deep freezer	☐	Kerosene stove	☐
Radio set	☐	Donkey Cart/truck	☐
Sewing machine	☐	Tractor mobile	☐
Lab top computer	☐	Grinding Mill	☐
Television set	☐	Desktop Computer	☐

14) Who usually lives at home with you? (Please tick one box on each row)

	Yes	No
a) Mother	☐	☐
b) Other female guardian (e.g. stepmother or foster mother)	☐	☐
c) Father	☐	☐
d) Other male guardian (e.g. stepfather or foster father)	☐	☐
e) Brother(s) (including stepbrothers)	☐	☐
f) Sister(s) (including stepsisters)	☐	☐
g) Grandparent(s)	☐	☐

15) **How many brothers and sisters do you have? If you have no brothers or sisters, please tick 'None'**

	None	One	Two	Three	Four or more
a) Older than you	☐	☐	☐	☐	☐
b) Younger than you	☐	☐	☐	☐	☐
c) Same age as you	☐	☐	☐	☐	☐

Section B: Home learning environment

Tick as many as applicable

16) What language do you speak at home most of the time?

I speak my local language most of the time at home ☐
I speak the English language most of the time at home ☐

17) Which of the following study materials are in your household?

A desk to study at ☐
A room of your own ☐
A quiet place to study ☐
A computer you can use for school work ☐
Story books and other books (e.g. Science, Geography etc) ☐
Mathematics books ☐

18) Circle the appropriate box to indicate the situation in your home learning environment **(Only one box)**

1: if this **never** happens in your home

2: if this **rarely** happens in your home

3: if this **sometimes** happens in your home

4: if this **often** happens in your home

5: if the situation described happens **almost always** in your home

	Never	Rarely	Sometimes	Often	Almost always
a) My parents believe it is important for me to study mathematics	1	2	3	4	5
b) My parents like mathematics	1	2	3	4	5
c) My parents help me in doing my home work	1	2	3	4	5
d) My parents inspect my books to be sure I have done my home work	1	2	3	4	5
e) My parents make sure I learn at home before I sleep	1	2	3	4	5
f) My parents study my terminal reports to check my performance	1	2	3	4	5
g) I tell my parent about my friends and our activities	1	2	3	4	5
h) I tell my parents about which of my friends I am meeting	1	2	3	4	5
i) My parents know where I go after school	1	2	3	4	5
j) When I leave the house my parents ask me where I am going	1	2	3	4	5
k) My parents know the parents of all my friends	1	2	3	4	5
l) My parents converse with me at home about school and	1	2	3	4	5

education					
m) I have extra lessons with a private teacher at home	1	2	3	4	5

Appendix C: Questionnaires: School inputs

Dear Teacher,

We are conducting a study on the quality of teaching in Mathematics. We would like to know the following on your professional profile**. Confidentiality in the use of the information you provide is assured.**

Name of teacher ……………………………………………..
School……………………………………
Class………………………….

Part A: Tick as applicable to you

Tick as applicable

1 **Gender** : Female ☐ Male ☐

2 **Is your age**
- Under 25 ☐
- Between 26 and 35 ☐
- Between 36 and 45 ☐
- Between 46 and 55 ☐
- Between 56 and above ☐

3 Years of teaching experience **(to the nearest year)**
- 0 - 3 years ☐
- 4 - 7 years ☐
- 8 - 13 years ☐
- 14 + years ☐

4 **Highest** Degree/Certificate obtained
- School Certificate (e.g. SSCE, GCE O Level, GCEA Level) ☐
- Teacher Certificate/Diploma from Training College ☐
- Bachelor of Education/or any other Bachelors Degree ☐
- Masters of Education or any other Masters Degree ☐

Part B: Indicate in the box provided by each question as appropriate.

1) Is your school part of the school feeding program? **YES [ ] NO [ ]**
2) Are your students given free uniforms? **YES [ ] NO [ ]**
3) Do you have access to electricity for academic work? **YES [ ] NO [ ]**
4) Do you have access to water? **YES [ ] NO [ ]**
5) Do you have a toilet facility in the school? **YES [ ] NO [ ]**
6) Do you have the following in your school for teaching and learning?
   a) Library **YES [ ] NO [ ]**
   b) Maths and other books **YES [ ] NO [ ]**
   c) Newspapers and other reading journals **YES [ ] NO [ ]**
7) Do you have computers in your school for teaching and learning? **YES [ ] NO [ ]**
8) Do you have your own copy of the Mathematics syllabus? **YES [ ] NO [ ]**
9) If NO, how often do you have access to the Mathematics syllabus?
   a) At the beginning of term when writing my scheme of work
   b) Only at weekends when preparing my lesson notes
   c) Any day during the week that I need it
   d) Other, Please specify…………………………………………….

Part C: Below is a list of classroom teaching and learning materials. Indicate the degree to which those materials are available in your school.

	Class inputs	**Not Available**	**Available But Inadequate**	**Available And Adequate**
a	Pupils exercise books			
b	Teacher's stationery (chalk, notebook, cardboard, etc)			
c	Pupils' Mathematics textbook(s)			
d	Students mathematical drawing instruments (ruler, compasses and protractor)			
e	Classroom condition and space			
f	Classroom furniture			
i	Resources for teaching math i.e. metre-ruler, tape measure, litter, weighing scale			

Appendix D: Student questionnaire of the dynamic model of educational effectiveness

Name of school: Class:

Dear student,

We are conducting a study and would like to know your opinion about the teaching of **Mathematics** in your classroom**. The answers you give will not be shown to your teachers, anyone else in your school or your parents.**

Please answer **all** of the questions. To answer the questions, please circle a number on each line. Please ask the interviewer if you do not understand what to do.

PART A

After each statement you read there are five numbers. Think carefully the number that most fits your opinion:

1: if this **never** happens in your class

2: if this **rarely** happens in your class

3: if this **sometimes** happens in your class

4: if this **often** happens in your class

5. if this almost always happens in your class

		Never	**Rarely**	**Sometimes**	**Often**	**Almost Always**
Q1	In Mathematics, we start the lesson with things that are easy to understand. As the lesson goes on what we cover is more difficult.	1	2	3	4	5
Q2	The teacher gives us exercises at the beginning of the lesson to check what we have learnt from the previous lesson.	1	2	3	4	5
Q3.	At the beginning of the lesson, the teacher starts with what we covered in the previous lessons.	1	2	3	4	5
Q4	My teacher helps us to understand how different activities (such as exercises, subject matter) during a lesson are related to each other.	1	2	3	4	5
Q5	A few days before the test, my teacher gives us similar exercises to those that will be in the test.	1	2	3	4	5
Q6	My teacher tells my parents how good I am compared to my classmates when they meet (or in my school report).	1	2	3	4	5

Q7	When the teacher is teaching, I always know what part of the lesson (beginning, middle, end) we are in.	1	2	3	4	5
Q8	When doing an activity in Mathematics I know why I am doing it.	1	2	3	4	5
Q9	When we go over our homework, our teacher finds what we had problems with and helps us to overcome these difficulties.	1	2	3	4	5
Q10	Our teacher has good ways of explaining how the new things we are learning are related to things we already know.	1	2	3	4	5
Q11	At the end of each lesson, the teacher gives us exercises on what we have just learned.	1	2	3	4	5
Q12	During lessons our teacher often covers the same things that we have already learned or done exercises in.	1	2	3	4	5
Q13	The teacher immediately comes to help me when I have problems doing an activity.	1	2	3	4	5
Q14	The teacher gives more exercises to some pupils than the rest of the class.	1	2	3	4	5
Q15	The teacher gives some pupils different exercises to do than the rest of the class.	1	2	3	4	5
Q16	The teacher gives all pupils the chance to take part in the lesson.	1	2	3	4	5
Q17	Our teacher encourages us to work together with our classmates during Mathematics lessons.	1	2	3	4	5
Q18	Some pupils in my classroom work together when our teacher asks us but some pupils do not.	1	2	3	4	5
Q19	Our teacher makes us feel that we can ask him/her for help or advice if we need it.	1	2	3	4	5
Q20	Our teacher encourages us to ask questions if there is something that we do not understand during the lesson.	1	2	3	4	5
Q21	During the lesson, our teacher encourages us and tells us that we are doing good work (i.e. she/he says to us "well done").	1	2	3	4	5
Q22	When we are working in teams, our teacher encourages competition between teams. (If you do not work in teams, please circle the number (1).	1	2	3	4	5
Q23	In Mathematics lessons, some of my classmates hide their work and answers so that none of the other pupils can see it.	1	2	3	4	5
Q24	When a pupil gives a wrong answer the teacher helps her/him to understand her/his mistake and find the correct answer.	1	2	3	4	5
Q25	When the teacher asks us a question about the lesson he/she asks us for the answer but does not	1	2	3	4	5

	ask us to explain how we worked out the answer.					
Q26	When one of the pupils in the class is having difficulties with the lesson, our teacher goes to help him/her straight away.	1	2	3	4	5
Q27	There are some pupils in the classroom that tease some of their classmates during Mathematics lessons.	1	2	3	4	5
Q28	I know that if I break a class rule I will be punished.	1	2	3	4	5
Q29	The teacher has to stop teaching the class because one of the pupils is being naughty	1	2	3	4	5
Q30	When a pupil gives a wrong answer in Mathematics lessons, the other children in the class make fun of her/him.	1	2	3	4	5
Q31	Our teacher keeps on teaching us even though it is break-time or the lesson is supposed to be over.	1	2	3	4	5
Q32	When I finish a task before my classmates my teacher immediately gives me something else to do.	1	2	3	4	5
Q33	When the teacher talks to a pupil after they have been naughty, sometimes after a while, that pupil will be naughty again.	1	2	3	4	5
Q34	We spend time at the end of the lesson to go over what we have just learned.	1	2	3	4	5
Q35	There are times we do not have the necessary materials for the lesson to take place (e.g., calculators, rulers)	1	2	3	4	5
Q36	There are times when I do not have anything to do during a lesson.	1	2	3	4	5
Q37	During a Mathematics lesson, our teacher asks us to give our own opinion on a certain issue.	1	2	3	4	5
Q38	Our teacher asks us questions at the beginning of the lesson to help us remember what we did in previous lesson.	1	2	3	4	5
Q39	Our teacher uses words that are hard to understand when he/she asks us a question.	1	2	3	4	5
Q40	When we do not understand a question, our teacher says it in a different way so we can understand it.	1	2	3	4	5
Q41	When a pupil gives wrong answer wrong to a question, our teacher gets another pupil to answer the question.	1	2	3	4	5
Q42	When I give a wrong answer to a question the teacher helps me to understand my mistake and find the correct answer.	1	2	3	4	5
Q43	Our teacher praises all pupils the same when we answer a question correctly.	1	2	3	4	5

Q44	When we have problem solving exercises and tasks in lessons, our teacher helps us by showing us easy ways or tricks to solve the exercises or tasks.	1	2	3	4	5
Q45	Our teacher lets us use our own easy ways or tricks to solve the exercises or tasks we have in Mathematics.	1	2	3	4	5
Q46	In Mathematics lessons, our teacher teaches us ways or tricks that can be used in different lessons.	1	2	3	4	5
Q47	Our teacher encourages us to find ways or tricks to solve the exercises or work s/he gives us.	1	2	3	4	5
Q48	I am there when my teacher talks to my parents for my progress.	1	2	3	4	5
Q49	When we are having a test I finish up within the time given to us.	1	2	3	4	5

PART B

In this part there are some statements. For each statement circle the answer that shows what usually happens in your class during Mathematics lessons.

We have tests

A. Every week

B. Every two weeks

C. Every month

D. Every term

E. Never

The teacher gives corrected tests back to us

A. Within a week

B. Within two weeks

C. Within three weeks

D. In a month or even longer

E. S/he never returns them.

The teacher explains to us what s/he expects us to learn from the Mathematics lessons. This happens:

A. in every lesson

B. in most of the lessons

C. only sometimes

D. very rarely

E. never.

When no student raises his/her hand to answer a question, the teacher usually (please choose one answer)

A. answers the question and moves to something else

B. repeats the question using the same words

C. restates the question using simpler words

D. asks an easier question

E. gives us hints or clues to help us answer the question.

You may write in the space below any other comments you may have to add to the answers above.

……
……
……
……

Thank you for your time

***Appendix E*. The High-Inference observation instrument of the dynamic model of educational effectiveness**

Observer's Name: ....
Teacher's Name: ....

School: .... **Date:**........................ **Time**: ....
Class: .... **Number of Students**:.................. **Subject**: ....
Lesson:..

DIRECTIONS: Use the scale to note the extent to which you agree with the following statements. (*Scale: 1:Minimum point ….. 4: Maximum point*).

	STATEMENT	**MINIMUM POINT**				**MAXIMUM POINT**
1.	The orientation activities that were organized during the lesson helped students understand the new content.	1	2	3	4	5
2.	The teacher explained how each activity served in fulfilling the aims of the lesson.	1	2	3	4	5
3.	The teacher explained the structure of the lesson in a way that was clear for the pupils.	1	2	3	4	5
4.	The teacher explained how the lesson of the day was linked to previous or to subsequent lessons of a unit.	1	2	3	4	5
5.	The teacher asked pupils to discover the purpose of doing specific activities.	1	2	3	4	5
6.	The teacher explained how the different activities were linked to each other.	1	2	3	4	5
7.	The teacher posed questions to link the lesson of the day with previous or subsequent lessons.	1	2	3	4	5
8.	The teacher posed revision questions to examine what pupils had	1	2	3	4	5

	understood from the lesson of the day.					
9.	The lesson transited from easier to more complex activities.	1	2	3	4	5
10.	The observed application activities referred (were linked) to the whole lesson.	1	2	3	4	5
11.	The observed application activities referred (were linked) to certain parts of the lesson.	1	2	3	4	5
12.	The observed application activities referred (were linked) to previous lessons as well.	1	2	3	4	5
13.	The application activities were nothing else but a replication of the activities that were organized during the presentation of the new content.	1	2	3	4	5
14.	The teacher asked pupils to deal with application exercises that were more demanding than those used for teaching the new concept.	1	2	3	4	5
15.	The teacher organised application activities that resulted in something that could be exploited for new learning.	1	2	3	4	5
16.	The teacher used to differentiate the application exercises that s/he gave to the pupils, according to their abilities.	1	2	3	4	5
17.	The teacher spent the teaching time on learning activities.	1	2	3	4	5
18.	The teacher challenged pupils to express their opinions on certain issues.	1	2	3	4	5
19.	During the lesson, the teacher gave only to some pupils the opportunity to participate in the lesson.	1	2	3	4	5
20.	The teacher encouraged pupils to co-operate with each other.	1	2	3	4	5
21.	During the lesson, pupils co-operated on their own initiative.	1	2	3	4	5
22.	Each pupil was engaged in individual work assigned to him/her by the teacher.	1	2	3	4	5
23.	The teacher encouraged competition between pupils.	1	2	3	4	5
24.	The teacher was interacting with pupils for the whole of the lesson.	1	2	3	4	5
25.	During the lesson, some pupils were co-operating with each other while others did not.	1	2	3	4	5
26.	Pupils interacted with each other during the whole of the lesson.	1	2	3	4	5

27.	Interaction between pupils contributed in achieving the lessons goals.	1	2	3	4	5
28.	The teacher discouraged the negative aspects of competition.	1	2	3	4	5
29.	There was pupil misbehaviour in the form of verbal harassment during the lesson.	1	2	3	4	5
30.	There was pupil misbehaviour in the form of serious verbal harassment during the lesson.	1	2	3	4	5
31.	There was pupil misbehaviour in the form of bodily harassment without putting others in danger during the lesson.	1	2	3	4	5
32.	There was pupil misbehaviour in the form of bodily harassment putting others in danger during the lesson.	1	2	3	4	5
33.	The lesson was interrupted by the misbehaviour of some pupils.	1	2	3	4	5
34.	The teacher was forced to make remarks to some students because they were talking to each other.	1	2	3	4	5
35.	In the case of misbehaviour in the classroom, the teacher ignored it deliberately.	1	2	3	4	5
36.	In the case of misbehaviour in the classroom, the teacher reacted and temporarily solved the problem.	1	2	3	4	5
37.	In the case of misbehaviour in the classroom, the teacher reacted and managed to solve the problem.	1	2	3	4	5
38.	In the case of misbehaviour in the classroom, the teacher reacted but did not manage to solve the problem.	1	2	3	4	5
39.	The lesson was interrupted by external factors.	1	2	3	4	5
40.	The aims that the teacher had set before the lesson were met during the 40-minute period of the lesson.	1	2	3	4	5
41.	The activities that were organised during the lesson helped each pupil to advance conceptually, according to his/her abilities.	1	2	3	4	5
42.	The majority of pupils were engaged in activities that were provided by their teacher.	1	2	3	4	5
43.	During the lesson the majority of the pupils were on task.	1	2	3	4	5
44.	Less able pupils considered the lesson activities as very difficult.	1	2	3	4	5
45.	More able pupils considered the lesson activities as very easy.	1	2	3	4	5

46.	The teacher used to pose questions that were clear for the pupils in terms of their content.	1	2	3	4	5
47.	The teacher used to correct pupils' misconceptions using their wrong answers.	1	2	3	4	5
48.	When teacher posed a question that was not clear for the pupils, she/he used to rephrased (restate) it.	1	2	3	4	5
49.	When teacher posed a question that was not clear for the pupils, she/he used to pose a simpler question to help pupils find the answer.	1	2	3	4	5
50.	Pupils were puzzled by the procedures or strategies that the teacher presented to them for overcoming problematic situations.	1	2	3	4	5
51.	When pupils faced certain learning obstacles or were confronted with a problematic situation, the teacher used to provide them with useful procedures or strategies for overcoming them.	1	2	3	4	5
52.	The procedures or strategies that teacher presented to the pupils to help them overcome the problematic situations they faced can be used in other lessons as well.	1	2	3	4	5
53.	The teacher used to explain the procedures and strategies to the pupils and then she/he requested using them.	1	2	3	4	5
54.	Pupils understood the procedures and strategies that were presented by the teacher.	1	2	3	4	5
55.	Pupils used on their own initiative, ways or strategies presented by the teacher, to solve similar problems.	1	2	3	4	5

If you have any further comments, please use the space provided below:

………
……

Thank you for your assistance

Appendix E. **Second low-inference observation instrument of the dynamic model of educational effectiveness (LI02)**

SECOND LOW-INFERENCE OBSERVATION INSTRUMENT (LIO2)

Observer: .... **Teacher**:..……………..………..............

School: ....…....…………………………………… **Date**:……................ **Time**: …...........................**Class**: .... **Number of**

(1) ORIENTATION																					
DIMENSIONS	**Instructions for coding**																				
Sequence of the activity	Ordinal number of the activity as observed during the lesson.																				
Duration	Duration in minutes.																				
Focus	*<u>Relation with:</u>* 1. an aim of the lesson 2. the day lesson 3. the unit/number of lessons.																				
Quality	1. typical 2. related to learning 3. students specify the aim(s).																				
Differentiation	Put down the sign √ for any type of differentiation you observe.																				

(2) STRUCTURING																					
DIMENSIONS	**Instructions for coding**																				
Sequence of the activity	Ordinal number of the activity as observed during the lesson.																				

Duration	Duration in minutes.																				
Focus	*Relation with:* 1. previous lessons 2. structure of the day lesson 3. the unit/number of lessons.																				
Quality: clarity	1. clear for the students 2. not clear for the students																				
Differentiation	Put down the sign √ for any type of differentiation you observe.																				

(3) APPLICATION																					
DIMENSIONS	**Instructions for coding**																				
Sequence of the activity	Ordinal number of the activity as observed during the lesson.																				
Duration	Duration in minutes.																				
Focus	*Relation with:* 1. only a part of the lesson 2. the whole lesson 3. the unit/a number of lessons.																				
Quality	1. use of the same activity to find a specific result, 2. activation of certain cognitive processes for the solution of more complex activities-algorithms.																				
Differentiation	Put down the sign √ for any type of differentiation you observe.																				

(4) NEW LEARNING-MODELLING																					
DIMENSIONS	**Instructions for coding**																				
Sequence of the activity	Ordinal number of the activity as observed during the lesson.																				
Duration	Duration in minutes.																				
Focus	1. can be used in the lesson only 2. can be used in the unit 3. can be used across units.																				
Quality: teacher 's role	1. Given by the teacher 2. guided discovery 3. Discovery																				
Quality: appropriateness of the model	1. Successful. 2. Not successful.																				
Quality: appropriateness of the model	1. Given by teacher after students have faced a problematic situation 2. Given before a problematic situation																				
Differentiation	Put down the sign √ for any type of differentiation you observe.																				

(5) QUESTIONING TECHNIQUES																					
DIMENSIONS	**Instructions for coding**																				
Sequence of the activity	Ordinal number of the activity as observed during the lesson.																				
Waiting time	Time given before answering																				
Focus	*<u>Relation with</u>*: 1. only a specific task 2. the whole lesson 3. the unit/a number of lessons.																				
Quality: type	1. product 2. process.																				
Quality: reaction if no answer from pupils (in case there is an answer put an X).	1. restate (easier words) 2. pose an easier question 3. move to another question or answers the question him/herself.																				
Quality: feedback-reaction to student	1. negative comment to incorrect and partly correct answers. 2. positive comment to correct answer only. 3. positive comment to correct answer and constructive comments to incorrect and to partly correct answers. 4. no comments.																				
Quality: feedback - reaction	1. teacher ignores the																				

about the answer	answer. 2. teacher indicates that the answer is correct or partly correct or incorrect. 3. students are invited to give comments on the answer.																				
Differentiation	Put down the sign √ for any type of differentiation you observe.																				

Appendix F. **Descriptive statistics: Second-low inference observation instrument**

Factors	Dimensions	Teaching activity in relation with	Average time used in minutes	Total number of activities	%
Orientation	Quantitative		**3**	**112**	
	Stage	(0=78.8, 1=21.2)			
	Focus	1. An aim of the lesson 2. The day lesson 3. The unit/number of lessons.		79 33 0	70.5 29.5
	Quality	1. Typical 2. Related to learning 3. Students specify the aim(s)		92 20 0	82 18 0
	Differentiation	1. Yes 2. No		23 89	21.6 79.4
Structuring	Quantitative		**4**	**170**	
	Stage	0= 59.1, 1= 34.6, 2=6.3			
	Focus	1. Previous lessons 2. Structure of the day lesson *3.* Unit/number of lessons		69 78 23	40.5 45.8 13.7
	Quality: clarity	1. Clear for the students 2. Not clear for the students		114 56	67.2 32.9
	Differentiation	1. Yes 2. No		37 133	21.8 78.2
Application	Quantitative		**12**	**268**	
	Stage	0 =17.7, 1=74.1, 2=8.2			
	Focus	1. Only a part of the lesson 2. The whole lesson 3. The unit/a number of lessons.		146 103 19	54.5 38.4 7.1
	Quality	3. Use of the same activity 4. Activation of cognitive processes		187 81	69 31
	Differentiation	1. Yes 2. No		119 149	34.4 65.5
Modeling	Quantitative		**6**	**361**	
	Stage	0 =2.3, 1=39, 2=58.7			
	Focus	1. Can be used in the lesson only 2. Can be used in the unit 3. Can be used across units.		203 121 37	56.2 33.5 10.2
	Quality 1: teacher 's role	4. Given by the teacher 5. Guided discovery 6. Discovery		212 78 71	58.7 21.6 19.6
	Differentiation	1. Yes 2. No		111 249	30.8 69.2
Questioning	Quantitative		**5**	**443**	
	Stage	0=11.9, 1=57.4, 2=30.7			
	Focus	1. Only a specific task 2. The whole lesson 3. The unit/a number of lessons		279 131 33	63 29.6 7.4
	Quality 1: type	3. Product 4. Process.		291 154	65.6 29.4
	Differentiation	1. Yes 2. No		130 313	29.3 70.6