UNIVERSITY OF CAPE COAST

THE EFFECT OF MULTIMEDIA COURSEWARE IN SOLVING COMMON FRACTIONS TO JUNIOR HIGH SCHOOL TWO PUPILS OF SUNYANI GARRISON SCHOOLS - GHANA

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BY

EMMANUEL EUGENE AMETEPEH

Dissertation submitted to the Department of Education of the College of Distance Education, University of Cape Coast, in partial fulfillment of the requirements for the award of Master of Education degree in Information Technology

JULY 2018

DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:.................................. Date:.................................

Name: Emmanuel Eugene Ametepeh

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature:............................ Date:.........................

Name: Dr. Benjamin Eduafo Arthur

ABSTRACT

The focus of this study was to investigate the computer proficiency of students and the effect to which its integration will affect instruction. It also determined if there exist significant difference in the mean score between students in the experimental group and control group on the post-test. The study used Technological Pedagogical Knowledge Framework by Mishra and Koehler (2006) as the conceptual base. The population was composed of 120 junior high school pupils of JHS two (2) from three Garrison clusters of schools in the Sunyani Municipality. Using a pre-test and post-test and questionnaire adapted, data was collected to address the research questions. The findings revealed that most of the students had positive attitude towards learning of mathematics. Furthermore, a mean of means of M = 3.41; and SD = 0.71 was obtained to signify that students in the experimental group had interest and satisfaction with the use of an interactive multimedia courseware in learning mathematics. Also, the result from the paired sample t-test showed that there was no statistical significant difference between the mean performance of pupils using post-test by control and experimental groups. The study recommends that Mathematics teachers should be made to attend more professional and refresher course and programmes on the use of interactive courseware for the teaching and learning of Mathematics.

ACKNOWLEDGEMENTS

I am highly appreciative of all who have helped me in diverse ways to make this dissertation a success. First and foremost I thank my supervisors, Late Dr. Emma Dawson Brew (who died untimely in the process), Dr. Paul Nyagorme (who is the coordinator of the M.Ed IT unit and also took over the supervision work) and Dr. Benjamin Eduafo Arthur (who made a final perusal to my work) for their intellectual guidance throughout the whole process and the meticulous approach adopted by Dr. Nyagorme in accessing my work. I must state that their contributions were significantly relevant to the success of the work.

Secondly, I acknowledge the kind-hearted supports of the Education officer of the Garrison school of 3BN, Major Hadjah. Not forgetting the heads and their assistants of the selected schools. I also say thank you to Mr. Bada Bingrin Jacob, Mr. Derry Dominic, Mr. Osei-Tutu Moses, Mr. Bonah Sampson, all mathematics teachers and Mr. Emmanuel Ackon, Mr. Bashiru Mohammed who are ICT instructors at the cluster of schools for providing assistance to the researcher and the students during the process.

My appreciation is also extended to my family for keeping faith with me all this while.Last but not the least, I want to express my heart-felt gratitude to my comrades who have been here before me for their encouragement not forgetting Miss. Mercy Mensah who generously provided me with a Laptop Computer which I used for this study.

DEDICATION

To my former school; Forces Basic School and the other three schools which form 3 Garrison cluster of schools.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

This study is purposed to bring to the attention of curriculum developers, mathematics teachers and other stakeholders in education the need to emphasis more on the teaching of the higher ability thinking skills such as application and reasoning. The focus on the teaching of the low ability skills and not giving much attention to the high ability skills has affected the performance of basic school candidates in examinations over the years. This trend could have a ripple effect on the nation's human resource development if not addressed. Other researchers have made much effort in ascertaining the effectiveness of using multimedia courseware as a medium of instruction in mathematics topics such as multiplication of common fractions, Algebra, etc. This study will provide the theoretical basis for curriculum developers and educational administrators an appropriate practical teaching approach (collaborative method) when multimedia courseware is used in the teaching and learning process.

Background to the Study

A catch phrase in education today is technology integration. The call to integrate Information and Communication Technology (ICT) in education has become a major concern to many countries all over the world. This is so because the importance of integrating technology in classroom instruction cannot be over emphasized. According to the Ministry of Education, Youth and Sports (MOEYS) and the Ghana Education Service (2002), integrating technology in classroom instruction ensures greater motivation, increases self-esteem and confidence. It also enhances good questioning skills, promotes initiative and independent learning, improves presentation of information or output, develops problem solving capabilities, promotes better information handling skills, increases focus time on task and improves social communication skills.

Computers have become the most useful tool in Ghana for the past two decades if not more. Many institutions have taken advantage of its immergence and the significant role it plays in enhancing work efficiency. Some of these institutions include the corporate world, industry players and as well as in governance. Instances of these are the biometric systems, the electronic banking, the e-pay slip systems and a lot more.

In the pedagogical settings, connection between ICT as a subject and the integration of it in teaching other subjects is yet to be realized fully. Efforts have been made by successive governments towards the improvement of the standard and performance of education. On the average; the performance of students over the years does not justify the effort put in the development of education.

The basic education certificate examination over the years shows pupils performance and how it relates to this study.

Table 1: Basic Education Certificate Examination (2004 - 2009)

Year	No. of districts	% of candidates with Average 6 – 30	> 30	National Average	% of Candidates with Average 6 – 30 above Nat. Ave &Dist.
2004	110	61.2	38.8	61.18	25 (22.7%)
2005	110	61.6	38.4	61.59	24 (21.8%)
2006	113	61.9	38.1	61.91	26 (23.0%)
2007	138	61.3	38.7	61.28	39 (28.3%)
2008	138	62.2	37.8	62.17	42 (30.4%)
2009	138	62.4	37.6	62.42	47 (34.1%)
Average	**124.5**	**61.8**	**38.2**	**61.65**	**34 (26.7%)**

Source: field survey, 2017

Table 1 shows the summary (National and the districts percentage of candidates with Aggregate 6 to 30) of the performance of pupils in the Basic Education Certificate Examination (BECE) from the West African Examinations Council (WAEC).

Since 2004 when the Ghana Education Service instituted the grading of performance of the various districts in terms of the national qualifying admission rate into the Senior High Schools (SHS) based on aggregate 6 to 30, the number of districts above the national aggregate has never exceeded 35%. The highest was achieved in 2009, where the national average was 62.42% and out of the 138 districts in Ghana, only 47 (i. e. 34.05%) had above the national average of 62.42%.

The General Standard of Mathematics at the Basic Education Level in Ghana

Trends in International Mathematics and Science Study (TIMSS) are series of studies undertaken once every four years by the International Association for the Evaluation of Educational Achievement (IEA). Trends in International Mathematics and Science Study monitor trends in mathematics and science at two levels: fourth grade (primary 4) and eighth grades (JHS 2). The goal is to provide comparative information about educational achievement across countries to improve teaching and learning in mathematics and science. The group's mathematics test for the eighth and fourth grades was designed to enable reporting on the five content areas in accordance with TIMSS' mathematics framework. These five content areas are:

1. Number (whole numbers, fractions and decimals, integers, ratio, proportion and percent) "At grade 4, integers are not included and the last topic includes only simple proportional reasoning".
2. Algebra (patterns, algebraic expressions, equations and formulas, relationships) "grade 4, algebraic expressions is not included".
3. Measurement (attributes and units, tools, techniques and formula)
4. Geometry (lines and angels, two and three – dimensional shape, congruence and similarity, locations and spatial relationship, symmetry and transformations)
5. Data (data collection organization, data representation, data interpretation, uncertainty and probability) "At grade 4, uncertainty and probability is not included".

Table 2: TIMSS Grade Eight (JHS 2) Mathematics Result for Ghana

Year	Number	Algebra	Geometry	Data	Number of countries	Rank	TIMSS Scale Average
2003	289	288	262	293	48	48	467
2007	310	358	275	321	56	55	500
2011	321	358	315	296	42	42	331

Source: Field data, 2016

Ghana participated in the eighth grade level (i.e. JHS 2) in the third, fourth and fifth of TIMSS in 2003, 2007 and 2011 respectively. Whereas, Ghana's performance in 2007 was better than that of 2003, that of 2011 was worse in performance. The content area scale averages for the three years were below the TIMSS scale average and the low international benchmark (400). This means that Ghana's performance was low across the entire content as shown in Table 2 below:

Table 3: TIMSS 2007 International Benchmark

Scale Average	International benchmark
625	Advanced International Benchmark
550	High International Benchmark
475	Intermediate International Benchmark
400	Low International Benchmark

Source: Mullis, Martin, & Foy, 2008

Ghana took part in the eighth grade level in 2003, 2007, 2011 & 2015 (not yet ready) the results showed that, Ghana's average performance in all three years were below the TIMSS scale average and the low international benchmark (400). This means that Ghana's performance was low across the entire content domain.

Table 4: Achievement in Mathematics Cognitive Domain - 2011

Country	Overall Average Scale Score	Knowing		Applying		Reasoning	
		Average Scale Score	Difference from Overall Average Scale Score	Average Scale Score	Difference from Overall Average Scale Score	Average Scale Score	Difference from Overall Average Scale Score
Ghana	331	332	1	316	-15	324	-7

Source: TIMSS 2011 International Results in Mathematics

TIMSS 2011 International Results in Mathematics

Similar to the results for the content domains, generally, TIMSS 2011 participants with the highest mathematics achievement overall also had highest achievement in the cognitive domains, although most countries showed a relative strength in one cognitive domain or another. Across the countries participating at the eighth and ninth grades, approximately the same number performed relatively higher in knowing than in mathematics overall as performed relatively lower. However, compared to mathematics overall, Ghana performed relatively higher in knowledge than applying and reasoning.

The average percentage correct in the cognitive domains was 49% for knowledge (refers to the student's knowledge base of mathematics facts, concepts, tools, and procedures), 39% for applying (focuses on the student's ability to apply knowledge and conceptual understanding in a problem situation), and 30% for reasoning (encompasses unfamiliar situations, complex contexts, and multi-step problems) at the eighth grade. This goes a long way to affirm the fact that Ghanaian pupils lack the ability to apply the knowledge of concepts and principles they acquire.

Situation of mathematics achievement at primary school level in Ghana

The National Education Assessment (NEA) conducted a standardised achievement multiple – choice test country wide for Primary 3 (P3) and Primary (P6) pupils in 3% random sample of all primary schools in Ghana. The test was in English and Mathematics. The broad skill areas tested in NEA for Mathematics includes:

1. Number and Numeracy
2. Basic Operation
3. Measurement
4. Shape and Space
5. Collecting and Handling Data

Two cut – off score were established to provide useful information regarding pupils' performance and system effectiveness. Minimum competency describes pupils reaching 35% and proficiency level identifies those reaching 55% of the total score on the test. The proficiency level of 55% shows that a pupil has learned the curriculum for the grade level (class) to the degree necessary to work at next grade level.

A sample of four hundred and twenty-three primary schools (423) were selected and tested in the 2005 administration of the National Education Assessment (NEA) (2005). The 423 primary schools represented a sampling fraction of 3% of all public primary schools in Ghana. The percentage of pupils meeting the minimum-competency level was higher than those reaching the proficiency level for Mathematics in both P3 and P6. Table 4 shows a summary result of NEA 2005.

Table 5: Pupils Meeting the Minimum Competency and Proficiency Level

Level	Subject	Minimum Competency 35%	Proficiency 55%
Primary 3	English	50.5%	16.4%
Primary 3	Mathematics	47.2%	18.6%
Primary 6	English	63.9%	23.6%
Primary 6	Mathematics	42.7%	23.6%

Source: Adu, 2006

The national results of the NEA demonstrate that the performance of pupils was weak in both Primary 3 and 6 levels in English and Mathematics. The mean scores percentage in Mathematics for P3 and P6 were all below that of English except the primary 3 proficients where, the mean score percentage in mathematics was 18.6% while that of English was16.4%.

This result indicates that, primary schools in Ghana face some difficulties in the teaching and learning of Mathematics.

Difficulty in learning Fractions

Ghanaian basic school pupils have difficulty in solving fraction questions which involves the use of Bracket, order, division, multiplication, addition and subtraction (BODMAS). It deals with the application of the mathematical operations which is the basis of mathematics progression. Hence, the attempt to apply the BODMAS principle in simplifying fractions is much more a complex situation to pupils. Teachers and researchers typically describe the teaching and learning of fractions as a challenging area in the mathematics curriculum. [Gould, Outhred, and Mitchelmore, (2006); Hiebert, (1988); National Assessment of Educational Progress (NAEP)]. The results of multiple assessments of the US National Assessment of Educational Progress (NAEP) dating 1978 to 1997 have shown that many children do not seem to possess basic fractional understanding. Mathematics being one of the most important subjects for life formation, it is necessary to get the basis right.

The Value of Courseware in Education

Managed courseware and electronic portfolios benefit both the teacher and the student, in terms of motivation and variety of manipulative materials. This promotes learning and self-assessment (Inkrott, 2001). A report titled Idaho Technology Initiative (Penuel & Means 2000) concluded that there exists enough evidence to say that technology has significant benefits on educational performance. Anamuah-Mensah, Mereku and Asabere-Ameyaw, (2004) in a presentation, 'Comparative analysis of performance of eighth graders from six African countries' on the outcome of the 2003 TIMSS result stated five contextual factors that influenced the poor performance. One of the five contextual factors was 'little use of technology (that is, computers and calculators in the science and mathematics curricula).' This meant that an increase in the use of technology will positively influence pupils' performance in mathematics and to a large extent, science.

The place of mathematics in the school curriculum manifests itself in it utilitarian value. The value of this utilitarianism is seen from the framework of computations. Among the framework of basic mathematical computations are the topics of Order/Exponent, Division, Multiplication, Addition and Subtraction (BODMAS). The abysmal performance in mathematics of basic school students (Grade 8 also called Junior High School [JHS 2]in Ghana) is evident in the results of the trends in International Mathematics and Science (TIMSS) 2003 and 2007 (Anamuah-Mensah & Mereku, 2005; Appiah, 2010) as well as in the Basic Education Certificate Examination (BECE) (West Afri can Examination Council[WAEC], 2007, 2008, 2009, 2010, 2011).

The reason being that students are unable to understand the principles behind the calculation of BODMAS and hence their inability to work out questions pertaining to BODMAS.

Statement of the Problem

It is expected that majority of BECE candidates who sit for examination yearly should perform above the national average of 62.42%. This is because, examiners set application questions most at times to reflect high thinking abilities of pupils for academic progression. Curriculum developers in the past have emphasised through the syllabus that there is the need for students to be encouraged to apply their knowledge. Unfortunately, it has been realized that majority of mathematics teachers still teach the low ability thinking skills of knowledge and understanding and ignores the higher ability thinking skills such as application and reasoning.

This situation is becoming more alarming and needs urgent attention to reverse the trend. It also has national implications if not addressed, because it will gradually decrease the Ghanaian Science, Technological and Architecture work force. Hence, the need to research into what bring about the low performance to remedy the situation for future progression and cohesion.

Purpose of the Study

The purpose of this study is to find out the effect of using multimedia courseware in teaching BODMAS concept to junior high school JHS 2 pupils in 3 Garrison cluster of schools in the Sunyani Municipality. Specifically, the study aims to:

1. assess the attitudes of the students towards mathematics as a subject.
2. identify students' cognitive levels of behaviour towards the concept of BODMAS.
3. ascertain the influence and effectiveness of interactive Multimedia Courseware on JHS 2 pupils' performance on the application of BODMAS in simplifying fractions.
4. find out pupils' interest with the use of an interactive Multimedia Courseware in the teaching of BODMAS concept.

Research Hypotheses

H0 1: There is no statistical significant difference in the mean scores of students in the control group on the pre-test and the post-test.

H0 2: There is no statistical significant difference in the mean scores of students in the experimental group on the pre-test and the post-test.

H0 3: There is no statistical significant difference in the mean score between students in the experimental group and control group on the post-test

H0 4: There is no statistical significant difference in the mean scores of male and female students in the experimental group on the interest with the use of an interactive Multimedia Courseware in the learning of BODMAS concept.

Significance of the Study

The findings of this study will be useful to teachers, parents and curriculum developers. This study is hoped to provide an insight on interactive multimedia courseware used as a learning medium. Teachers will be opened to alternative approach of teaching that brings fun to pupils and easy ways of understanding and applying mathematics concepts. Parents will also save themselves the headache of finding teachers to teach their wards at home, because pupils will understand what will be taught. Since the courseware is interactive in nature, parents can acquire the courseware for their wards to engage them at home. This study will provide information to curriculum developers and educational administrators an appropriate teaching approach (collaborative method) when multimedia courseware is used as the teaching and learning process.

Delimitation of the Study

The study was delimited to 3 Garrison cluster of schools, which is made up of four schools out of over 50 basic schools in the Sunyani municipality with the reason that, they have the ICT facility that will be used for the research. Also, the results of the study can be replicated to other schools with the same characteristics. The JHS 2 students were selected because they had completed and have applied about 90% of the basic operations (+, –, ÷, ×, ^) which forms the content area of the BODMAS concept. Specifically, fractions were treated in Primary 2 – 6 and were repeated and enhanced in JHS 1.

Limitations of the Study

In spite of the arduous work by the researcher to conduct the study thoroughly, the main limitation was the short fall of computers in most basic schools. Also, the experimental nature of the research made it impossible for this study to involve more schools. Hence, only 3 Garrison cluster of schools formed the population for the study. This selection limits the strength of generalization. The use of multiple research instruments for data collection enrich information than the sole use of one instrument, but the use of multiple instruments comes with its own challenges which includes the difficulty it poses to planning and implementing one method by drawing on the findings of another. It may also be unclear on how to resolve discrepancies that arise in the interpretation of the findings.

Organization of the Study

The study was organized into five chapters. The first chapter deals with the general introduction of the study, background to the problem, statement of the problem, purpose of the study, research questions, hypotheses, significance of the study, delimitation and limitation of the study. Chapter Two of the study deals with the review of related literature. It covered the theoretical framework, conceptual framework and empirical review. Chapter Three looked at methodology, specifically, research design; population; sample and sampling procedure; research instrument; data collection procedure and data analysis. Chapter Four of the study deals with the presentation of results/findings of the study. Chapter five covers the summary of the study, conclusions based on the findings, and recommendations.

CHAPTER TWO

LITERATURE REVIEW

Overview

This chapter of the research work focuses on materials written by other researchers in the same or related area of study. It involves the systematic identification, location and analysis of documents containing information related to the research problem (Amedahe, 2002). This chapter reviews the following areas related to the study: History of Courseware, Courseware Design, Multimedia Courseware, Educational Theories, Traditional Teaching and Learning situation, Studies on the Effectiveness of Courseware, Concept of BODMAS.

History of Courseware

The use of computer hardware and software in education dates to the early 1940s, when American researchers developed flight simulators, which used analogue computers to generate simulated on board instrument data. During the period of the World War II to the mid-1970s, educational software was dictated by the hardware, usually mainframe computers, on which it ran. Pioneering educational computer systems in this era included the Programmed Logic for Automated Teaching Operations (PLATO) system, developed at the University of Illinois and Time – shared Interactive Computer – Controlled Information Television (TICCIT), first developed by the MITRE Corporation in 1968 as an interactive Cable Television (CATV) system (Surry, 1995).

In 1963, IBM in partnership with Stanford University's Institute for Mathematical Studies in the Social Sciences (IMSSS) directed by Patrick Colonel Suppes, an American philosopher, to develop the first comprehensive CAI elementary school curriculum, which was implemented on a large scale in schools both in California and Mississippi (Instructional System Development, 1960). At the launch of Pearson Education Technology concert in 1967, by Computer Curriculum Corporation, Pearson Education Technology was formed to market to schools the materials developed through the IBM partnership. The PLATO IV system, released in 1972, supported many features that later became standard in educational software running on home computers, its features included bitmap graphics, primitive sound generation and support for non-keyboard input devices, including the touch screen (Staff, 1994).

The Arrival of the Personal Computer

With the Apple II, Commodore PET, Commodore VIC-20 and Commodore 64 allowed for the creation of companies and non-profits organisations, which specialised in educational software. Broderbund and the Learning Company are key companies from this period and Minnesota Educational Computing Consortium (MECC), a key non-profit software developer. These and other companies designed a range of titles for personal computers, with the bulk of the software initially developed for the Apple II.

Major developments in educational software in the early and mid-1990s were made possible by advances in computer hardware. Multimedia graphics and sound were increasingly used in educational programmes. Compact Disc Read-only Memory (CD-ROMs) became the preferred method for content delivery. With the spread of the internet in the second half of the 1990s, new methods of educational software delivery appeared. In the history of virtual learning environments (VLE) is a system that creates an environment designed to facilitate teachers in the management of educational courses for their studies, especially a system using computer hardware and software which involves distance learning. The 1990s were a time of growth for educational software systems, primarily due to the advent of the affordable computer and of the internet. Today Higher Education institutions use virtual learning environments like Blackboard Inc. and Blackboard LLC to provide greater accessibility to learners.

Courseware Design

Courseware design comprises the definition of requirements and specifications for the instructional system. Troutner (2002) called these specifications for the instructional system phases' Analysis and Macro-Design.

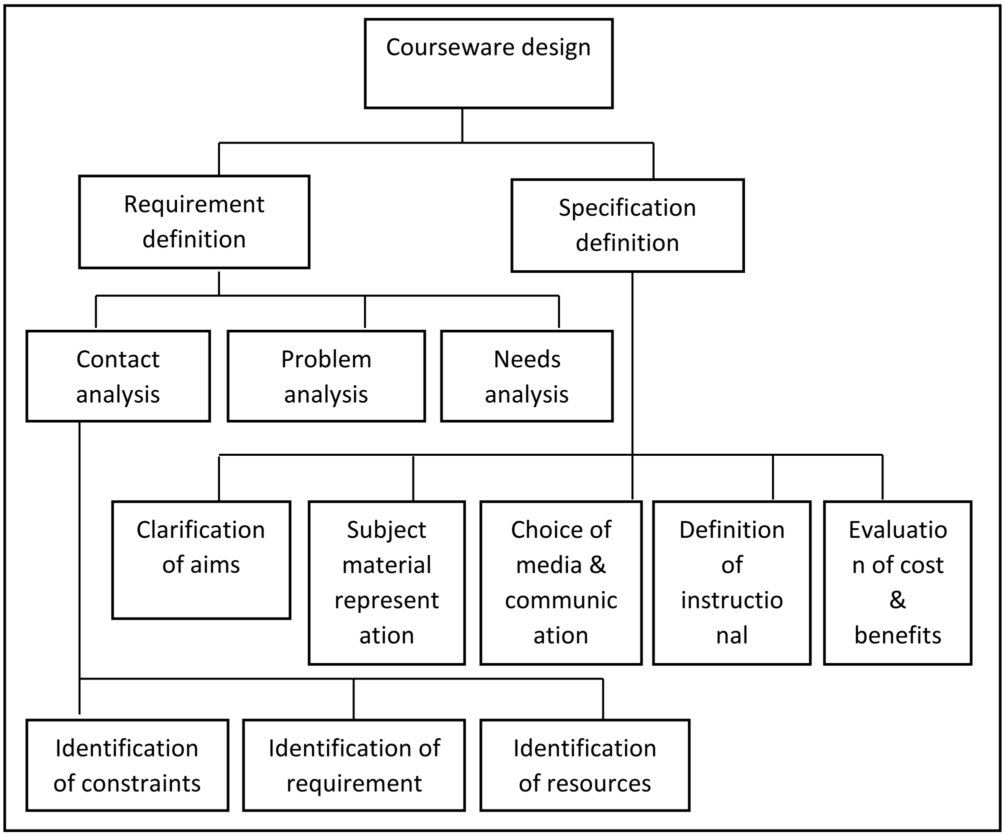

Figure 1: Courseware Design

The definition of requirements for an instructional system involves analysing several factors: the problem in question, the educational content in which the system is to operate and the demands and restraints that could determine the success or otherwise of the project. "Analysis of the problem "means identifying the weakness that need to be confronted in the current system. These may include teachers' weakness in specific subjects areas, ineffectiveness of the current approach, lack of students motivation, differences in their basic level of knowledge, inherent difficulty of the subject area, physical distance separating students and teachers, large student-teacher ratio, or as is often the case, a combination of factors such as these. Analysis of the learning environment means studying the setting for which the instructional system is designed (level and type of target population, demands and nature of context, constraints that the new system must respond to). According to some authors (Farquhar and Surry, 1994), this phase ought to include a study of the conditions that may aid or hinder adoption of the innovative system: this could help prevent it being rejected out of hand because it is considered too revolutionary for the educational setting. Finally, analysis of requirements and constraints is entwined in the aforementioned activities and helps to clarify the conditions surrounding the problem in question, including the matter of available resources (staffing, funding, production time, etc) and learning tools already to hand.

Definition of instructional specifications, on the other hand, involves clarification of the project's aims and the subject area it is to address the choice of learning strategies to be adopted and the most suitable means for carrying out the project (choice of media and communication codes).

These activities are all closing linked and should be carried out bearing in mind the background constraints and conditions outlined above. Another aspect to be taken into consideration at this stage is the so called cost benefit ratio, a term that goes beyond purely economic considerations. Indeed, benefits are often evaluated in terms of significance and applicability of final results, while costs are greatly affected by production times. The conceptual tools proposed for many of the specification activities have either been custom-made for the purpose or "borrowed" from other working environments. The aim of these tools is twofold: to assist both in carrying out the activity and in the exchange of information between the various parties in the development process. Let us take as an example the phase of content structuring, i.e., the presentation of contents in a form that, at a level of detail that fulfills courseware production requirements. Hence, numerous studies reveal that the adoption of a specific formalism (graphs (Mispelkamp et al., 1994), frame network (Jones et al., 1990), learning hierarchies (Persico et al., 1985) (Ferraris et al., 1984b), among others) allows the author to manage content complexity in the analysis phase. However, this is but one of the advantages: others lies in the "legibility" of the final product, the absence of ambiguity that characterizes natural language and ease of management with automatic tools in the subsequent development phase.

Furthermore, it must be pointed out that while a table of contents may constitute an adequate representation for the planning of a book, the same is not true of software. Indeed, the content sequencing typical of tables of contents could hinder the development of a software environment that offers highly adaptive and diversified pathways and might ultimately limit the degree of flexibility available to the student. In the design phase it is useful to begin planning a series of measures to assess courseware quality. Once the general aims of the courseware and the specific objectives of its main elements have been set, criteria and methods should be established to evaluate to what extent these goals have been achieved. If this planning is conducted before moving on to the production of fully-fledged learning and validation material, evaluation activities can be directly linked to the "knowledge" and "know how" that the students should build up through courseware use. Though it may seem pointless or trivial, this precaution should not be undervalued. Proof can be seen in a number of cases, both inside the match up only in part with the process itself and its aims.

Given that each of the above activities generally calls for different skills, most of the above tasks can be carried out by separate groups of authors working in parallel, provided that effective cooperation and coordination is achieved. For a discussion of tools that can support the authors in this collaboration effort and the project managers in their coordination tasks. (Ulloa, 1994).

Production

In this phase, the result of the activities described above constitutes the basis for transforming the educational project into a set of tangible materials. Here, activities include software implementation, production of audio-visual material (graphics animation, video, sound) writing of texts for both teachers and students, drafting of use manual and so on. Again, these activities can be performed separately, but cooperatively by people whose abilities may range from computer programming to writing educational texts, graphic design and general educational communication.

Dividing up the tasks among the various authors involved in the courseware production phase leads naturally to breaking down the final product into modules and also offers distinct advantages in product validation. In fact, it is often possible to move on directly to assessment of the technical performance and educational effectiveness of the individual courseware components. For example, the technical quality of the software can indeed be evaluated according to the software engineering principles of quality control. Subsequently, the software can be tried out with a small group of students under the direct supervision of the authors so that design and interface problems can be identified. In some cases, self-contained modules of learning materials such as a single chapter of a workbook or a particular software function may be completed before the rest and can thus be tried out on a small sample of the target population. This allows faults to be spotted early in the process and limits costly modification later on.

Validation

As indicated above, validation can be considered a phase of courseware development even though it is spread along the entire length of the process (granted that a substantial part lies in final product validation). This is especially true from the conceptual point of view. In fact, by definition, validation reveals faults in the adopted approach which are generally overcome by backtracking through the process until the problem is located and weeded out. The cycle is then resumed and followed through to the end and includes verification that the errors been successfully corrected. So, correcting errors committed in the design phase is more costly in terms of time and effort than overcoming production faults. It is, therefore, essential that any problems be weeded out early in the development phase in order to keep a lid on such costs.

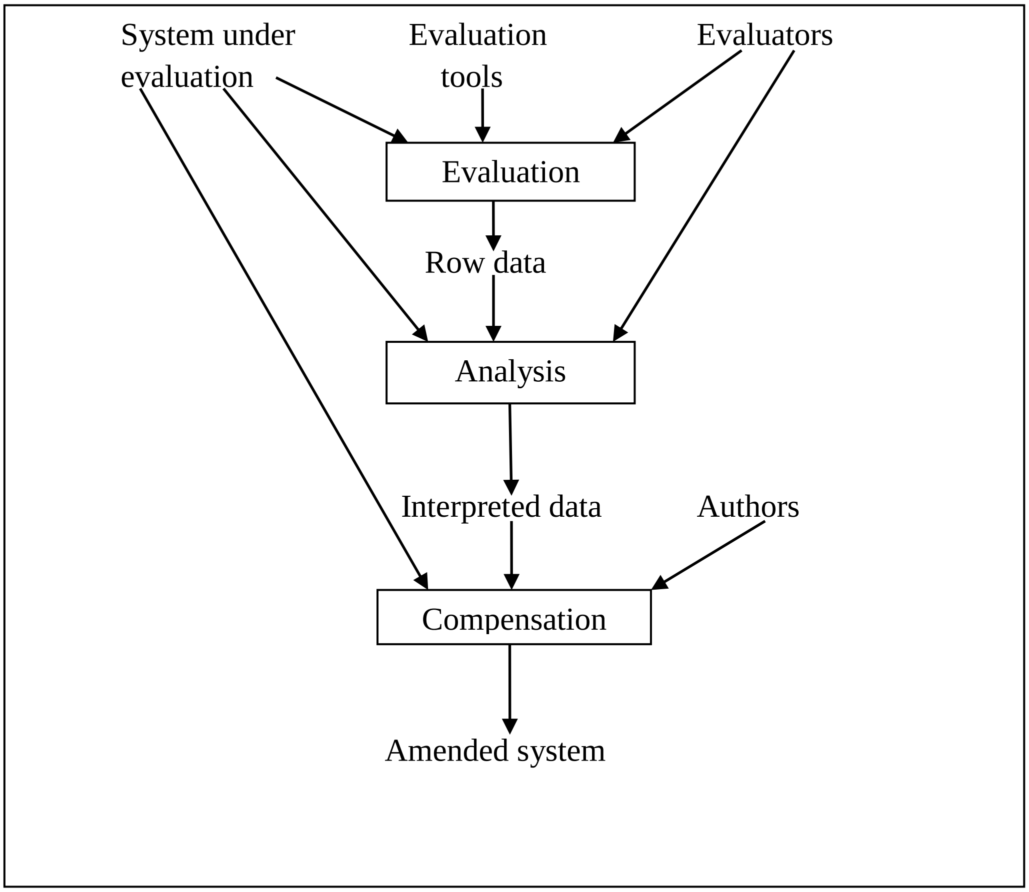

Figure 2: The Validation Process

Now let us examine the most common validation method in a little detail. The validation process in figure 1 usually begins with an evaluation phase, which produces information (or data) about the object to be validated. These data must then be analysed and interpreted in a way that provides the basis for compensatory process designed to correct and improve the initial object. Hence, the three typical validation activities are evaluation, data analysis and compensation.

Multimedia Courseware

Multimedia refers to the integration of two or more different information media within a computer system. These media can include text, images, audio, video, and animation which are also known as Computer-based instructional courseware. Computer-based instructional courseware is software developed for the purpose of providing instruction. It is generally thought to fall into one of the following categories: drill and practice, tutorial, simulation, instructional game and problem solving (Hannafin & Peck, 1988). In the early 1980s, the educational market was flooded with diverse courseware applications that lacked instructional quality. Hannafin and Peck (1988) pointed out that, although there were examples of effective educational computer programs, much of the available software was terrible. Roblyer (1988) stated that poor-quality courseware affected educators' use of computer-assisted instruction (CAI).

The increased availability of instructional courseware generally, and poor-quality courseware particularly, engendered attempts to develop methods for software assessment (Shuell & Schueckler, 1989) and helped make evaluation more common. The importance of evaluation is recognized, and it is vitally important for educators to partake in software reviews (Dudley-Marling & Owston, 1987; Zahner, Reiser & Gill, 1992). However, evaluation can be an intricate process complicated by a variety of intervening factors. Educators frequently are not cognizant of the most suitable methods to use when evaluating and selecting instructional programmes. Evaluation entails methodical decision making about the value of a particular object and identification of reliable methods with which to base decisions or judgments (Gros & Spector, 1994). According to Gros and Spector (1994) difficulties encountered in evaluation relate to "not determining reliable methods, which produce generally useful judgments" (p. 37).

A review of the literature yields a variety of instructional courseware evaluation methodologies. Heller (1991), for example, lists several organizations, initiatives, and services that developed evaluation methodologies such as the National Council of Teachers of Mathematics, MicroSOFT, EDUCOM's Software Initiative, or York Educational Software Evaluation Scales (YESES). Each approached the evaluation process somewhat differently. In some cases, students and educators evaluate courseware based on criteria that generally fall into one of four categories: accuracy, effective instructional strategies, instructional objectives, and ease of use (Morrison, Lowther, & DeMeulle, 1999). By adopting textbook review protocols, professional organizations and associations have conducted software critiques, provided software ratings and recommendations, and distributed the results.

On many evaluation instruments, evaluators judge courseware using predetermined criteria (such as ease of use or instructional quality) and rating scales (such as highly favorable to highly unfavorable). Other types of instruments present a checklist format. Roblyer, Edwards, and Havriluk (1997), for instance, presented a minimum criterion checklist comprised of four primary categories: instructional design and pedagogical soundness, content, user flexibility, and technical soundness. Reviewers marked "yes" or "no" on the checklist to indicate whether the program met the criterion.

Criteria used in evaluation instruments have also come under scrutiny because they are sometimes confusing. Likewise, evaluation rating systems have been criticized for not being comprehensive, understandable, and easy to use (Chang &c Osguthorpe, 1987). Developing representative and reliable criteria and categorizing them are challenging. Software adopters and agencies that publish courseware reviews often use comparative evaluations. Comparative evaluations are often useful for initial software screening (Dudley-Marling & Owston, 1987; Zahner et al., 1992). But some researchers question the value of comparative evaluations because they are subjective assessments and do not provide adequate information about program effectiveness (Dudley-Marling & Owston, 1987; Heller, 1991; Jolicoeur & Berger, 1986, 1988; Schueckler & Shuell, 1989; Zahner et al. 1992).

Two alternatives to comparative evaluation include a criterion-based evaluation, the YESES and the Zahner et al. (1992) Courseware Review Model. YESES evaluate software on four dimensions: pedagogical content, instructional presentation, documentation, and technical adequacy (Dudley-Marling & Owston, 1987). Software is rated on each dimension using a four-point criterion-based scale (exemplary software, desirable software, minimally acceptable software, and deficient software). The Zahner et al. model is not based on subjective judgments of predetermined criteria, but on learners' pre- and post-testing and survey data.

For the purposes of this study, multimedia instructional courseware is defined as a single instructional unit with one or more lessons designed for self-instruction or small-group instruction using a stand-alone computing system.

Whether the courseware is drill, tutorial, simulation, gaming, or problem solving, it would most commonly be available on CD-ROM. In this instance, multimedia is defined in accordance with Tolhurst's (1995) definition, which suggests multimedia is a comprehensive term encompassing both hypermedia and hypertext when it uses the interactive nature of the computer to include nonlinear access to informational content. This definition of multimedia courseware was chosen for the following reasons:

1. It narrowed the scope of software selection to a defined media type (specifically CD-ROM).
2. Many instructional courseware programs are developed and delivered on CD-ROM.
3. Although the Internet and Web offer seemingly unprecedented opportunity for instructional delivery through Web sites, the design for such learning environments is notably different, in many ways, than CD-ROM delivery.

The presentation of video, audio, and graphics, for example, is often limited because of bandwidth restrictions. Additionally, the Web is an open environment where users can potentially link to sites of varying quality and interface and to sites containing unrelated informational content. The CD-ROM format offers a multimedia designer greater control of the content presentation and interface.

The pedagogical strength of multimedia is that it uses the natural information-processing abilities that we already possess as humans. Our eyes and ears, in conjunction with our brain, form a formidable system for transforming meaningless sense data into information that is data imbued with meaning. The old saying that "a picture is worth a thousand words" often understates the case especially with regard to moving images, as our eyes are highly adapted by evolution to detecting and interpreting movement. So, for example, a photograph of Dentdale in the Yorkshire Dales, apart from being aesthetically pleasing, can contain a wealth of information relating to the geology, climate, society, history, and economics of the area. Similarly, a recording of a politician's speech can allow us to discern significant semantic factors which would not be apparent in a written transcript. Even when an image or sound can be described accurately and concisely in words it can still be processed by the brain more quickly and easily than its text equivalent because text, as a symbolic system, incurs 'processing overheads' - the symbols have to be decoded before their information content is released.

To the student one advantage of multimedia courseware over the text-based variety is that the application looks better. If the courseware only includes a few images at least this gives relief from screens of text and stimulates the eye, even if the images have little pedagogical value. More often than not, however, the inclusion of non-textual media into courseware adds pedagogical value to the application. For example, a piece of courseware describing a dig at an archaeological site would be of much more value to the student if it included images of the site, such as enhanced aerial images showing interesting features like old field boundaries, or diagrams illustrating where digging and scanning took place, than if it merely used text even in an imaginative and interesting way.

Multimedia places considerable demands on computer hardware in terms of processor speed, memory, disk space, and data throughput. Sound, images, animation, and especially video constitute bodies of data magnitudes greater in size than text files. As a result of the challenge this has presented to hardware designers multimedia has been a late arrival on the desktop, particularly in the PC arena, and this means that there are many machines currently in use that struggle with multimedia elements. Although at the time of writing a standard, mid-range desktop PC is capable of displaying multimedia documents, most machines only 2 or 3 years older struggle to do so and in many cases require significant modifications in terms of extra memory and expansion cards to handle multimedia to an acceptable standard. Hence a major disadvantage of writing multimedia courseware is that it may not be accessible to a large section of its intended audience which does not have access to multimedia-capable machines.

This is particularly the case in the academic sector where the provision of microcomputers for staff and students is a significant item of expenditure and one which the institution is not likely to want to repeat every 2 or 3 years. For this reason courseware developers should think very carefully about which multimedia elements to incorporate into applications and only include those which have significant value.

Educational Theories

To understand how knowledge transforms, how a learner learns and how a teacher teaches, it is very important to know what the psychologists and mind-blowing theorists perceive knowledge transformation to be. To the constructivist learning is a product of an active process rather than passively waiting to receive it (Colburn, 2007). The purpose of learning is for the individual learner to build his/her own meanings. Piaget, one of the prominent educational psychologists of the constructivist paradigm stressed that learners construct knowledge through a rational combination of internal challenges us to gain knowledge and understand it through a God given brain.

To Piaget, human is always in constant evolution. We learn something by the help of our past knowledge. In the process, we reinvent new knowledge (Farnoush, 2009). These informed the researcher to pay more attention to the prerequisite previous knowledge of the topic to be trained and user interface of the courseware, as it is the environment that the learner interacts with when using the courseware to learn.

The constructivist paradigm suggests that the learner is active, constructive, collective goal oriented, investigative and thoughtful. For this study, learning is student centred and learners construct their own knowledge through the interaction with the courseware. The learner has to take initiative for self – testing and constantly checking his/her progress to make sure that all the goals and objectives of the learning are met successfully. In constructivist learning, when students are allowed to make their own investigations, they gain better understanding (Chuang 2004).

Bruner emphasizes that when children in their early ages, try to roll over, sit down, sit up, walk and fall, they are in fact learning based on their own trial and error. As such, the courseware on BODMAS is to engage learners in meaningful activities and the teacher is to guide them when necessary. On the other hand, the behaviourist believes that learning happens only through observable behaviours and is strengthened by reinforcement. The reinforcement can be in the form of rewards or punishment.

Behaviourist's Theory of Concept of Prevention

This theory is useful as it is the traditional way of teaching by teachers who believe in the concept of rewards and punishments as the only means of education (Qais, Zainab & Hamidah, 2007). To behaviourist, man's action must be controlled as scientists control and influence other natural phenomena (Steve, 2013). This theory denies the existence of the human mind as a distinct feature between man and animal. To behaviourist, man is like a machine, he can be switched on and off. To behaviourist, action should be controlled (Liu & Matthew, 2005), as scientist control and influence other natural phenomena. The theory of behaviourism is in fact a simple theory with an extraordinary message; animals learn and so do humans. Behaviourists further claim that we learn because we follow certain accepted universal laws of behaviour and discipline. Although, Vygotsky, Jerome Bruner, etc, of the constructivist camp heavily criticised the behaviourist theory of learning but one thing for sure, that influence this study is the emphasis on the concept of rewards and punishments. Therefore, the courseware for this study gives instance feedback on the entire test and the examination to motivate the learner.

Learners construct mathematical structures that are complex, abstract and powerful actively in a constructivist learning environment. The collaborative learning process allows students to construct and scaffold for critical thinking and provides immediacy of feedback in which peers give and receive feedback, challenge and encourage each other and jointly reflecting on progress and process (Curtis & Lawson, 2001). In such a setting, they explore mathematical ideas by thinking, participating and reflecting. They take the responsibility of completion of assignment, controlling and creating their own mathematical ideas.

The headache of work of mathematicians is solving problems. The conception of mathematical problem-solving varies from mathematical problem-solving being utilised in the service of other curricular goals to mathematical problem-solving being at the very heart of mathematics, (O'Shea, 2013). According to him, there is one particular mathematical point of view regarding the role that problem have in the lives of those who do mathematics.

The role of teacher is to guide and support students' invention of viable mathematical ideas rather than correct expert way of doing mathematics (Karen & Fortune, 2016). It is seen as crucial in mathematics education to find a bridge between these two comparing demands 'rote' learning and relational learning in the classroom and teachers are being encouraged to champion the cause of thinking skills in the mathematics classroom, Ball and Pratt (2002) postulated that when pupils are stimulated with challenging problems it encourages them to think.

Traditional Teaching and Learning situation

In traditional teaching and learning method, the teacher transmits his knowledge of the subject (or the knowledge he/she considers relevant) as an expert to learners. The teacher is the one who is primarily active, while the learners are the passive recipient of the knowledge offered by the teacher. Their learning progress was examined regularly in test, designed by the teacher. This method was based on the assumption that it is possible for the teacher to determine what the students should know. The teacher assumes that the goals set can be achieved. For this purpose, the material to be transmitted is analysed and subdivided into units that are to be transmitted to the students one by one.

Studies on the Effectiveness of Courseware

In this technological era, educators have turned their attention to the use of technology to enhance and enrich the learning environment (Barker, 2000). The role of technology in the classroom is not to replace traditional educational methods, it does act as an enhancement for teaching students to think critically, communicate creatively and solve problems in analytical way (Chi-Un Lei, 2010).

A simple multimedia presentation helps the students to better understand a subject without the help of a teacher particularly for shy and weak students. Silvinn-Kachala (2000) reviewed 311 research studies on the effectiveness of technology on student achievement. Their findings revealed positive and consistent patterns when students were engaged in technology-rich environments, including significant gains and achievement in all subject areas, increased achievement in preschool through high school for both regular and special needs students and improves attitude towards learning and increased self-esteem. Linkels, Dording and Meinel (2006) said that e-learning could improve school results.

Whatanarang (2002) investigated and compared the effects of learners in the areas of quality of students' term papers, homework, reference sources, analytical ability, synthesis and summarization of information and time used for study. The samples were 80 graduate students randomly selected from the class of four subjects registered from the second semester of academic year 2000 to the first semester of academic year 2002. They were divided into 4 control groups and 4 experimental groups. The control groups studied with traditional instruction. The experimental groups studied with teacher-prepared instruction programs on the internet-based system.

Data were analysed by using a one way t-test for independent samples. The pre-test and post-test results indicated that there was no negative effect on the learners. The scores of the experimental groups were not significantly higher than the scores of the control groups in the area of quality of students' term paper, homework, however, the experimental group spent significantly less time. According to Ali and Elfessi (2004), the significant role of technology in teaching and learning is limited as an instructional delivery medium and not a key determinant of learning. It can only support the classroom learning.

Mathematics Syllabus for Primary Schools in Ghana

Pupils are expected to read and use numbers competently, reason logically, solve problems and communicate mathematical ideas effectively to other people. Mathematics at the primary school level in Ghana emphasizes knowledge and skills that will help the pupils to develop the foundation for numeracy. Mathematics Syllabus for primary schools in Ghana is structured to cover the first six years of the primary school education. Each year's work is divided into units and not terms because at that level it is difficult to predict with any degree of certainty the rate of progress of pupils. Each class has 15 units but primary three and five have 11 and 16 units respectively. The mathematics syllabus specified profile dimensions for teaching, learning and assessment.

Table 6: Profile Dimension for Primary Schools

	Primary1- 3	Primary 4 - 6
Knowledge & Understanding	40%	30%
Knowledge & Application	60%	70%
Total	**100**	**100**

Source: Teaching Syllabus for Mathematics Primary School 1 – 6

The JHS syllabus does not provide percentages for the levels of the profile dimension (Knowledge, Understanding and Application). However, the syllabus emphasises on the need for students to be encouraged to apply their knowledge. National Syllabus for Mathematics – JHS 1 – 3 (2012) state that "It has been realized unfortunately that schools still teach the low ability thinking skills of knowledge and understanding and have ignored the higher ability thinking skills like application" (page xv, Definition of Profile Dimensions). The topic fraction is introduced in primary two. Table 8, shows the class matched with the units and the sub topic of fractions taught at that level.

Table 7: Structure and Objectives of Fractions in the Syllabus

Class	Unit	Topic	Objectives
2	8	Meaning of fraction	Recognition of fraction
3	4/11	Equivalent fractions Addition & Subtraction	Presentation and Comparing adding and subtracting of fractions like fractions
4	9	Identification &comparison of fraction to decimals	Identification &comparison of fraction to decimals
5	11	Multiplication and Division of whole numbers by fraction	Multiply whole numbers by a fraction, divide a fraction by a whole number and convert fraction to percentages
6	2	Multiplication and Division Of fraction	Multiplication & division of a fraction by a fraction
JHS 1	3	Equivalent fraction Add & Subtract fractions Multiply fractions Divide fractions	comparing & ordering fractions adding & subtracting fractions multiplication of fractions division of fractions NB: All including word problems

Source: Teaching Syllabus for Mathematics Primary School 1 – 6 & JHS 1- 3

Concept of Bracket, Order, Division, Multiplication, Addition and Subtraction (BODMAS) of Fraction

Reasoning in BODMAS

Despite a widespread of acceptance of the notion that students have low attaining levels in mathematics compared to other subject, there is the believe that among other factors poor knowledge or misconceptions of BODMAS is a contributing factor to this low level of mathematics attainment. Olivier cited in Osei, (1998) maintains that misconceptions play a very important role in the learning and teaching, because misconceptions form part of the pupils' conceptual structure that will interact negatively with new concepts, so teachers should then carefully select instructional activities to dispel them so that learning can take place. For it is believed that students cannot build more advanced knowledge from misconceived understanding (Setati, 2002), teachers are also advised to use baseline assessment on the topic they are to teach, for instance Order of operations in this case, to carefully interpret the idea and conceptions that students bring to mathematics classes. That is testing learners thinking in ways that facilitate exposure of their misconceptions so as to dispel them and make a way for new knowledge acquisition.

Piaget's theories of development and ideas of learners constructing their own knowledge were used to illuminate the idea of misconceptions. The important aspect of his theory is that learners have existing schemas before being exposed to new information. If these schemas are inconsistent with accepted mathematical notion it means that they may interfere with, or impede new learning. Many researchers have found that misconceptions are strongly held and learners often resist change even after receiving instruction specifically designed to change them. But still learning should remain an activity in which generally accepted mathematical notions must be acquired and misconceptions dispelled.

As teachers, we need to understand misconceptions as both flawed and productive, this gives us courage to confront and dispel them during instruction so as to refine and reorganize knowledge. As we refine and reorganize that knowledge, learning is taking place. Expertise is in the making errors and these errors are a great contribution to the learning process. (Nesher, 1987)

It is known that mathematics is a language that people use to communicate to solve problems and to engage in recreation. It is a language of words, numerals and symbols (signs of operations) which are at times interrelated or interdependent. For most learners across all grade levels, their weakness in mathematics ability is often related to the obstacles they face in focusing on these symbols as they attempt to read the language of mathematics. Symbols have important roles in mathematics, so learners must be able to decipher (convert the symbols code to the mathematical language) correctly. Symbols are used to indicate an operation to be performed, such as in an arithmetic expression of $45 \times 6 =?$ The '×' is a standard symbol that in this case indicates one should perform the operation of multiplying. Symbols communicate meaning and messages.

A major cause of misconceptions is the lack of understanding of mathematical concepts. Algebra seems to be as simple as the computational algorithm suggests but most students must often show that they have many misconceptions about algebraic concepts. Here misconceptions are not due to students' lack of procedural fluency knowledge of algebra, (Kilpatrick et al, 2001); but are rather due to their conceptual understanding. For example, some students write that $(3m + 2n) = 5mn$ or $2 + 5 \times 3 = 21$ here students should apply their conceptual understanding of like terms and of bracket introduction.

Also misconception can be caused by various ways (Osei, 1998) which can be grouped as follows:

I. The cognitive level of pupils;
II. The pupils' background knowledge and preconceptions;
III. The influence of the teacher;
IV. Teacher's misconceived knowledge;
V. Learners' perceptual difficulties;

I. Cognitive level of the learners;

Piaget cited in Reader, (2001) asserted that learners assimilates new information into existing cognitive schemata. The learner (regardless of age) continually retrieves the earlier learnt concepts in order to interpret the new information for him/herself.

II. Learners' background knowledge and preconceptions;

Learners, because of their background, normally come to class with other meanings from their everyday life for some of the words, which are used in mathematics. These alternative meanings occur because of the children's culture (Osei, 1998). For example, the normal use of the word volume, which is associated with the loudness of a radio or a TV etc, is different from the mathematical use which is about space. So when learners were introduced to order of operations in BODMAS they might have misconceived it with a company's operations i.e. how a company operates.

III. The influence of the teacher;

Pupils' misconceptions have been traced to teachers' explanation. For example, Blubaugh (1988) suggested that the broad use of the word "cancel" during mathematics lessons could have led to students misconception. In such cases students fail to distinguish between different meanings associated with the word cancel as they may apply it to cancel the meeting, the meeting is no more there. Likewise in BODMAS, teachers often use the phrase 'remove brackets'. The question is; how? Some learners for instance will think it is to leave them out in the next step, for example (2a + b) + 3 – a (6 - 5) becomes 2a + b + 3 – a 6 – 5. Instead teachers should explain that the leaner needs to simplify what is inside the brackets. Afterwards they can multiply this with what is on the outside of that bracket, thus removing brackets.

IV. Teacher's misconceived knowledge;

Many research studies have shown that some teachers harbour some misconceptions, which are eventually passed on to the learners they teach. These may be mainly as a result of language. Language can either help learners to understand a concept or hinder their understanding (Boulet, 2007). Arzarello cited by Osei, (1998) reports that many learners do not understand algebraic language correctly and as a result, their thinking and performance are badly affected.

Representations in algebra and symbols or the language of algebra in general are likely to be major factors affecting misconceptions. Inappropriate information or lack of it, by teachers is likely to be one of the major contributing factor affecting misconceptions of order of operations in arithmetic and algebra of two or more variables in schools.

V. Learners' perceptual difficulties;

Some learners have perceptual difficulties in mathematics which distort their understanding of symbols, signs and words. Learners with perceptual difficulties may mix up operational signs such as + and × and confuse numbers such as 6 and 9 and most do not outgrow this confusion. This confusion can still be detected in upper grades and also at university level.

BODMAS rule defines the correct sequence in which operations are to be performed in a given mathematical expression to find its value. In BODMAS,

B = Bracket

O = Order (Powers, Square, Root, Exponents, Indices, etc)

DM = Division and Multiplication (left – to - right)

AS = Addition and Subtraction (left – to - right)

Operands: An entity or a quantity, upon which a mathematical operation is performed, is called an operand. For example; in the expression 2 + 3, the numbers 2 and 3 are operands, while the sign '+' is the **operator.**

Mathematical Operators

They are called operators because they 'operate on' the quantities or the numbers (operands).

1. *Brackets:* They are operators used to break the general order of operations. Suppose in a mathematical sentence, it is desired that multiplication be performed on the numbers before division, then we use brackets to group the operands. The commonly used bracket are ( ), { } and [ ].

For example, $10 \times 2 + 4 \div 2 - 10 = ?$

In the given mathematical sentence, if we want to set a different order of solving the equation, we could do something like this,

$10 \times (2 + 4) \div 2 - 10 = ?$

Here, instead of doing the division /multiplication operation first, we would have to complete the addition operation first, and then proceed with the remaining operators in the usual sequence. If there is more than one bracket (s), we will have to work them all out first. There are different types of brackets too: Parentheses ( ), Curly brackets { } and Square brackets [ ]. These are used for creating nested operations.

The order of prominence or the order of precedence state that we can nest multiple parentheses in curly brackets and multiple curly brackets in square brackets. $[\{(x + y) - (2x + 3)\} \times \{(3y - 4) \times 3\}]$

Here, we will solve the inner brackets (parentheses) first, then the {curly brackets} and then finally the [square bracket]. We can also nest similar brackets too. For example, it is acceptable to nest parentheses in another pair of parentheses. It is a matter of convention and choice. But remember, the inner brackets always get solved first. Brackets are utilized for not just their utility but sometimes also their aesthetic value in an equation. In a large equation, which has multiple operators, sometimes it becomes hard to make it easier for others to understand your expression, you can use brackets.

For example, in the expression, 10y + 4 × 3 + 12x + 3 × 12, through the BODMAS rule, we can ascertain the correct answer, but it can be tedious to solve. Instead, the same expression when written in this manner; 10y + (4 × 3) + 12x + (3 × 12) can increase the readability of the expression. It should also be kept in mind that, bracket usage in this way is error-prone. If you are not careful, a misplaced bracket could change the correct answer. Choose with caution.

2. *Order/Exponents:* Are the number of times the entity must be multiplied with itself. These are normally of the type x, y, etc.
3. *Division:* It is separating something into equal part. Suppose you had to separate 32 peaches into 4 equal groups. To achieve this, we would have to know how to divide a group of 32 entities in 4 equal parts. The division sign is '÷'. So, we will represent the division in this way: 32 ÷ 4 = 8. That is, there will be 8 peaches in each group.
4. *Multiplication:* Multiplication is repeated addition. When you start adding more and more peaches to this small group of two peaches, it grows. Now, suppose you are adding three peaches every time you come and study. Suppose you came in ten times. Now, instead of saying that we have '2 + 3 + 3 + 3 + 3 + 3 + 3 + 3 + 3 + 3 + 3" peaches, would it not be better to say we have "2 + 10 times 3" peaches? It would definitely be simple and easier to read. This is why we use multiplication. The sign of the

multiplication operator is '×'. So we will now say that we have $2 + 10 \times 3 = 2 + 30 = 32$ peaches.

5. *Subtraction* is the process of removing one quantity from another. When you take three out of a group of five peaches, you are left with two. This is subtraction. Sad, but true! Just two peaches! The sign of the subtraction operator is '–'(pronounced minus). Therefore, we will say, we now have $5 – 3 = 2$ peaches.
6. *Addition* is the process of combining two or more quantities. When you have two peaches and you bring one more, you have basically added the two with the one to get three peaches. The sign of the addition operator is '+' (pronounced plus). Thus, having $2 + 1 = 3$ peaches.

Chapter Summary

Chapter two was on the literature review. In the review, an attempt has been made to explore the relevant and related literature which would help to have a broader knowledge of the topic at hand. The review revealed that very little has been done in Ghana to incorporate the use of technology in teaching, especially in Mathematics not to talk of BODMAS as a concept in mathematics. It should however be noted that most of the studies that form the basis for this conclusion were carried out in foreign countries and on students and teachers who had different sociological, philosophical and educational backgrounds from what pertains in Ghana. This puts the researcher in a challenging but better position to carry out such a study in Ghana, especially in Sunyani Municipality in the Brong Ahafo Region of Ghana. The study used Technological Pedagogical Knowledge

Framework by Mishra and Koehler (2007) as the conceptual base to investigate the effect of multimedia courseware on teaching and learning BODMAS concept, the case of JHS 2 pupils of Sunyani 3 Garrison schools in Ghana. It is widely known that mathematics is a subject which needs reasoning, conceptual understanding (Kilpatrick, et al. 2001) and more practice.

CHAPTER THREE

RESEARCH METHODS

Overview

This research has been designed to test the effectiveness of an interactive Multimedia courseware on BODMAS concept in solving basic arithmetic operators on common fractions. This chapter encompasses research design, description of the population, methods for selecting the sample, multimedia courseware and normal classroom teaching. Others are teaching strategy, description of material, data collection procedure, lesson notes on the topics of common fractions for normal classroom teaching and learning process, report on lessons on how pupils used the interactive multimedia courseware to learn multiplication, division, addition and subtraction of fractions, pilot study and data analysis.

Research Design

The study verifies the effectiveness of an interactive multimedia courseware as an instructional medium for teaching fractions and solving fraction questions using BODMAS concept. This study is an experimental research which employs the static – group comparison design. Two pre – existing groups (i.e. Forces JHS 2A and Forces JHS 2B, Garrison JHS 2A and Garrison JHS 2B, Services JHS 2A and Services JHS 2B, Liberation JHS 2A and Liberation JHS 2B) were compared. All the JHS 2A classes were the control groups while all the JHS 2B classes were the experimental groups. The classification was done through balloting by the mathematics teachers of the schools. The control groups were taught common fractions without the use of the interactive multimedia courseware. The experimental groups were taught common fractions using the interactive multimedia courseware. This design is expected to be a weak design because differences in pupils' ability may exist for some reasons. This deficiency was corrected by administering a pre – test to establish the entry behavior of the two groups, before the interventions were applied.

Population

This study took place in public basic schools at the 3 Garrison cluster of schools in New Dormaa, a suburb of the Sunyani municipality. These schools formed the target population because, computer availability was highly considered in the choice of the schools that were used for the study. As the proposed policy of one computer per child for all basic schools in Ghana has not been fully implemented, 3 Garrison cluster of schools was chosen for the study. This was to make sure that the experimental group could get access to the well-equipped computer laboratory of the school. The accessible population was the 3 Garrison cluster of schools made up of four schools (Services, Garrison, Forces and Liberation Basic schools). The total population of JHS 2 pupils in the four schools in the cluster is 180 pupils. Of the 180, 96 were females representing 53.3% and 84 males representing 46.7%. Each class was made up of an average of 45 pupils. Out of the 45 pupils of the Services class 28 were females representing 62.2% and 17 males representing 37.8%. The Garrison class had 25 being females representing 55.6% and 20 males representing 44.4%. The Forces class had 20 being females representing 44.4% and 25 males representing 55.6%.

For the Liberation class, 23 were females representing 51.1% and 22 males representing 48.9%.The minimum and maximum age range of the population for the study was 14 years to 16 years. The mean age of population was 14.8 and the standard deviation was 0.15.

Sample and Sampling Procedures

The teachers of the four schools balloted to assign the control group and the experimental group. The JHS 2A classes were considered as the control groups and the JHS 2B classes were considered as the experimental groups. The class register was used to identify pupils who were very punctual to school. Forty – five (45), forty – three (43), forty – three (43) and forty – four (44) pupils were found to be punctual to school respectively in the four schools. Stratified random technique was used to draw the sample of 30 each from the cluster (that is, Service JHS 2A and B, Garrison JHS 2A and B, Forces JHS 2A and B and Liberation JHS 2A and B) to make up the total sample of 120. This was because, the researcher wanted to get a representative sample of the population and also to determine the desired levels of sampling precision for each group. The stratified random was done by dividing the population into a number of homogenous strata. The control group of each class was made up of 32 females representing 53.3% and 28 males representing 46.7%. The experimental group was also made up 28 females representing 46.7% and 32 males representing 53.3%.

Four classes from four schools of the 3 Garrison cluster of schools formed the population for the study. Sixty pupils each were selected for the control group (that is, Services JHS 2A-15, Garrison JHS 2A-15, Forces JHS 2A-15 and

Liberation JHS 2A-15) and experimental group (that is, Services JHS 2B-15, Garrison JHS 2B-15, Forces JHS 2B-15 and Liberation JHS 2B-15) to make up the total of 120. The minimum and the maximum ages were 14 years and 16 years respectively for both the control group and the experimental group. The mean age of control group and experimental group was 10.5 years, but the spread age of pupils' age around the mean age in the two groups varied.

Instruments

The instrument that was used for the study was test items and questionnaire. The test items were teacher made test. The teacher made tests were of two types, the pre-test and post-test. The pre-test was used to find the entry level of performance of the two groups. The post-test was used to compare the performance of the experimental groups to the control groups. The questionnaire was used to verify whether there was any variation between the control groups and the experimental groups in terms of interest, satisfaction and using the courseware without the assistance of the teacher.

Assessment Test: Pre – Test and Post – Test

The pre-test and the post - test were of parallel forms and reflected the content of the pupils' JHS mathematics Book 1, 2 & 3 for Ghanaian schools. Each test was made up of 10 questions and comprises items for low, average and high level abilities of pupils. The first three questions (1, 2 & 3) were for the low performing pupils, the second three questions (4, 5 & 6) were for the average performing pupils and the last four questions (7, 8, 9 & 10) were for the above average pupils. The pre-test was used to assess the entry behavior of pupils before the treatment. The face and content validity of the test items was established by a mathematics tutor at the St. Joseph's College of Education, Bechem-B/A at the department of Mathematics and ICT. A pilot test was conducted on the May/June 2016 candidates of the Basic Education Certificate Examination batch to measure the reliability of the test item. For both pre-test and post - test, Spearman–Brown prophecy formula was used to calculate the reliability.

Questionnaire on pupils' impression on effectiveness of courseware

A questionnaire was used as a second instrument to assess the impression of the experimental and the control groups. The questionnaire was made up of 30 items. The first five items assessed the interest of the two groups in using the courseware to learn BODMAS concept to solving fractions. The next five items on the questionnaire assessed the learning habits of pupils. The next 10 items of the questionnaire assessed the cognitive level of pupils and the last 10 items assessed the attitude of teachers towards the teaching of mathematics in class.

Data Collection Procedure

The researcher sought permission from the Education Officer of 3 Garrison cluster of schools to use pupils in the school for the study. The officer then introduced the researcher to the various head teachers who in turn introduced the researcher to the mathematics teachers and pupils of the various schools. The head teacher together with the mathematics teachers scheduled the time for meeting and having the lesson for both the control group and the experimental group. The duration for each lesson lasted for one hour and each lesson commenced at 10:00am and ended at 11:00am.

On the first day, the pre - test was administered to both groups under study. On the second day the experimental group was taken through the basic mouse movement skills and typing of numerals. The intervention lasted for two hours. That means, there were two lessons for the intervention. Both the control group and the experimental group had one hour lessons for two days. The post-test was administered after the two groups were done with the intervention session.

The organization of the learning process of the experimental group

The orientation and the lessons of experimental group took place at the school's computer laboratory. Each person was assigned to a computer. Pupils were taken through the usage of the entire programme. They were taught the navigation tools of the software and how to navigate through the software, how to launch the courseware, how to get to the direction page as a help guide to the learners, how to use the drill and how to take the test. Pupils were given strict guidelines to complete each unit before moving on to the other next unit during the lessons. Pupils were advised not to jump the lessons. They were allowed to learn at their own pace. Pupil who had difficulty in the learning process were supported by the facilitator.

Pupils' activities were monitored throughout the lesson and assisted when necessary by the facilitator. Each lesson was concluded with at least 5 minutes peer to peer collaboration and 5 minutes overall discussion of the lesson with the teacher. This discussion encompasses individual difficulty, findings and suggestions. Each pupil was given a copy of the programme on Compact Disk (CD) for keep. The CD was prepared having in mind that not all pupils could get access to a computer. The CD that was given to the pupils could also be played on a DVD deck player. This provision provided pupils the opportunity to practice after the lesson at home.

The initial preparation for the experimental group lesson

The researcher together with two other teachers facilitated the experimental group. With the help of the researcher, teachers installed the interactive multimedia courseware programme, shared the program folder and installed it on the computers in the laboratory with support from the ICT teacher. The teachers launched the programme and there was no administrator control for user name and password. The programme after launching takes the user to its home page (See Figure 2).

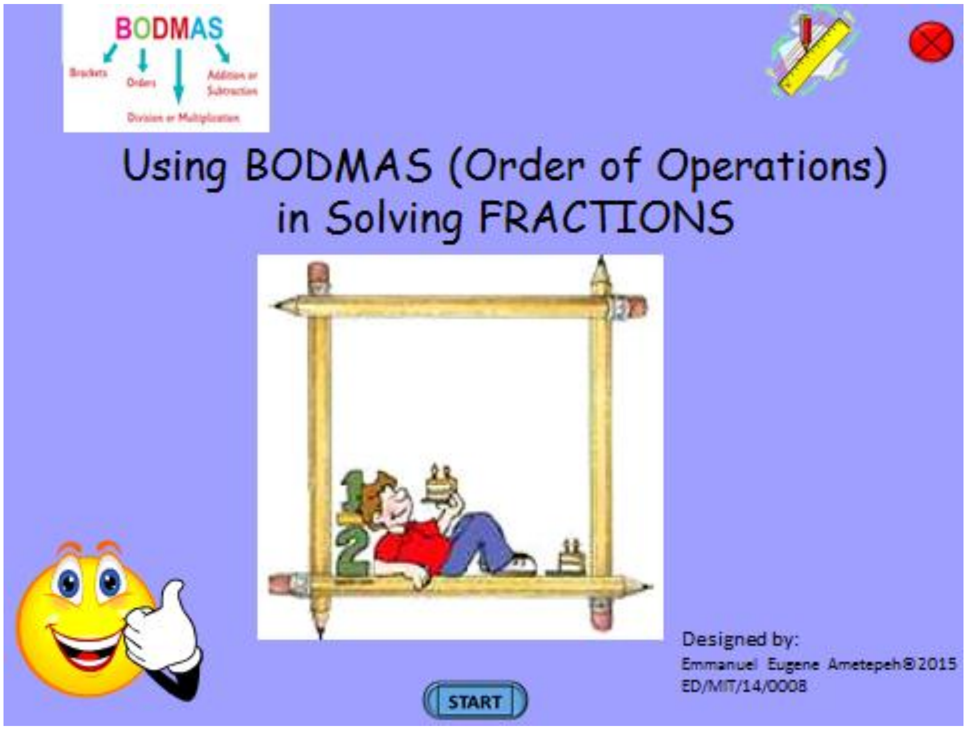

Figure 3: Home Page

The home page captioned, “Using BODMAS (Order of Operations) in solving COMMON FRACTIONS”, contains the designer’s details, the start button 

, which ushers the user into the direction page of the courseware; it also has the close button  , which gives the user an option to close the program.

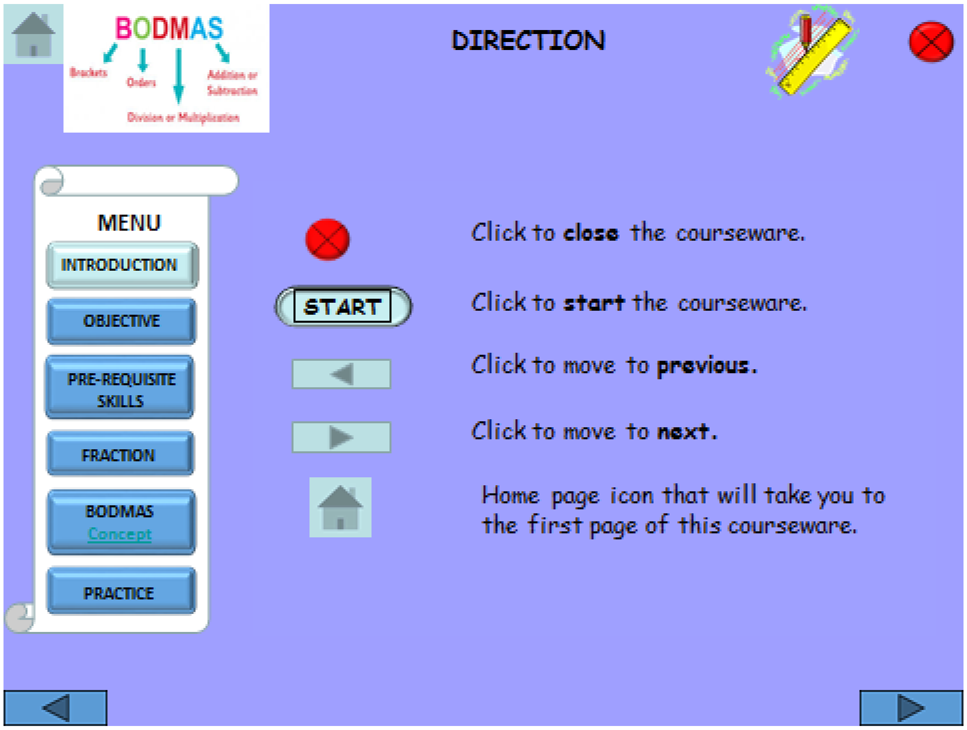

Figure 4: Direction Page

The direction page or slide contains all the navigation icons and their use. This program helped the user to navigate through the program with ease and comfort. The left side of the direction page is the menu bar that runs through all the pages. It contains the introduction to the courseware, the objectives of the courseware, the pre - requisite skills that is expected from learners, all about fractions, the BODMAS concept and some practical questions for practice. It was desirable that pupils using this courseware went strictly through the menu step by step.

Data Analysis

The data analysis of this study was done according to the research hypothesis. The Software Package for the Service Solution (SPSS 15.0) was used in the analysis of the results. All the data was entered into the SPSS. The frequency distribution of each of the variables in the data files was processed. The outputs were carefully reviewed for missing data and unusual or unexpected entries. Data for the difference in learner performance was analyzed using frequency, percentages and t-test. The statistical analysis procedure of the comparison on performance was partitioned into three main parts.

1. The mean comparison of the pre-test performance of the control and the experimental groups.
2. The mean comparison of the pre-test and post-test of the control and the experimental groups.
3. The mean comparison of the post-test performance of the control and the experimental groups.

The independence t-test was used for 1 and 3 because, two different treatments (traditional teaching and courseware) and two different participants, (the control group and the experimental group) were compared while paired t-test was used to compare the means of the pre-test and the post-test of the control and the experimental groups, because the pre-test which was compared to the post-test was taken by the same group of pupils (that is, Control and experimental groups). The data on difference in learner interest in common fractions was analyzed using frequency, percentages and Pearson's Chi-square. The data analysis on interest was only analyzed on the experimental group. Pupil's interest was measured according to the ordinal scale categories, strongly agree, agree, disagree and strongly disagree. The categories of variables used were under the ordinal scale. Learners' interest with the use of courseware as instructional medium for teaching fractions was analyzed using frequency and percentages. The perception of pupils to learn order of operations and fractions using a courseware without the support of the teacher was analyzed using frequency and percentages. The categories of variables used were classified under the ordinal scale and the analysis was done on only the experimental group.

Chapter Summary

Chapter three was to figure out the methodology of the research. In the process, the static group comparison design was used because of the nature of this research, which is an experimental research with the use of interactive multimedia courseware as an instructional medium for teaching fractions and solving common fraction questions using BODMAS concept. Pre-test questions were administered to establish the entry behavior of the two groups before the interventions were applied.

The target population was the 3Garrison cluster of schools. The cluster is made up of four schools (Forces, Garrison, Services and Liberation basic schools) which form the accessible population. Four classes from the four schools formed the population for the study and were put into two groups, sixty pupils in the experimental group and sixty in the control group. The instruments used were test items and a questionnaire because of the nature of the research.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter comprises the analysis, presentation and interpretation of the findings resulting from the study. The analysis and interpretation of data were carried out based on the results of the research hypotheses.

Pre-intervention test result of pupils' performance

The target population for the study were given pre-test question to determine the entry behaviour of pupils before the intervention was introduced. The test items were administered and marked by the mathematics teachers of the four schools respectively. The results obtained are detailed in table 8.

Table 8: Pre-intervention test result of pupils' performance (Pre-test results)

		Control Group		Experimental Group	
Marks X	Midpoint X	Freq	fx	Freq.	fx
100-80	90	2	180	2	180
79-75	77	0	0	2	154
74-70	72	1	72	0	0
69-65	67	1	67	2	134
64-60	62	0	0	0	0
59-55	57	1	57	2	114
54-50	52	0	0	0	0
49-45	47	1	47	3	141
44-0	42	54	2268	49	2058
		Σf = 60	**Σfx = 2691**	**Σf = 60**	**Σfx =2781**

Source: Field data, 2016

$$\text{Mean} = \frac{\Sigma fx}{\Sigma f} \qquad \text{Mean} = \frac{\Sigma fx}{\Sigma f}$$

$$\text{Mean (x)} = \frac{2691}{60} \qquad \text{Mean (x)} = \frac{2781}{60}$$

Control group pre-intervention mean mark = **44.85**

Experimental group pre-intervention mean mark = **46.35**

$$\text{Average mean performance} = \frac{(\text{control group} + \text{experimental group})}{2}$$

$$= \frac{44.85 + 46.35}{2}$$

$$45.6$$

The findings from Table 8 show that the students' performance before the intervention was very poor. For example, the performance of the pupils in the control group yielded a mean score of 44.85 while that of the pupils in the experimental group had a mean score of 46.35. On average, it is evident that the majority of the students' performance (M=45.6) in mathematics before intervention was below average mean score of (M=50). This result could be attributed to absence of interactive multimedia courseware, attitude of pupils towards mathematics and poor pupils-teachers relationship.

Post-intervention test result of pupils' performance

The findings of Table 8 indicate that the pupils' performance during the pre-intervention stage was very poor. Meanwhile, after the intervention lessons using interactive multimedia courseware (see Table 9), the performance of the pupils in the experimental group improved significantly from a mean mark of 46.35 to a mean mark of 53.75. It was clearly seen that pupils performance in mathematics (BODMAS) had considerably improved by a mean score difference of 7.4. This improvement in pupils' performance was as a result of the improved participation in the intervention lessons due to the strategy used by the researcher. This is evident in Table 9.

Table 9: Post-intervention test result of pupils' performance

(Post-test results)

		Control Group		Experimental Group	
Marks x	Midpoint x	Freq	fx	Freq.	fx
100-80	90	2	180	5	450
79-75	77	0	0	3	231
74-70	72	1	72	2	144
69-65	67	3	201	4	268
64-60	62	1	62	4	248
59-55	57	2	114	3	171
54-50	52	3	159	6	312
49-45	47	4	188	3	141
44-0	42	44	1848	30	1260
		Σf = 60	**Σfx = 2824**	**Σf = 60**	**Σfx =3225**

Source: Field data, 2016

Mean = $\frac{\Sigma fx}{\Sigma f}$

Mean (x) = $\frac{2824}{60}$

Mean = $\frac{\Sigma fx}{\Sigma f}$

Mean (x) = $\frac{3225}{60}$

Control group post-intervention mean mark = **47.07**

Experimental group post-intervention mean mark = **53.75**

From this result, it was concluded that interactive Multimedia Courseware is an effective intervention that significantly influenced and improved pupils' performance on the application of BODMAS in simplifying fractions.

Pupils' attitudes towards mathematics as a subject

The pupils (both experimental and control group) were given a questionnaire concerning their attitude towards mathematics. They were to tick according to their degree of agreeing with the statements provided by the researcher. The majority of the pupils had positive attitude towards mathematics based on the findings in table 10.

Table 10: Pupils' attitudes towards mathematics as a subject (both Pupils, n=120)

Statements	Mean	Std. Dev
I allocate much time to study mathematics than other subjects.	2.50	1.14
I study mathematics mostly with friends/relatives.	3.08	0.93
I have learning materials that aids me in the study of mathematics.	2.82	0.97
I am most at times motivated whenever I perform well in mathematics.	3.38	0.80
The availability of learning materials encourages me to learn mathematics.	3.18	0.87
Total Means/Std. Dev.	14.96	4.71
Mean of Means/Std. Dev	**2.99**	**0.94**

Source: Field data, 2016

NB: *A mean score of 2.50 and above indicates a positive attitude of pupils while a mean of 2.49 and below indicates a negative attitude of pupils towards mathematics.*

Table 10 indicates the results of the pupils (both experimental and control group) concerning their attitude towards mathematics. It was obvious from Table 10 that the majority of the pupils had positive attitude towards mathematics. For example, it was found that most of the pupils strongly agreed with the statement that they were most at times motivated whenever they performed well in mathematics with a means score (M=3.38; SD=0.80). This result indicates a positive attitude from the pupils towards mathematics.

Similarly, it was found that the majority of the pupils strongly agreed (M=3.18; SD=0.87) with the statement that they were encouraged to learn mathematics when learning materials were availability. The majority of the pupils variedly agreed (M=2.50; SD=1.14) with the statement that they allocate much time to study mathematics than other subjects. This result indicates a positive attitude from the pupils towards mathematics; however, most of the pupils' responses to the statement were heterogeneous in nature. We can infer that most of the pupils had diverse views concerning that particular statement. Thus, while other pupils might allocate much time to learning of mathematics than other subjects, other pupils might allocate less time to learning of mathematics or equal time to all the subjects.

From the results in Table 10, the study concludes that on average, the majority of the pupils agreed (M=2.99; SD=0.94) with the statements concerning their attitude towards mathematics. This result indicates that most of the pupils had a positive attitude towards learning of mathematics.

Pupils' cognitive levels of behaviour towards BODMAS concept

Section B of the same questionnaire contains the content areas of the BODMAS concept and it was to find out the cognitive levels of behavior of pupils towards the content areas (addition, subtraction, multiplication, exponents and division). Pupils did this by ticking their degree of understanding provided in the questionnaire and the result is found in table 11.

Table 11: Pupils' cognitive levels of behaviour towards BODMAS concept (both pupils, n=120)

	Frequency and Percentages			
Content areas and Cognitive levels	Very High N (%)	High N (%)	Low N (%)	Very Low N (%)
Addition	106(88.3)	14(11.7)	0	0
Subtraction	80(66.7)	38(31.7)	2(1.7)	0
Multiplication	36(30.0)	36(30.0)	38(31.7)	10(8.3)
Exponents	22(18.3)	52(43.3)	40(33.3)	6(5.0)
Division	30(25.0)	52(43.3)	26(31.7)	12(10.0)
Average Frequency and Percentages	**55(45.8)**	**38(31.7)**	**21(17.5)**	**6(5.0)**

Source: Field data, 2016

As shown in Table 11, it was found that out of 120 pupils, 88.3% of them indicated that they had a very high cognitive levels of behaviour towards addition as a concept of BODMAS. Similarly, it was found that 66.7% and 31.7% of the pupils had very high and high cognitive levels of behaviour towards subtraction as a concept of BODMAS respectively. From Table 11, out of 120 pupils, 30% each of them revealed that they had very high cognitive levels of behaviour towards multiplication as a concept of BODMAS while 31.7% of the pupils indicated that they had low cognitive levels of behaviour towards multiplication as a concept of BODMAS. These results suggest that most of the pupils' had a very high level of easiness in solving questions related to addition, and subtraction.

Concerning "Exponents" as a concept of BODMAS, it was found that 43.3% of the pupils reported that they had a high cognitive level of behaviour towards exponents while 33.3% of the pupils revealed that they had a low cognitive level of behaviour towards exponents. Similarly, regarding division as a concept of BODMAS, 43.3% of the pupils were found to have high cognitive level of behaviour towards the concept while 31.7% of the pupils were also found to have low cognitive level of behaviour towards the concept. These results suggests that most of the pupils' had a low level of easiness in solving questions related to "Multiplication", "Division" and "Exponents".

Despite these results, it is concluded that an average, 55(45.8%) and 52(43.3%) of the pupils had a very high cognitive level of behaviour towards BODMAS concept, while 26(31.7%) of them had a low cognitive level of behaviour towards BODMAS concept.

Pupils' interest with the use of an interactive multimedia courseware

In other to assess the effectiveness of the interactive courseware, section C of the questionnaire was used for that. Pupils ticked according to their impression of the degrees provided. This was done by only the experimental group because they had their lesson with the use of the interactive courseware and are reflected in Table 12.

Table 12: Pupils' interest with the use of an interactive multimedia courseware (experimental group, n=60)

Statements	Mean	Std. Dev
The lesson was interesting with the courseware.	3.77	0.43
The content of the lesson was satisfactory.	3.60	0.53
A similar courseware can be used to learn without teacher supervision.	3.22	0.80
Mathematics is important for my future career.	3.53	0.75
Mathematics is an interesting subject I like.	2.93	1.02
Total Means/ Std. Dev.	17.05	3.53
Mean of Means	**3.41**	**0.71**

Source: Field data, 2016

NB: *A mean score of 2.50 and above indicates pupils' interest and satisfaction while a mean score of 2.49 and below indicates students 'disinterest and dissatisfaction with the use of an interactive multimedia courseware in teaching mathematics.*

Table 12 revealed the result of the pupils' in experimental group concerning their interest and satisfaction with the use of an interactive multimedia courseware in teaching mathematics. Generally, results from Table 12 indicate clearly that the majority of the pupils' in the experimental group had interest and were satisfied (MM=3.41; SD=0.71) with the use of an interactive multimedia courseware in teaching mathematics. For example, the majority of the pupils' in the experimental group strongly agreed (M=3.77; SD=0.43) with the statement that the lesson was interesting with the introduction of interactive multimedia courseware. Correspondingly, it was found that the majority of the pupils in the experimental group strongly agreed that the content of the lesson was satisfactory with the introduction of interactive multimedia courseware having a mean score of 3.60 and a standard deviation of 0.5. From Table 12, it was realised that the majority of the pupils strongly agreed (M=3.22; SD=0.80) with the statement that a similar interactive multimedia courseware can be used to learn without teacher supervision. These results imply and suggest that the majority of the pupils in the experimental group were satisfied with the introduction of the interactive multimedia courseware in teaching mathematics.

Results from Research Hypotheses

In this section, the results of the hypotheses testing were given (Table 13-16). In all, four hypotheses were postulated and tested. Each was analyzed as follows:

Hypothesis 1: There is no statistical significant difference in the mean scores of pupils in the control group on the pre-test and the post-test.

Table 13: Results of t-test comparing pupils' in the control group Performance based on tests

	Gender	N	Mean	SD	t-value	df	Sig. (2-tailed)
Control Group	Pre-test	60	23.38	19.19	-3.730*	59	0.000
	Post-test	60	32.50	21.15			
Paired Differences			Mean = -9.12			SD= 18.93	

Source: Field Data, 2016 ***Significant, p<0.05**

Table 13 shows the result of paired samples t-test for significance difference in the performance of pupils in the control group with respect to their pre-test and post-test. Preliminary analyses were performed to ensure no violation of the assumptions of random sampling, level of measurement, independence of observations, normal distribution and homogeneity of variance.

The result revealed that pupils' in control groups have difficulties in understanding BODMAS concept. It was realized that pre-test result of the pupils' in the control group had a mean score of (M=23.38; SD=19.19) while the post-test result of the pupils in the control group had a mean score of (M=32.50; SD=21.15). This results shows that the performance of the pupils' in the post test was far better than in the pre-test. However, the standard deviation (SD=21.15) of the performance of the pupils in the post-test indicates that the individual pupils' scores on mathematics varied more than that of pre-test (SD=19.19).

When the means scores of the pupils' performance in the two tests were tested using the paired samplest-test at 5% significant level, two-tailed, the results revealed that there was statistical significant difference in mean performance of pupils result in pre-test (M=23.38; SD=19.19) and post-test [M=32.50; SD=21.15; $t(59)= -3.730$, $p=0.000$] in the control group. Thus, there was statistical significant difference between the mean performance of pupils in the control group using pre-test and post-test, hence, the null hypothesis is thereby rejected.

Hypothesis 2: There is no statistical significant difference in the mean scores of pupils in the experimental group on the pre-test and the post-test.

Table 13 shows the result of paired samples t-test for significant difference in the performance of pupils in the control group with respect to their pre-test and post-test. Preliminary analyses were performed to ensure no violation of the assumptions of random sampling, level of measurement, independence of observations, normal distribution and homogeneity of variance.

Table 14: Results of t-test comparing pupils' in the experimental group Performance based on tests

	Gender	N	Mean	SD	t-value	df	Sig. (2-tailed)
Experimental Group	Pre-test	60	23.20	24.44	-4.194*	59	0.000
	Post-test	60	34.62	22.86			
Paired Differences			Mean = -11.42			SD= 21.09	

Source: Field Data, 2016 ***Significant, $p<0.05$**

The results revealed that pupils' in experimental group have difficulties in understanding BODMAS concept. It was realized that pre-test result of the pupils' in the experimental group had a mean score of (M=23.20; SD=24.44) while the post-test result of the pupils in the experimental group had a mean score of (M=34.62; SD=22.86). These results show that the performance of the pupils in the post - test was far better than in the pre-test. Thus, the performance of the pupils in the experimental group had significantly improved. This could be credited to the intervention used "interactive multimedia courseware". The study adduced to say that the intervention used "interactive multimedia courseware" was effective in influencing and improving students in BODMAS application in mathematics.

When the means scores of the pupils' performance in the two tests were tested using the paired sample-test at 5% significant level, two-tailed, the results revealed that there was statistical significant difference in mean performance of students results in pre-test (M=23.20; SD=24.44) and post-test [M=34.62; SD=22.86; t(59)= -4.194, *p*=0.000] in the experimental group. Thus, there was statistical significant difference between the mean performance of pupils in the experimental group using pre-test and post-test, hence, the null hypothesis was thereby rejected.

Hypothesis 3: There is no statistical significant difference in the mean score between pupils in the experimental group and control group on the post-test

Table 15: Results of t-test comparing pupils' performance based on post-tests

	Gender	N	Mean	SD	t-value	df	Sig. (2-tailed)
Students Group	Control	60	32.50	21.15	-0.591*	59	0.557
	Experimental	60	34.62	22.86			
Paired Differences			Mean = -2.12			SD= 27.75	

Source: Field Data, 2016 ***Significant, p<0.05**

As shown in Table 15, the post-test scores showed that the control group had a mean score of (M=32.50; SD=21.15) while the experimental group had a mean score of (M=34.62; SD=22.86). By implication, the pupils in the experimental group performed relatively better than the pupils in the control group. When the mean scores of the two groups were tested using the independent samples t-test at 5% significant level, two-tailed, the results revealed that there is no statistical significant difference in the performance of the pupils in the control group (M=32.50; SD=21.15) and experimental groups of [M=34.62; SD=22.86; t(59)=-0.591, p = 0.557). Thus, there was no statistical significant difference between the mean performance of children using post-test by control and experimental groups, hence, the null hypothesis, was thereby retained.

Hypothesis 4: There is no statistical significant difference in the mean scores of male and female pupils in the experimental group on the interest with the use of an interactive Multimedia Courseware in the teaching of BODMAS concept.

Table 16: Results of t-test comparing experimental group pupils' Interest on interactive multimedia courseware in teaching BODMAS concept

	Gender	N	Mean	SD	t-value	Df	Sig. (2-tailed)
Students interest on interactive Multimedia Courseware	Male	31	16.84	2.28	-0.822*	58	0.415
	Female	29	17.28	1.79			

Source: Field Data, 2016 ***Significant, p<0.05**

Table 16 shows the result of paired samples t-test for significance difference in the performance of pupils in the control group with respect to their pre-test and post-test. Preliminary analyses were performed to ensure no violation of the assumptions of random sampling, level of measurement, independence of observations, normal distribution and homogeneity of variance.

The result revealed that pupils' in control group have difficulties in understanding BODMAS concept. It was realized that pre-test result of the pupils' in the control group had a mean score of (M=23.38; SD=19.19) while the post-test result of the pupils in the control group had a mean score of (M=32.50; SD=21.15). These results show that the performance of the pupils in the post test was far better than in the pre-test. However, the standard deviation (SD=21.15) of the performance of the pupils in the post-test indicates that the individual pupils' scores on mathematics varied more than that of pre-test (SD=19.19).

When the mean scores of the pupils' performance in the two tests were tested using the paired sample-test at 5% significant level, two-tailed, the results revealed that there was statistical significant difference in mean performance of pupils result in pre-test *(M=23.38; SD=19.19)* and post-test [M=32.50; SD=21.15; t(59)= -3.730, *p*=0.000] in the control group. Thus, there was statistical significant difference between the mean performance of pupils in the control group using pre-test and post-test, hence, the null hypothesis is thereby rejected.

Chapter Summary

In chapter four, the data was cleaned, edited for completeness, coded and analysed with the use of descriptive statistics for the research questions. Specifically, research question one and four were analysed using mean and standard deviation whiles research question two was analysed using frequencies and percentages, hence, inferential statistics.

On average, it was evident that the majority of the pupils' performance (M = 45.6) in mathematics before intervention was below the average mean score of (M = 50). This result could be attributed to pupils towards mathematics. This implies that most of the pupils had positive attitudes towards learning of mathematics and pupils performance significantly improved as a result of initiating the post – intervention.

In addition, the result from the paired sample t – test showed that there was statistical significant difference between the mean performance of pupils in the control group and the experimental group using pre – test and post – test respectively, hence, the null hypothesis of both was thereby rejected.

The interest of pupils from the 3Garrison cluster of schools in New Dormaa, a suburb in the Sunyani Municipality confirmed Ringstaff and Kelley (2002) findings that interactive multimedia courseware in teaching can help develop higher order thinking and creativity research skills in order to increase pupils interest.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview of the Study

This chapter seeks to present a summary of the research process as well as the key findings that emerged from the research. The chapter also contains the conclusions and recommendations that were made based on the findings of the study. Areas suggested for further research are also presented in this final chapter of the study.

Summary of the Study

The place of mathematics in the school curriculum manifests itself in its utilitarian value. The value of this utilitarianism is seen from the framework of computations. Among the framework of basic mathematical computations are the topics of Order/Exponent, Division, Multiplication, Addition and Subtraction (BODMAS). The abysmal performance in mathematics of basic school students (Grade 8 in Ghana also known as Junior Secondary School or Junior High School [JHS 2]) is evident in the results of the Trends in international Mathematics and Science Studies (TIMSS) 2003 and 2007 (Anamuah-Mensah & Mereku, 2005) as well as in the Basic Education Certificate Examination (BECE) (West Africa Examination Council [WAEC], 2007, 2008, 2009, 2010, 2011).

The reason being that students are unable to understand the principles behind the calculation of BODMAS (Bracket, Order, Division, Multiplication, Addition and Subtraction) and hence their inability to work out questions pertaining to BODMAS.

Integrating technology in classroom instruction ensures greater motivation, increases self-esteem and confidence (Ghana's Ministry of Education, Youth and Sports [MOEYS] and the Ghana Education Service, 2002). It also enhances good questioning skills, promotes initiative and independent learning, improves presentation of information or output, develops problem solving capabilities, promotes better information handling skills, increasing focus time on task and improves social communication skills.

Generally, the study aimed at experimenting the use of multimedia courseware in teaching BODMAS concept to Junior High School (JHS) two pupils in Garrison cluster of schools in the Sunyani Municipality.

The study specifically sought to answer the following questions:

1. What are the attitudes of the students towards mathematics as a subject?
2. What are students' cognitive levels of behaviour towards BODMAS concept?
3. What is the influence and effectiveness of interactive Multimedia Courseware on JHS 2 pupils' performance on the application of BODMAS in simplifying fractions?
4. What are the pupils' interest and satisfaction with the use of an interactive Multimedia Courseware in the teaching of BODMAS concept?

Research Hypotheses

The study dealt with four research hypothesis, which were stated as follows:

H0 1: There is no statistical significant difference in the mean scores of students in the control group on the pre-test and the post-test.

H0 2: There is no statistical significant difference in the mean scores of students in the experimental group on the pre-test and the post-test.

H0 3: There is no statistical significant difference in the mean score between students in the experimental group and control group on the post-test

H0 4: There is no statistical significant difference in the mean scores of male and female students in the experimental group on the interest with the use of an interactive Multimedia Courseware in the teaching of BODMAS concept.

An experimental design was adopted through the use of static-group comparison. The target population was the pupils in the public basic schools at the 3 Garrison cluster of schools in New Dormaa a suburb in the Sunyani Municipality. The researcher used four classes from four schools of the 3 Garrison cluster of schools. Sixty pupils in each group were selected for the control and the experimental group making the sample 120 pupils. Stratified random technique was used to collect the data. The researcher used test items (pre-test and post-test) and questionnaires to collect data on all the respondents. The data was cleaned, edited for completeness, coded and analysed with the use of descriptive statistics for the research questions. Specifically, research question one and four were analysed using mean and standard deviation whiles research question two was analysed using frequencies and percentages, hence, inferential statistics.

Key Finding

Some objective and informative findings have been made from this study. The key findings of the study are summarized as follows:

1. The performance of the students in the control group yielded a mean score of (M = 44.85) while that of the pupils in the experimental group had a mean score of (M = 46.35). The study revealed a mean of means of (M=45.6) signifying that there was the absence of interactive multimedia courseware, attitude of pupils towards mathematics and poor pupil teacher relationship.
2. The study discovered a mean of means value of M= 2.99; and standard deviation of SD = 0.94 on pupils attitude towards mathematics. This implies that most of the pupils had positive attitude towards learning of mathematics.
3. The finding of the study further discovered 55 (45.8%) and 38 (31.7%) of pupils in both the control and experimental groups respectively had a very high and high cognitive level of behaviour towards BODMAS concept respectively whilst 21 (17.5%) of them had a low cognitive level of behaviour towards BODMAS concept.
4. Furthermore, a mean of means of M = 3.41; and standard deviation of SD = 0.71 was obtained to signify that pupils in the experimental group had interest with the use of an interactive multimedia courseware in teaching mathematics.

5. The result derived from the paired sample t-test shows that there is statistical significant difference between the mean performance of pupils in the control group using pre-test and post-test, hence, the null hypothesis was thereby rejected.
6. A cross examination of the paired sample t-test showed that there was statistical significant difference between the mean performance of pupils in the experimental group using pre-test and post-test, hence, the null hypothesis was thereby rejected.
7. Also, the result from the paired sample t-test showed that there was no statistical significant difference between the mean performance of children using post-test by control and experimental groups, hence, the null hypothesis, was thereby retained.
8. In addition, the result from the paired sample t-test showed that there was statistical significant difference between the mean performance of pupils in the control group using pre-test and post-test, hence, the null hypothesis was thereby rejected.

Conclusions

Based on the findings of this study, the following were conclusions drawn. Even though Ausburn (2004) attest that course design has greater impact on pupils' learning, the result from 3 Garrison cluster of schools indicated the absence of interactive multimedia courseware leading to dissatisfaction of pupils towards mathematics and poor pupil teacher relationship.

Irrespective of the absence of courseware for effective teaching and learning of mathematics, pupils from the 3 Garrison clusters of schools in New Dormaa, a suburb in the Sunyani municipality had positive attitude towards the learning of mathematics.

Pupils from the 3 Garrison clusters of schools in New Dormaa, a suburb in the Sunyani municipality had a very high and high cognitive level of behaviour towards BODMAS concept respectively.

On pupils interest and satisfaction, pupils from the 3 Garrison cluster of schools in New Dormaa, a suburb in the Sunyani municipality confirmed Ringstaff and Kelley (2002) finding that interactive multimedia courseware in teaching can help develop higher order thinking and creativity research skills in order to increase pupils interest and satisfaction.

Recommendations

The following recommendations have been made regarding the result of the study. It is envisaged that these recommendations, when taken into consideration would bring about efficiency and effectiveness in the integration of technology in the teaching and learning of mathematics within New Dormaa.

1. There is the need for the Curriculum Research and Development Division (CRDD) of the Ghana Education Service to review the content of Mathematics to make it suitable for technological unification.
2. In addition, there should be a collaboration between the Ministry of Education, Mathematics curriculum designers and application software

developers to design applications that is inherently technological to enhance pedagogical skills of teachers.

3. It is recommended that Mathematics teachers should be made to attend more professional and refresher courses and programmes on the use of interactive courseware for the teaching and learning of Mathematics. By so doing, teachers and pupils will find mathematics very easy and interesting which will enhance performance in the long run.

Suggestions for Further Studies

1. It is suggested that this topic should be replicated in other regions of Ghana to enable a nationwide call and awareness for use of an interactive multimedia courseware in the teaching of BODMAS concept.
2. It is also suggested for future researchers should consider investigations into identifying more misconceptions on other small but important concepts like BODMAS.

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APPENDIX A

LESSON NOTE

College of Distance Education

University of Cape Coast

Solving basic arithmetic operators involving common fractions. Using BODMAS for the experimental group

Lesson Plan 1

Day: Monday

Date: 23rd May, 2016

Duration: 1hour

Time: 10:00am – 11:00am

Topic: Revision of previous knowledge of fractions

1. Meaning of fractions
2. Model fractions
3. Subtraction of fractions
4. Addition of fractions
5. Multiplication of fractions
6. Division of fractions
7. Equivalent fractions

Relevant Previous Knowledge (R.P.K)

1. Pupils have an idea of the meaning of fractions
2. Pupils model fractions
3. Pupils could add and subtract common fractions
4. Pupils could multiply and divide fractions

5. Pupils could find an equivalent fraction of another fraction

Objectives

By the end of the lesson, the pupil will be able to;

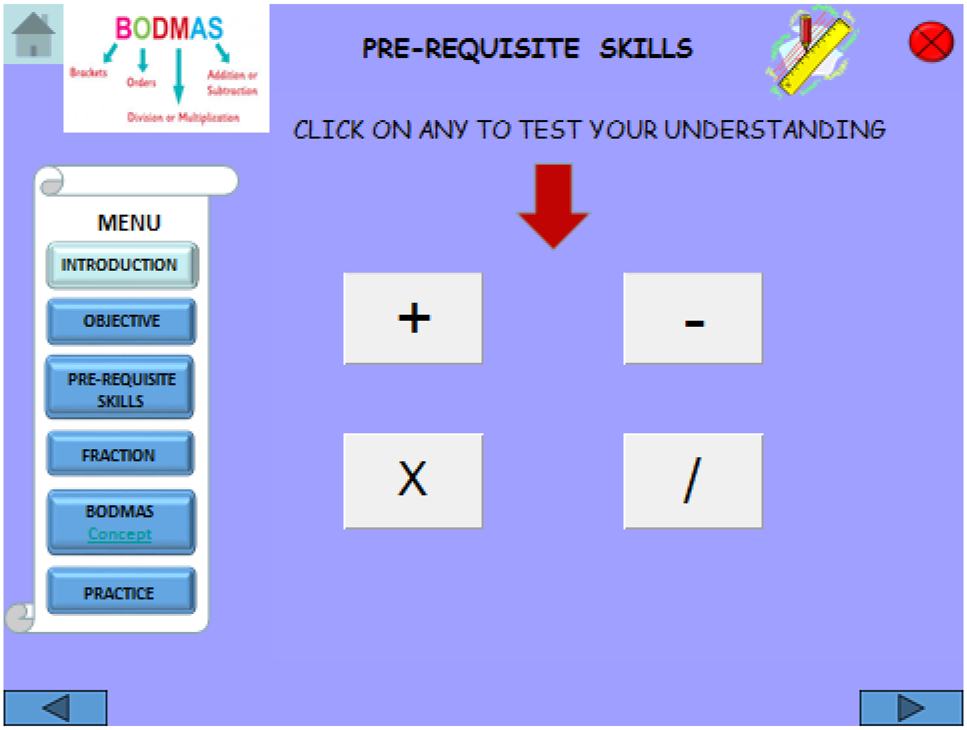
1. State the meaning of common fraction
2. model a fraction
3. add pairs of common fraction
4. subtract pairs of common fraction
5. multiply pairs of common fraction
6. divide pairs of common fraction
7. solve equivalent fraction

Teacher, Learner Activity (TLA)

Activity 1. Teacher take pupils through the introduction of the lesson by singing a song relating to fractions.

Activity 2. Teacher guide pupils to go through the pre-requisite skills session of the courseware.

a. Pupils go through with the use of the mouse to click on any of the operation signs to solve some simple addition, subtraction, multiplication and division of common fractions.



Pre requisite skills page

Any of the operations when clicked, will generate a ‘user form’ that contains randomized questions for pupils to type in an answer. This randomization can be done as many times as possible till pupils are comfortable to move on.

b. Pupils try their hands on some practical questions provided by the courseware and later check their answers with that of the multimedia courseware.

Activity 3. Pupils are allowed to go through the fraction topics step by step while they brainstorm with their colleagues on the next step needed for each common fraction question to be solved.

Lesson Plan 2

Day: Thursday

Date: 26th May, 2016

Duration: 1hour

Time: 10:00am – 11:00am

Topic: Application of mathematical operations/order of operation (BODMAS concept).

1. Bracket/parenthesis,
2. Orders (Indices, exponents, powers and roots)
3. Division
4. Multiplication
5. Addition
6. Subtraction

Relevant Previous Knowledge (R.P.K)

Pupils can solve questions relating to;

1. Orders (exponents, indices, powers and roots)
2. Division of common fractions
3. Multiplication of common fractions
4. Addition of common fractions
5. Subtraction of common fractions

Objectives

By the end of the lesson, pupils should be able to;

1. restate the expanded rules for order of operations.
2. examine examples in which the expanded rules are applied to arithmetic expressions.
3. describe how to evaluate an arithmetic expression using the order of operations.
4. apply the revised rules to complete interactive exercises.

Teacher, Learner Activity (TLA)

Activity 1.Teacher guides pupils to sing a BODMAS song as an introduction to the lesson.

a. Teacher guides pupils to brainstorm on the meaning of BODMAS

Activity 2. Teacher guides pupils to go through some practical BODMAS application examples.

b. Pupils repeat the practice as a drill for perfection/recollection.

Activity 3. Pupils try their hands on solving some practical questions provided by the multimedia courseware.

Activity 4. Teacher administers the post-test questions to pupils in other to compare the performance of the experimental group and the control group.

Solving basic arithmetic operators involving common fractions. Using BODMAS for the control group

Lesson Plan 1

Day: Monday

Date: 23rd May, 2016

Duration: 1hour

Time: 10:00am – 11:00am

Topic: Revision of previous knowledge of common fractions

1. Meaning of common fractions
2. Model common fractions
3. Subtraction of common fractions
4. Addition of common fractions
5. Multiplication of common fractions
6. Division of common fractions
7. Equivalent fractions

Relevant Previous Knowledge (R.P.K)

1. Pupils have an idea of the meaning of common fractions
2. Pupils model common fractions
3. Pupils could add and subtract common fractions
4. Pupils could multiply and divide common fractions
5. Pupils could find an equivalent fraction of another fraction

Objectives

By the end of the lesson, pupil will be able to;

1. State the meaning of common fraction
2. Model a common fraction
3. add common fraction
4. subtract common fraction
5. multiply common fraction
6. divide common fraction
7. Solve equivalent fraction

Teacher, Learner Activity (TLA)

Activity 1. Teacher takes pupils through the introduction of the lesson by brainstorming the aspects of common fractions.

Activity 2. Teacher guides pupils with leading questions to generate all other aspects of fractions forgotten by pupils.

a. Pupils try their hands on some practical questions provided by the teacher and later check their answers with their colleagues with the teacher facilitating the process.

Activity 3. Pupils are allowed to go through the fraction topics step by step while they brainstorm with their colleagues on the next step needed for each fraction question to be solved.

Lesson Plan 2

Day: Thursday

Date: 26th May, 2016

Duration: 1hour

Time: 10:00am – 11:00am

Topic: Application of mathematical operations/order of operation (BODMAS concept)

1. Bracket/parenthesis
2. Orders (Indices, exponents, powers and roots)
3. Division
4. Multiplication
5. Addition
6. Subtraction

Relevant Previous Knowledge (R.P.K)

Pupils can solve questions relating to;

1. Orders (exponents, indices, powers and roots)
2. Division of common fractions
3. Multiplication of common fractions
4. Addition of common fractions
5. Subtraction of common fractions

Objectives

By the end of the lesson, pupils should be able to;

1. restate the expanded rules for order of operations.
2. examine examples in which the expanded rules are applied to arithmetic expressions.
3. describe how to evaluate an arithmetic expression using the order of operations.
4. apply the revised rules to complete interactive exercises.

Teacher, Learner Activity (TLA)

Activity 1. Teacher guides pupils to brainstorm on the meaning of BODMAS

Activity 2. Teacher guides pupils to go through some practical BODMAS application examples written on the board.

Activity 3. Pupils try their hands on solving some practical questions provided by the teacher.

Activity 4. Teacher administers the post-test questions to pupils in other to compare the performance of the experimental group and the control group.

APPENDIX B

PRE - TEST QUESTIONS
College of Distance Education
University of Cape Coast

Simplify the expressions below:

1. $1/5 - 2/3 + \frac{1}{2}$

2. $\frac{1}{4} + 2/4 - 1/3$

3. $6 \times 2/6 + (1/5 - 2/5)$

4. $3/5$ of $10 \div 5/7$

5. $(3/4 + \frac{1}{2}) \div (6/5 - 2/5)$

6. $4/5 \div 6/7 + (3/6 - 1/3) \times 2$

7. $5/8 \times 6/10 - 2/8 \div (4/9 + 1/3)$

8. $(1/6 - 2/3)$ of $6/8 \div 4(2/7 \times 14)$

9. $[(12 \times 2/6) + (3/8 - \frac{1}{4})] \div 11/16$

10. $2^3 \div [(4/5 - \frac{3}{4}) \times 8] \div 5/7$

APPENDIX C

POST-TEST QUESTIONS

College of Distance Education

University of Cape Coast

Simplify the expressions below:

1. $1/3 + 2/5 - 1/3$

2. $3/4 - 2/3 + 1/4$

3. $(2/7 - 3/7) + 4/6 \times 12$

4. $6/7 \div 12$ of $3/5$

5. $(3/5 - 4/5) \div (2/3 + 1/6)$

6. $3/5 \div 9/10 + (4/9 - 2/3) \times 4$

7. $(5/9 + 2/3) \div 3/8 - 4/8 \times 3/6$

8. $(1/5 \div 2/3)$ of $6/9 \div 3\ (1/8 \times 16)$

9. $3^2 \div [(3/5 - 1/3) \times 5] \div 8/10$

10. $11/16 \div [(3/8 - 1/4) + (12 \times 1/3)]$

APPENDIX D

QUESTIONNAIRE

(Experimental Group)

College of Distance Education

University of Cape Coast

Technology Integration Survey (TIS)

Topic: The Effect of Multimedia Courseware in the Solving Common fractions to JHS 2 Pupils in Sunyani Garrison Schools - Ghana

The bearer of this questionnaire is undertaking a research on the above topic. Your candid responses to the items would be greatly appreciated. Be assured that your responses will be treated with utmost confidentiality. Thank you.

Section A

Please tick **(**√**)** in the spaces provided to indicate your response.

1. Gender: a) Male [ ] b) Female [ ]

2. Age (in years): a) 20-29 [ ] b) 30-39 [ ] c) 40-49 [ ] d) 50 and above [ ]

Section B

COGNITIVE LEVEL OF BEHAVIOUR

Tick [] where applicable.

VH = Very High H = High L = Low VL = Very Low

What is the level of easiness in solving questions related to the topics below?

	VH	H	L	VL
Addition				
Subtraction				
Multiplication				
Exponents				
Division				

Section C

IMPRESSION OF THE COURSEWARE USAGE

Tick [] where applicable.

SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree

	SA	A	D	SD
The lesson was interesting with the courseware.				
The content of the lesson was satisfactory.				
A similar courseware can be used tolearn without teacher supervision.				
Mathematics is important for my future career.				
Mathematics is an interesting subject I like.				

Section D

ATTITUDE OF TEACHERS TOWARDS THE TACHING OF MATHEMATICS

Tick [] where applicable.

SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree

	SA	A	D	SD
Teacher is very punctual and hardworking.				
Teacher is impatient when teaching and learning is taking place.				
Teacher has good relationship with pupils.				
Teacher is always in class when it is time for mathematics.				
Teacher is very confident when teaching mathematics.				
Teacher understands everything he/she teaches in mathematics.				
Teacher gives class exercises after every lesson.				
Teacher gives homework almost after every class lesson.				
Teacher often discusses marked exercises and homework with the class.				
Teacher understands pupils' individual abilities and factors it in the teaching process.				

Section E

LEARNING HABIT OF MATHEMATICS

	SA	A	SD	D
I allocate much time to study mathematics than other subjects.				
I study mathematics mostly with friends/relatives.				
I have learning materials that aids me in the study of mathematics.				
I am most at times motivated whenever I perform well in mathematics.				
The availability of learning materials encourages me to learn mathematics.				

What is your understanding level of mathematical concept when the following approaches are adopted? (Learning Style)

	VH	H	L	VL
During lesson delivery by listening more to teacher. (teacher centered)				
After the lesson by consulting friends. (Peer to peer learning)				
When the lesson is supported with drawings, films, maps, graphs and charts.				
By regular practice after lesson delivery.				
When lesson involves hands on experience.				

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Cape Coast

Our Ref. No: CCE/MED/17/Vol.1/034

12th May, 2016

Your Ref. No:

TO WHOM IT MAY CONCERN

This is to certify that **Mr. Emmanuel Eugene Ametepeh** with registration number **ED/MIT/14/0008** is pursuing a two year Master of Education Degree in Information Technology at the University of Cape Coast.

He is conducting a research on the topic **"The Effect of Multimedia Course ware in the Teaching and Learning of BODMAS concept to JHS 3 pupils in Ghana"**

We will strongly appreciate any courtesy extended to him.

Thank you.

Paul Nyagorme (PhD)
(Coordinator, eLearning and Technology)