UNIVERSITY OF CAPE COAST

COMPARATIVE EFFECT OF TEACHING APPROACHES ON SELECTED SCIENCE CONCEPTS IN INTEGRATED SCIENCE

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BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis 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: Mr. Eliot Kosi Kumassah

Supervisors' Declaration

We 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: Prof. Christian Anthony-Krueger

Co-Supervisor's Signature...................................... Date ....

Name: Dr. Godwin Kwame Aboagye

ABSTRACT

Studies have shown that students in science courses often have difficulty gaining a robust understanding of physical concepts such as linear momentum and direct current. Almost the same issues have been reported on teacher trainees of Colleges of Education in Ghana, i.e., most teacher trainees of colleges of education in Ghana face performance problems in some science concepts such as direct current, and linear momentum in integrated science. In order to address theses difficulties in teacher trainess, the study went through two phases, i.e., need analysis and intervention phases. With the need analysis, where 100 teacher trainees and 5 integrated science tutors were used, the study showed most teacher trainees faced challenges in direct current and linear momentum concepts. Again, most integrated science tutors employ combination of traditional and computer aided instructional approaches and that integrated science tutors face challenges with usage of computer aided combination of traditional and computer aided instruction approaches. With the intervention phase, where 20 teacher trainees were used in each Colleges of Education through two group non-equivalent quasi-experimental pretest-posttest design. The findings were that any of the three approaches, i.e., traditional, computer aided instruction 1 and computer aided instruction 2, could be used in teaching teacher trainees′ concept of momentum, applications of (momentum, change in momentum, conservation of momentum, collision, current, voltage, resistance in series, current in parallel circuit connection, and resistance in parallel circuit connection).

KEY WORDS

Computer Aided Instruction

Collision

Direct Current

Linear Momentum

Potential Difference

Resistance

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DEDICATION

To my son and daughter: Mr. Enoch Makafui Kosi Kumassah and Ms. Ruth Yawa Kumassah

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CHAPTER ONE

INTRODUCTION

This chapter is made up of background to the study, statement of the problem, purpose of the study, research questions, significance of the study, delimitation of the study, limitation of the study, definition of terms and organisation of the study.

Background to the Study

Momentum and direct current are some of the fundamental concepts in science, necessary for understanding a variety of phenomena of importance such as work, energy (potential and kinetic), impulse, power, pressure and force. The application of the law of conservation of momentum and some concepts such as collisions and current in solving problems and gaining deeper understanding are also a fundamental requirement of learning and doing science. However, investigations conducted among science students indicated that the difference between what are taught, and learnt in science classrooms is much greater than what most instructors perceived (Engelhardt & Beichner, 2004; McDermott, 1991).

This is due to the fact that studies done on linear momentum (George, Broadstock & Vazquez-Abad, 2000; Jewett, 2008; McDermott, 1991), for example have shown that students have difficulty understanding and in applying momentum concepts, especially the laws of conservation of momentum, in studying a phenomenon. In addition, most students have difficulty in qualitatively interpreting basic principles related to linear momentum and in applying it in physical situations. Further evidence in science education researches has shown that students have difficulties in conceptual understanding and reasoning in linear momentum and these problems in students have extended from the introductory level to the graduate level and beyond (George *et al*., 2000; Jewett, 2008; McDermott, 1991). Indeed, in traditional laboratories students have not been given enough conditions to inquire sufficiently into phenomena such as collisions that involve momentum (George *et al*., 2000). This has led to students having difficulties in linear momentum.

Students' difficulties and conceptual understanding in electricity have been studied extensively. A substantial amount of this research has been carried out at the secondary school level, as well as at introductory university courses, both for technical and non-technical careers. Most of the work so far focuses on students' ideas about direct current (dc) circuits, with few studies about alternating current (ac) circuits (Coppens, Cock & Kautz, 2012; Engelhardt & Beichner, 2004; McDermott, 1991).

It was also observed that students fail to see the direct current circuit as one entity and therefore analyse every component separately while 'going around' the circuit (Coppens *et al*., 2012; Engelhardt & Beichner, 2004; McDermott, 1991). Students interchangeably use terms associated with circuits, often assigning the properties of current either to voltage, resistance, energy or power (Engelhardt & Beichner, 2004). The situation of students' difficulties in linear momentum and direct current is not only prevalent in other countries alone but it is also found among teacher trainees of Colleges of Education in Ghana (Institute of Education, 2008, 2009, 2011, 2013a, & 2013b).

Integrated science is one of the programmes studied by teacher trainees in all Colleges of Education in Ghana. A recommendation has been made in the integrated science syllabus that tutors should endeavour to employ diverse teaching approaches in order to enhance teacher trainees understanding of science concepts (Institute of Education, 2014). Linear momentum and direct current are some of the various concepts in integrated science but most teacher trainees have problems in understanding these two concepts (Institute of Education, 2008, 2009, 2011, 2013a, & 2013b). Could these problems faced by teacher trainees be due to; teaching approaches of tutors, teacher trainees' learning style, insufficient teaching and learning facilities in the Colleges of Education and whether instructors lacked employment of modern (blended) teaching approaches? Actually, these are some of the areas, which need investigation.

Students' understanding of fundamental concepts of science topics has been an exciting research area for some years now. This is so because literature suggests that students come to class with a range of informal ideas and experiences with most of them different from scientific conceptions (Engelhardt & Beichner, 2004; McDermott, 1991; Taşlıdere, 2013). Learners' experiences of the world, the influence of their peers, the media and pre-instructions have been suggested to lead students to develop these conceptions (Taşlıdere, 2013). Students' incorrect pattern of response, informal ideas, non-scientific interpretations and conceptions leading to conflict with scientific view were termed differently as "misconceptions", "alternative frameworks", or "alternative conceptions" by different authors (Engelhardt & Beichner, 2004; McDermott, 1991; Osborne, 1983; Suchai & Thasaneeya, 2012; Taşlıdere, 2013; Wandersee, Mintzes, & Novak, 1994).

All over the world, science classrooms are filled with students who have diverse ideas. Many of these students may have grown up with computers and the internet. Some may primarily be visual learners, some auditory learners and some kinesthetic. Others may be gifted and talented. Others too may struggle with physical, mental, behavioural or emotional challenges (Björklund, 2013; Tong, 2012). It is based on this background that both constructivist and sociocultural views of learning suggest that the focus of science teaching and learning should rather be shifted from theory to practice and from passive to active (Sean, Brophy & Schwartz**,** 2000).

The constructivist and sociocultural views of learning have brought in its wake many approaches to make teaching and learning of science concepts in the quest to bridge the gap between theory and practice and passive and active learning in science education. These approaches include the integration of interactive analogies (Sean *et al*.**,** 2000), usage of interactive whiteboards (Beauchamp, 2004; Cogill, 2002), usage of interactive computer simulations (Lane, & Peres, 2006; Perkins, Lancaster, Loeblein, Parson, & Podolefsky, 2010), usage of images, animations and videos (Cogill, 2002), usage of blended teaching (Poon, 2013), utilization of demonstration (Alorvor & el Sadat, 2011), and usage of computer assisted instructions (Lane *et at*., 2010) in lesson delivery by teachers.

All these approaches to teaching and learning of science concepts have shown tremendous effects in teaching and learning of science (Chang, Jones, & Kunnemeyer, 2002; Laferrière, Erickson, & Breuleux, 2007; Lane, & Peres, 2006; Lane *et al*., 2010; Perkins *et al*., 2010). Most of these approaches, as applied in science education, are part of traditional and modern. Some examples of traditional methods used in the teaching and learning of science are the use of lecture, question and answer, discussion, role-play, and storytelling. Some examples of modern methods applied in the teaching and learning of science are the use of images, animations (cartoon characters), videos, interactive whiteboard, computer simulations and blended (traditional and technology). However, the application of traditional and modern approaches (blended approach) to teaching and learning in integrated science in Ghana schools appears to be minimal (Antwi, Hanson, Savelsbergh, & Eijkelhof, 2011), which then makes it prudent to embark on this study.

Technology generally is seen as the study and knowledge of science and use of scientific discoveries to solve the needs and problems of man (Dunmire, 2010; Earle, 2002; Marshall, 2002). Thus, technology in this sense is a tool and a process employed by people to solve their problems. Technology as a tool is based on systematic knowledge of how to design artefacts such as technology instructions (Luppicini, 2005). Technology as a process concerns itself with problem-solving by using human and other resources to seek solutions to human problems (Earle, 2002; Marshall, 2002) such as improving on pedagogy in the classroom to improve students' understanding of science concepts.

In the 21st century, mentioning technology inspires thoughts of advancement, improvement, progress in scientific discoveries. But, in modern times, the lack of technology stirs feelings towards a practice as antiquated, ineffective, and clumsy (Dunmire, 2010). Notwithstanding, sometimes the failures of technology, the remarkable advances in technology over the past few years have provided new hope for science education that technological solutions, intelligently applied, can allow greater access, higher quality, and lower cost per learner (Brown, 2005).

Today the demand for technology in science education is high, and when technology is used thoughtfully and is student-centered, its results are gratifying. Actually, the world today has witnessed the power of technology in science education, which has enabled people to learn, interact and simulate with computers, even in the most remote areas of the developing world such as Ghana (Brown, 2005).

Enhancing student-learning experiences has become more important in the education of recent times due to increased student enrollment and diversification (Poon, 2013). Advances in technology provide new opportunities for teachers to design and deliver their courses in ways that support and enhance the teachers' role, the students' individual cognitive experiences, as well as the social environment (Bath & Bourke, 2010). One of such ways to apply these advances of technology in the classroom situation is through the computer aided instructions (CAI) to teaching and learning (Collins, Deck, & McCrickard, 2008; Mann, 2009; Yu-bao, Qian-li, & Shao-tang, 2009). It is therefore not just about using technology because it is available, but finding better ways of supporting students in achieving learning objectives. That is by providing them with the best possible learning experiences, as well as supporting teachers in their teaching roles (Bath & Bourke, 2010).

Computer aided instruction (CAI) is currently a new emerging teaching and learning approach in classroom instructions (Collins, Deck, & McCrickard, 2008; Mann, 2009; Yu-bao, Qian-li, & Shao-tang, 2009). However, in reality, this teaching and learning approach is in itself not a new teaching and learning approach (Mann, 2009). That is, for most courses of modern times, there has always been an element of CAI with traditional teaching method (Mann, 2009). For example, a traditional face-to-face course with integration of power point, videos and computer simulations (Bath & Bourke, 2010).

There are some many definitions of a CAI to teaching and learning; one of such definition is that CAI is seen as an instruction or remediation presented on a computer (Collins, Deck, & McCrickard, 2008; Yu-bao, Qian-li, & Shao-tang, 2009). It is also seen as an aid or assistance towards the teaching and learning process using a computer (Yu-bao, Qian-li, & Shao-tang, 2009). This study agrees with the definition of Yu-bao, Qian-li, & Shao-tang (2009) that CAI to teaching and learning is about effective integration of power point, videos, animations, images, pictures, computer simulation among others into traditional teaching courses design to enhance the teaching and learning experiences for students and teachers. It is important to note that CAI should not be considered as a single program or application that fulfill a certain task as desired by the user. CAI can be a single or series of programs or application which acts as an aid to the overall teaching and learning process.

CAI will enable teachers and students to engage in ways that would not normally be available or effective in their usual environment, whether it is traditional primarily face-to-face or distance mode with the aid of computer. In this respect, CAI to learning in this study is the face-to-face combination of traditional and integration of power point, video and computer simulation to teaching and learning of linear momentum and direct current. This CAI is believed to have enhanced students understanding and application of science concepts (Collins, Deck, & McCrickard, 2008; Mann, 2009; Yu-bao, Qian-li, & Shao-tang, 2009). Effective usage of CAI in the classroom makes the classroom environment and instructions very interactive (Collins, Deck, & McCrickard, 2008; Mann, 2009; Yu-bao, Qian-li, & Shao-tang, 2009).

Interactive strategies are those approaches, which makes classroom teaching and learning lively and is more of learner-centred than teacher centred as it involves broader and more diverse approaches to teaching and learning (Tomljenović, 2015). What do we want our students to get out of the science programmes and teaching? Often these goals include improved conceptual understanding, improved critical thinking and improved writing and communication skills (Allain, Abbott, & Deardorff, 2006). Improved conceptual understanding of students about concepts of linear momentum and direct current (dc) is much of concern to this study and it is believed would bring out in students (1) improved critical thinking and (2) improved writing and communication skills.

This can be achieved through integration of CAI into traditional teaching methods i.e., integration of CAI (power point, video and computer simulation) into traditional (lecture, question and answer and discussion) to teaching linear momentum and direct current (Kadzera, 2006; Marković, 2013) for meaningful understanding by students. This is because CAI alone cannot bring about meaningful learning in students if not combined with traditional methods to teaching such as lecture, question and answer and discussion. Perkins (1999) was of the view that employment of appropriate teaching approaches for "conceptually difficult knowledge" is an arrangement of inquiry processes that confront students with discrepancies in their initial theories. Students discrepancies could be addressed using 'interactive engagement approaches' (CAI) as it help in eliminating alternate conception in students (Taşlıdere, 2013). This is because students having alternative concepts are one of the important problems preventing them from learning science but the use of CAI in teaching of science has the potential of removing students' misconception. For this study, traditional teaching approach comprise of lecture, question and answer, and the discussion method; computer aided instruction 1 is composed of lecture, question and answer, discussion, power point, and video while computer aided instruction 2 comprised of lecture, question and answer, discussion, power point, video, and computer simulation.

Teaching and learning of integrated science concepts whether in developed or developing country like Ghana requires the use of various teaching aids, apparatus, materials and methods (Institute of Education, 2014; Odera, 2011). In most areas of science education, the use of CAI (power point, video and computer simulation) is quite acceptable and highly recommended to enhance learning. Researchers have pointed out the capabilities of CAI (power point, video and computer simulation) to improve students' scientific knowledge and it is stated that CAI gives science teachers access to rich variety of textual materials and graphic information (Chang *et al*., 2002; Laferrière *et al*., 2007; Lane, & Peres, 2006; Odera, 2011; Perkins *et al*., 2010). However, in some applications of CAI (power point, video and computer simulation), especially those involving abstract reasoning and problem-solving processes, CAI has not been very effective in general. Critics claim that poorly designed CAI can dehumanise or regiment the educational experience and thereby diminish students' interest and motivation (Lane *et al*., 2010).

Notwithstanding these setbacks in CAI, its effectiveness abounds. That is information that helps teachers teach or encourages students' interaction can be presented in the form of text or in multimedia formats, which include images, photographs, videos, animation, speech, music and simulation (Chang *et al*., 2002; Laferrière *et al*., 2007; Lane, & Peres, 2006; Odera, 2011; Perkins *et al*., 2010). As it stands, employment of CAI in the teaching and learning of science in the Colleges of Education could help enhance teacher trainees' performance in linear momentum and direct current concepts.

Due to constant changes and developments of the 21st century, the environments in which teaching and learning take place have changed (Anderson & Shattuck, 2012; Elgazzar, 2014; Joseph, 2004). These have paved the way for novel ways to research into teaching. It has also made it possible to explore how teaching and learning could be supported with the current teaching and learning innovative methods to bring about meaningful performance in students. One of such approaches to research teaching and learning is research using quasi-experimental designs (Joseph, 2004; Fishman, Penuel, Allen, Cheng, & Sabelli, 2014; Hoadley, 2004). This is because it develops a methodology of experimenting with interventions in the classroom for teaching and learning that accounted for the multiple interactions of people acting in a social setting (Dawson & DeWitt, 2013; Sandoval & Bell, 2004).

It has been argued that quasi-experimental researches have potential for the study of computer aided instructions enhanced learning environments such as the use of combination traditional and computer aided instructions methods in science teaching. Combination of the traditional and CAI are still evolving and much needs to be learned about effective practices to teaching and learning with combination traditional and CAI in science education (Snelson, 2006). Despite the challenges of implementing this multifaceted approach of quasi-experimental research, yet it has the potential to provide new insights into learning and teaching in science education, which invariably has effect on science educational practices (Abdallah, 2013; Bergroth-Koskinen & Seppälä, 2012; Meijer, Bulte, & Pilot, 2013). In view of this, quasi-experimental research design was the appropriate methodology for this study. This was carried out in two stages of (1) need analysis, (2) intervention phase.

Statement of the Problem

Studies have shown that students in science courses often have difficulty gaining a robust understanding of universal physical principles concepts of linear momentum and direct current (Dostal, 2005; Engelhardt & Beichner, 2004; Graham & Berry, 1996; Lawson & McDermott, 1987; McDermott, 1991). Almost the same issues have been reported on teacher trainees of Colleges of Education in Ghana. For example (1) with the concept of direct current, the Chief Examiner's report for August 2008, 2009 and 2011 on integrated science (FDC 224: Science 3) indicated that majority of candidates could not realise that when a potential difference across a resistor is doubled, the current is also doubled; that candidates could not differentiate between electromotive force (e.m.f) and potential difference (p.d) of a cell. (2) With the concept of linear momentum, the Chief Examiner's report for August 2008, 2009 and 2011 on integrated science (FDC 224: Science 3) indicated that momentum is a concept candidate had not mastered. It was observed that candidates multiplied masses suggesting that they were not familiar with mathematical problems on momentum.

Based on the Chief Examiner's report on integrated science, it is clear that teacher trainees have performance problems in concepts that involve direct current and linear momentum. Could the teacher trainees' performance problems be due to integrated science tutors factors, teacher trainees' factors and or institutional factors? Since the Chief Examiner's report could not indicate explicitly, the root of the problems of teacher trainees, and for lack of published work of teacher trainees' performance in linear momentum and direct current Colleges of Education in Ghana has shown a need for this research. In view of the foregoing issues, it has become imperative to carry out a study to see if using combination of the traditional and CAI would enhance teacher trainees' performance in linear momentum and direct current.

Also, because literature has reported the effectiveness of the traditional and CAI teaching approaches such as lecture, discussion, question, answer, power point and video and computer simulation (Collins, Deck, & McCrickard, 2008; Mann, 2009; Sarabando, Cravino, & Soares, 2014; Spodniaková Pfefferová, 2015; Yu-bao, Qian-li, & Shao-tang, 2009) and yet, has not been explicitly specific as to the best teaching approach, this study would compare the traditional method and combination of the traditional method and CAI (i.e., computer aided instruction 1 and 2). This comparison of traditional and combination of traditional method and CAI through two groups quasi-experimental design to see which of these methods are the best plausible in teaching linear momentum and direct current concepts at the Colleges of Education level. Hence the need for this current study.

Purpose of the Study

The purpose of this study was to investigate the effectiveness of the traditional and combination of traditional and CAI approaches on teacher trainees' performances of concepts in linear momentum and direct current at the Colleges of Education. Specifically, the study went through two stages. Firstly, need analysis was done to ascertain whether teacher trainees' encounter problems with concepts in linear momentum and direct current and whether integrated science tutors use combination of traditional and CAI approaches in their teaching. Secondly, the intervention phase of the study was carried out.

Research Questions

The following were the four main questions that guided the study:

1. What challenges do Colleges of Education teacher trainees face in the learning of concepts of linear momentum and direct current?
2. What teaching approaches do colleges of education science tutors employ in the teaching of concepts of linear momentum and direct current?
3. What plausible combination of traditional and CAI teaching approaches would enhance teacher trainees' performance in linear momentum and direct current?
4. What challenges do colleges of education science tutors' face in employing combination of traditional and CAI teaching approaches in the teaching of concepts of linear momentum and direct current?

Research Hypothesis

The only main research hypothesis that guided the study and tested at 0.05 level of significance was:

Ho: There is no statistically significant difference in performance among teacher trainees taught with the traditional approach and teacher trainees taught with combination of traditional and computer aided instruction 1 and computer aided instruction 2 approaches.

H1: There is a statistically significant difference in performance among teacher trainees taught with the traditional approach and teacher trainees taught with combination of traditional and computer aided instruction 1 and computer aided instruction 2 approaches..

Significance of the Study

It is of the hope that the findings of this study would unearth to integrated science tutors the difficulties the Colleges of Education teacher trainees face with the learning of linear momentum and direct current concepts in integrated science. It is of the hope also that the findings of the study will unearth the difficulties the Colleges of Education integrated science tutors face with the use of traditional and CAI approach in teaching of linear momentum and direct current concepts in integrated science.

It is of the hope that the findings of this study would inform the policy makers such as Ministry of Education, National Accreditation Board, National Council for Tertiary Education, National Teaching Council, Ghana Education Service, Curriculum Research Development Division, Teacher Education Division on the challenges integrated science tutors and colleges of education teacher trainees faced with the teaching and learning of linear momentum and direct current.

It is of the hope that the findings of this study would inform the Ministry of Education, National Accreditation Board, National Council for Tertiary Education, National Teaching Council, Ghana Education Service, Curriculum Research Development Division, Teacher Education Division on the traditional and CAI approach used in this study, so that there could be a national policy on its usage in the colleges of education not only in integrated science but in other subjects as well.

Delimitation

There are many aspects of traditional teaching approaches such as lecture, expanded lecture, question and answer, discussion, group work, role-play, storytelling, and brainstorming as already mentioned. The study employed lecture, question and answer and discussion in teaching and learning of linear momentum and direct current. This is because studies have shown the effectiveness of lecture, question and answer and discussion in enhancing students' performances in science concepts in general (Barnes, & Blevins, 2003;Benckert, & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Casado, 2000; Chaudhury, 2011; de Caprariis, Barman, & Magee, 2001; Holubová, 2010; G¨u´emez, Fiolhais, & Fiolhais, 2009; Hussain, Azeem, & Shakoor, 2011; Morgan, Whorton, & Gunsalus, 2000; Qualters, 2001; Perkins, & Saris, 2001; Yoder & Hochevar, 2005).

Also, there are many aspects of computer aided instructions such as films, power point presentation, videos, animations (cartoon characters), images, computer simulations, and games among others. The study employed power point, video and computer simulation in teaching and learning of linear momentum and direct current. This is because studies have shown the effectiveness of power point, video and computer simulation in enhancing students' performances in science concepts in general (Abbasi, Hazrati, Mohammed, & Rajaeefard, 2013; Bang & Luft, 2013; Bishop & Verleger 2013;

Brill & Galloway, 2007; Gulek & Demirtas, 2005; Guzey & Roehrig, 2009; Hussain, Azeem, & Shakoor, 2011; Ketelhut, Nelson, Clarke & Dede, 2010; Sadedhi, Sedaghat & Ahmadi, 2014; Zacharia, 2003).

Furthermore, there are many concepts in integrated science studied at the colleges of education such as rate of chemical reaction, linear momentum, direct current, organic chemistry, and living and non-living things. The study was limited to direct current and linear momentum. This is because (1) these concepts had almost every year been problems to teacher trainees as has been reported by the Chief Examiners of integrated science, and (2) these two concepts are the bases of other science concepts such as work, energy (potential and kinetic), impulse, power, pressure and force.

Finally, currently, there are 43 colleges of education with 38 colleges of education being public and five colleges of education being private offering integrated science. But because of convenience, the study was limited to four public colleges of education, namely Colleges-A, B, C and D.

Limitations

Instead of conducting an entry behaviour tests on the second year teacher trainees in the selected college of education before the commencement of the study for the teaching of the intervention lessons in direct current and linear momentum. The study rather stood on the assumptions that (1) teacher trainees entered the colleges of education with the same entry behaviour that is a minimum grade of D7 in three core subjects (English Language, Integrated Science and Core Mathematics), and any other three elective subjects in

WASSCE, and (2) teacher trainees did integrated science in their first year first semester as a core subject in all colleges of education in Ghana.

The limitation here was that some of the teacher trainees in the selected colleges of education might have entered with very higher grades than the minimum D7, so the study might not get the same knowledge, reasoning, application of knowledge and understanding outcomes from the teacher trainees because the teacher trainees entry behaviours may not be the same.

Also, 20 (40%) out of 50 (100%) of the teacher trainees in each of the selected four colleges of education participated in the study. So, the outcome of the results might not give the accurate and or true reflection of the entire intact-class, on the teacher trainees' performance in linear momentum and direct current.

Furthermore, the study could not look at gender (male and female), since studies in Africa had shown that male students do better than female students in science courses and programmes such as the one in this study.

Finally, the study could not use the actual practical aspects of momentum and direct current (experiment) as a teaching approach to the other methods used. The lack of the practical aspects of momentum and direct current to some extent could affect the outcome of the study since most of the teacher trainees interviewed agitated for the practical science approach in the study.

List of Abbreviations

WASSCE: West African Senior School Certificate Examination

WAEC: West African Examination Council

MoE: Ministry of Education

NCTE: National Council for Tertiary Education

GES: Ghana Education Service

NTC: National Teaching Council

TED: Teacher Education Division

CRDD: Curriculum Research and Development Division

CoE: Colleges of Education

Organisation of the Study

The study is made up of five chapters. Chapter one is the introduction and is made up of background to the study, statement of the problem, purpose of the study, research questions, , significance of the study, limitation of the study, delimitation of the study, and definition of terms.

Chapter two is the literature review and is made up of the concept approaches to teaching, traditional approaches to teaching, literature analysis on traditional approaches to teaching, modern approaches to teaching, the PhET computer simulation, literature analysis of modern approaches to teaching, two groups quasi-experimental research design, brief dsicription of the research framework of the study, the design framework of the study and design principles of the study.

Chapter three is the research methods and is made up of research design, population, sample, sampling procedure, data collection procedures, research instruments, pre-testing of the research instruments, reliability of the research instruments, validity of the research instruments, scoring of the test items, intervention lessons, arrangement of initial teaching plans of the intervention lessons, and data processing and analysis.

Chapter four is the results and discussion and is made up of need analysis phase, teaching approaches of integrated science tutors in College-A, plausible combination of traditional and CAI approaches to enhance teacher trainees' performance in concepts of linear momentum and direct current, integrated science tutors challenges in the usage of combination of traditional and CAI approach in the teaching of concepts of linear momentum and direct current, intervention phase: teaching in Colleges-B, C and D, focused group interview schedule in Colleges-B, C and D.

Chapter five is the summary, conclusion and recommendation is made up of summary, key findings of the study, conclusions, recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

This chapter is made up of the concept of approaches to teaching, i.e., traditional approach to teaching, literature analysis on traditional approach to teaching, modern approach to teaching, the PhET computer simulation, literature analysis on modern approaches to teaching, a brief description of the research framework of this study, design principles of the study.

Teaching Approaches Concepts

Teaching approaches concepts could be seen as the general principles, pedagogy and management strategies used for classroom instruction (Renau, 2016). In addition, it is a set of principles, beliefs or ideas about the nature of learning, which is translated into the classroom (Johnson, 2015). Thus, approaches to teaching are the different kinds of teaching techniques that both teachers and learners use in a teaching and learning environment. There are different kinds of approaches to teaching, but this study will put all the approaches to teaching into two, that is traditional and modern.

Traditional teaching approach

Many scholars have defined the traditional teaching approach. This study generally agreed with the notion of Johnson (2015), that traditional teaching approach could generally be viewed as teacher-directed where the teacher mostly is perceived as the dispenser of knowledge, the arbitrator of truth, and the final evaluator of learning and in which students follow cookbook steps of activities and demonstrations (Harris & Johnson, 2003). A critical look at Johnson (2015) meant that this traditional approach might not provide students with much valuable skills or even with a much body of knowledge that would last much beyond the end of an academic semester or in life (Khalid & Azeem, 2012).

Some traditional teaching approaches ignore students' mental level and interest (Khalid & Azeem, 2012) but rather involve coverage of the context and rote memorization of students (Khalid & Azeem, 2012). It does not involve students' inherent creativity and thinking abilities but rather is perceived to have prevented students' participation in the creative activities in the teaching and learning processes, while some also involves students mental level and interest (Serbessa, 2006) such as discussion, question and answer, group work, cooperative learning, and story-telling. Surprisingly this same traditional approach to teaching which had been criticised as a weak approach has a long-standing history of success and effectiveness of students understanding of concepts in humanities and sciences (Serbessa, 2006).

Empirical studies of traditional teaching approaches

Many studies and authors had critiqued the use of traditional teaching approaches as not good an approach to teaching that had made students over the years be rote and passive learners (Harris & Johnson, 2003; Johnson 2015; Khalid & Azeem, 2012; Serbessa, 2006). Yet its use had helped in transmitting knowledge and has assisted in unearthing certain discoveries in humanities and sciences (Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011; G¨u´emez, Fiolhais & Fiolhais, 2009; Hussain, Latiff, & Yahaya, 2012; Holubová, 2010; Kock, Taconis, Bolhuis, &

Gravemeijer, 2015; Qualters, 2001). This is because Hussain, Latiff, and Yahaya (2012) conducted a study using a traditional approach where they evaluated and analysed alternative conceptions among students about an open and short circuit concept. They used first-year electrical engineering students. Their study sought to find out students alternative conceptions. Students' pre-and post-test answers to three questions on concept test were analysed. The results show that students held very strong alternative designs on the concept tested.

Karamustafaoglu (2009) conducted a study on active learning strategies in physics teaching. The purpose of the study was to determine physics teachers' opinions about student centered activities applicable in physics teaching and learning in context. A case study approach was used in the research. First, semi-structured interviews were carried out with 6 physics teachers. Then, a questionnaire was developed based on the data obtained from the interviews. This questionnaire was implemented to 40 physics teachers in Amasya, a small provincial city in Turkey. Finally, a semi-structured observation chart was used in physics lessons to determine how these activities were demonstrated. In this way, the relation between teachers' views about active learning techniques and their actual implementation were compared. The findings indicated that although teachers were aware of student-centered physics instruction, they were still using traditional techniques widely.

Deslauriers, Schelew, and Wieman (2011) conducted a study on improved learning in a large-enrollment physics class. They compared the amounts of learning achieved using two different instructional approaches under controlled conditions. They measured the learning of a specific set of topics and objectives when taught by 3 hours of traditional lecture given by an experienced highly rated instructor and 3 hours of instruction given by a trained but inexperienced instructor using instruction based on research in cognitive psychology and physics education. The comparison was made between two large sections (N = 267 and N = 271) of an introductory undergraduate physics course. They found increased student attendance higher in engagement with the traditional lecture more than twice the learning in the section taught using research-based instruction.

Marušić and Sliško (2012) conducted a study into influence of three different methods of teaching physics on the gain in students' development of reasoning. The Lawson Classroom Test of Scientific Reasoning (LCTSR) was used to gauge the relative effectiveness of three different methods of pedagogy, Reading, Presenting, and Questioning (RPQ), Experimenting and Discussion (ED), and Traditional Methods (TM), on increasing students' level of scientific thinking. The data of a one-semester-long senior high-school project indicate that, for the LCTSR: (a) the RPQ group (n=91) achieved effect-sizes d=0.30 and (b) the ED group (n = 85) attained effect-sizes d=0.64. These methods have shown that the Piagetian and Vygotskian visions on learning and teaching can go hand in hand and as such achieve respectable results. To do so, it was important to challenge the students and thus encourage the shift towards higher levels of reasoning. This aim was facilitated through class management which recognizes the importance of collaborative learning. Carrying out Vygotsky's original intention to use teaching to promote cognitive development as well as subject concepts, this research has shown that it is better to have students experience cognitive conflict from directly observed experiments than by reflecting on reported experience from popularization papers or writings found on the internet.

Tural (2013) conducted a study on the functioning of context-based physics instruction in higher education. The study examined the effects of context-based physics instruction on undergraduate students' achievement compared to traditional physics instruction at a university. Three topics were utilized: potential energy, kinetic energy, and rotational kinetic energy. Also, the effect of context-based physics instruction about students' attitudes towards physics was determined alongside what students think they have gained with context-based physics instruction. The study used both qualitative and quantitative dimensions in terms of using achievement test and the interview. The sample of the study was second year undergraduate students of Primary School Teaching Program. The findings from the study showed the context based approach application on the subjects created no significant effect on students' exam scores. However, students' attitudes were positive.

Williams and Clement (2014) conducted a study on identifying multiple levels of discussion-based teaching strategies for constructing scientific models. This study sought to identify specific types of discussion-based strategies that two successful high school physics teachers using a model-based approach utilized in attempting to foster students' construction of explanatory models for scientific concepts. They found out that, in addition to previously documented dialogical strategies that teachers utilize to engage students in effectively communicating their scientific ideas in class, there is a second level of more cognitively focused model-construction-supporting strategies that these teachers utilized in attempting to foster students' learning. A further distinction between macro and micro strategy levels within the set of cognitive strategies was proposed. The relationships between the resulting three levels of strategies were portrayed in a diagramming system that tracks discussions over time. The study attempts to contribute to a clearer understanding of how discussion-leading strategies may be used to scaffold the development of conceptual understanding.

Kock et al (2015) conducted a design research cycle to investigate how physics instruction aimed at creating a classroom culture of inquiry that can contribute to Grade 9 students' understanding of theoretical concepts in direct current electric circuits. A hypothesised local instruction theory and classroom pedagogy were created in cooperation with three physics teachers, emphasising (a) establishing classroom norms of inquiry, (b) providing a theoretical starting point, (c) using targeted experiments guided by conceptual questions, and (d) theory-oriented, whole-class discussions. After data collection, retrospective analysis of one class showed that the enactment of the local instruction theory and the development of classroom norms of inquiry had led to the expected learning processes and increased student conceptual understanding. Science education promoting the nature of science as inquiry might consider the importance of an effective local instruction theory and the social classroom processes that require science-oriented classroom norms.

Bligh (2000) conducted an extensive meta-review of literature on the use of the lecture approach. Bligh reviewed over one hundred studies comparing the lecture approach against other teaching methods such as discussion, independent reading, and inquiry projects. The main criterion for the extensive meta-review of literature was students' acquisition of information. The evidence supported his assertion that the lecture approach was valid as any other teaching methods for transmitting information.

Chaudhury (2011) presented evidence in the favour of the lecture approach that the lecture approach can be a useful element of instructional practice. He asserted that most lecture approaches are not devoid of specific activities that involve students' active participation in learning of a subject. A study by Barnes and Blevins (2003) revealed that active, discussion-based methods are inferior to the traditional lecture-based method. A study by Qualters (2001) showed that students do not favour active learning approaches because of the in-class time taken by the activities, fear of not covering all of the material in the course, and anxiety about changing from traditional classroom expectations to the active structure. A study by Carpenter (2006) on the effectiveness of teaching methods through multiple comparisons revealed that student performance improved under the lecture method as compared to the lecture and discussion.

In contrast to the above studies, Holubová (2010) conducted a study to improve the quality of teaching science by modern teaching approaches (e.g., problem-based learning, didactic games, how to express the idea with a pencil (mind maps and tasks), discussion (use of brainstorming, Philips 66, and Hobo, brainstorming, and heuristic approach). These approaches were tested during high school physics lessons in Olomouc and Skuteč. The approaches were used in various classes by in-service teachers and by pre-graduated teachers. The findings of the study made him recommend interactive teaching approaches in teaching science for meaningful understanding by students. What this study failed to do was it could not specify the types of interactive approaches, such as traditional and modern. This is because both modern and traditional approaches have interactive approaches within its confinement. For example, limiting to only traditional approach, approaches like discussion, question and answer, story-telling, group discussion, guided discovery, cooperative learning are interactive in nature and students centered (Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011; G¨u´emez & Fiolhais, 2009; Holubová, 2010; Qualters, 2001). The reality is that these traditional approaches have been working and teachers frequently employ these traditional approaches when teaching (Serbessa, 2006). Therefore, it very difficult to agree with some authors that this traditional approach is not good an approach to use in teaching for meaningful understanding in students. This is because any approach has its own merits and demerits, so it depends on how the teacher employs a particular approach and the respective activities the teacher embarks upon.

Benckert and Pettersson (2008) conducted a study on students learning of physics involving group discussions around context-rich problems in introductory physics courses at university level. Their study revealed that group discussions around physics problems stimulate learning discussions of physics. G¨u´emez, Fiolhais and Fiolhais (2009) used toys in their physics lectures and observed that toys are not only very useful in lectures and demonstrations to motivate students but makes instruction in physics very interesting. The findings of a study by de Caprariis, Barman, and Magee (2001) suggest that lecture leads to the ability to recall facts, but discussion produces higher-level comprehension. Further, research on group-oriented discussion approaches revealed that team learning and student-led discussions not only provide favourable student performance outcomes but also foster greater participation, self-confidence and leadership ability (Perkins & Saris, 2001; Yoder & Hochevar, 2005).

A comparison of lecture combined with discussion versus active, cooperative learning approaches by Morgan, Whorton, and Gunsalus (2000) revealed that the use of the lecture combined with discussion resulted in superior retention of material among students. Research by Casado (2000) examined perceptions across six teaching methods (lecture and discussion, lab work, in-class exercises, guest speakers, applied projects, and oral presentations). His study revealed that students preferred lecture and discussion approach most to though lab work, oral presentation, and applied projects. Based on these assertions of researchers on effective combination of traditional approaches, the study, therefore, employed lecture, question and answer, and discussion (LQAD) as a teaching approach.

Modern teaching approach

A modern teaching approach focuses more on innovative activities and knowledge acquisition (Harris & Johnson, 2003; Johnson, 2015; Khalid & Azeem, 2012). Some examples of modern teaching approaches are power point, video, animation, computer simulation, and the media.

Designed innovative instructional interventions based on modern learning theories and advanced learning technologies are advocated for the acquisition of quality knowledge (Sarfo, Clarebout, & Louw, 2010). As a result of substantial curriculum reforms, teaching and learning in many countries worldwide is now supposed to be learner-centred in nature and to employ innovative teaching approaches that meet learner's needs (Sarfo, Clarebout, & Louw, 2010). Actually, educational researchers are now calling for the inclusion of modern technology in schools' instructional delivery (Borota, 2010). Technology has been changing in both the strategies of teaching and the processes of learning. Using power point, video and computer simulation are some of the simple ways to integrate technology into the classroom (Cruse, 2007). Nevertheless, in doing this, it is important to plan carefully the follow-up and evaluation of power point, video and computer simulation integration into the classroom instructions. While doing this, one is primarily interested in the adequacy, applicability and effectiveness of the power point, video and computer simulation approaches (Borota, 2010).

However, Lei and Zhao (2007) in their study supported employment of innovative interventions and technologies in science teaching and learning. To this effect, they proposed specificity to the general usage of these technologies and innovative interventions. That particular usage of these educational innovativeness and technologies in their study brought out the right desired outcomes in students in specific lessons. Given the assertion of Lei and Zhao (2007) on the viability of specific to the general usage of educational innovativeness and technologies, this study used linear momentum and direct current aspect of PhET simulation (Perkins, Adams, Dubson, Finkelstein, Reid, Wieman, & LeMaster, 2006). These two simulations, i.e., linear momentum and a direct current of PhET simulation were specific educational innovativeness and technologies to the purpose of this study.

The PhET computer simulation

PhET stands for physics education technology (Perkins *et al*., 2006) designed by a group of researchers in the university of Colorado at Boulder, USA. This project creates useful computer simulations for teaching and learning specific concepts in physics (Perkins *et al.*, 2006) and makes them freely available from the PhET website (http://phet.colorado.edu). This simulation is animated, interactive, and game-like environments in which students learn through exploration.

The PhET simulation, has been tested and validated (Perkins *et al*., 2006). In addition other researchers had tried it on students which had yielded desired results (Ajredini, Izairi, & Zajkov, 2013; Chamberlain, Lancaster, Parson,

& Perkins, 2014; Khatri, Henderson, Cole, & Froyd, 2016; Kriek, & Stols, 2010; Rutten, van Joolingen, & van der Veen, 2012; Wieman, Adams, Loeblein, & Perkins, 2010; Wieman, Perkins, & Adams, 2008). Therefore, based on the outcome of other studies on the use of PhET simulation, the study adopted the linear momentum and direct current aspect of it.

Empirical studies of modern teaching approaches

In contrast to the traditional teaching approach, George, Broadstock, and Vazquez Abad (2000) conducted a study that used modern-based instructional approaches (microcomputer-based laboratories (MBL) and digital video analysis of experimental data (DVA)) on undergraduate students' learning of physics specifically linear momentum. The video and audio tapes of the lab activities showed that there were differences in time of using these tools to conduct an experiment, and differences in students' discussion time and their interaction while using these tools. Students' lab books and interviews showed that most students using MBL and DVA technologies could easily describe what happens to momentum and energy during different collision processes.

Spodniaková Pfefferová, (2015) conducted a study on computer simulations and their influence on students' understanding of oscillatory motion. In this study he discussed the use of simulations in the teaching process that can positively influence students' achievements. At the beginning of the study he presented the results of a research aimed at exploring the impact of the use of computer simulations on secondary school students' understanding of oscillatory motion. The aim of the study was to explore the effect of the use of simulations on students' abilities to work with graphs and to find out relevant information. In the conclusion, the possibilities of integration of simulations into the teaching process were discussed.

Sarabando, Cravino, and Soares, (2014) conducted a study on contribution of a computer simulation to students' learning of the physics concepts of weight and mass. The purpose of this study was to investigate the contribution of a computer simulation to students´ learning of physics concepts (weight and mass). The study simulation was produced using the software Modellus. This study evaluates progresses in understanding made by students (grade 7; 12-13 years old) after one lesson (90 minutes) in three different scenarios: using only "hands-on" activities, using only a computer simulation, and using both. The progresses were measured through pre- and post-tests. The results show that the total gains were higher when students used the computer simulation, alone or together with "hands-on" activities. However, we found that the total gains obtained depend on the teachers' pedagogy when using the computer simulation to teach the concepts of weight and mass.

Kollöffel and de Jong (2012) conducted a study on conceptual understanding of electrical circuits in secondary vocational engineering education, where they combined traditional instruction with inquiry learning in a virtual lab. The results showed that students in the virtual lab condition scored significantly higher on conceptual understanding (Cohen's $d = 0.65$) *and* on procedural skills ($d = 0.76$). In particular, students in this condition scored higher on solving complex problems ($d = 1.19$). Chen, Pan, Sung, and Chang (2013) conducted a study that elucidated misconceptions in learning on diodes and constructed a conceptual-change learning system that incorporated prediction-observation-explanation (POE) and simulation-based learning strategies to explore its effects on correcting misconceptions and improving learning performance. 34 sophomore students majoring in engineering participated in the experiments. The empirical results indicated that the system significantly corrects participants' misconceptions on diodes and improves learning performance. Their study showed that conceptual change instructions could correct misconceptions effectively by constructing scenarios that conflict with existing knowledge structures. Their results also showed that misconceptions on diode models and semiconductor characteristics could be corrected in more than 80% of cases.

Ozkan and Selcuk (2015a) conducted a study on effect of technology enhanced conceptual change texts on students' understanding of buoyant force. The conceptual change texts (written forms) used in this study was proven to be effective and enriched by using technology support. These texts were tried out on two groups. A pre-test/post-test quasi-experimental design and one control group (n=20) and one experimental group (n=20). Experimental group were given the technology enhanced conceptual change texts, whereas the control group was taught in the traditional instruction. Data were collected with five open-ended questions concerning buoyancy. The study found that experimental group's conceptual understanding was higher to the traditional instruction group. It is believed that these texts about "buoyant force," an often misunderstood subject in science education, are very useful class materials that could enable students to learn meaningfully.

Kaya and Geban (2011) conducted a study on the effect of conceptual change based instruction on students' attitudes toward chemistry. Their study explored the effect of conceptual change based instruction accompanied with demonstrations (CCBIAD) on 11th grade students' attitudes toward chemistry. The sample consists of sixty-nine 11th grade students in two classes in a high school. In the experimental group, CCBIAD was used, whereas in the control group, traditionally designed chemistry instruction was used. Attitude Scale toward Chemistry measured the students' attitudes. The results of ANOVA show that there was a significant mean difference between post-test scores of two groups in favor of the experimental group. As a conclusion, CCBIAD has a key role in forcing students' attitudes toward chemistry.

Eshetu and Mekbib Alemu (2018) conducted a study on students' conception of voltage and resistance concepts after conventional instruction. The purpose of this study was to determine the level of conceptions reached by students' who learnt the concepts of voltage and resistance with the conventional direct instruction. To answer the research questions, descriptive non-experimental research design was used. A two tier test on the concepts of voltage and resistance was administered to 49 physics and chemistry major first year students in Medda Walabu University, Ethiopia. Students' responses to the five items qualitatively compared to those found in literature for secondary school and university students. The result showed that the conception of students formed at school level about voltage and resistance were not that much affected even by learning the same concepts at advanced levels and with mathematical rigor at university. Besides, the analysis revealed that students hold multiple opposing ideas regarding the same concept, which contradicts the classical conceptual change perspective. Further, the average conception level reached by the students after learning university level physics courses was “partial understanding”. Therefore, attending advanced but traditional course would not enhance students’ conceptual understanding. Hence, teachers should have to investigate students’ conceptions, as a first step, to subsequently design and implement appropriate instructional interventions.

Ozkan and Selcuk (2015b) conducted a study on the effectiveness of conceptual change texts and context-based learning on students’ conceptual achievement. The purpose of the research was to research the effectiveness of three different methods of teaching physics (conceptual change-based, real life context-based and traditional learning on upper-secondary physics students in the 11th grade in terms of conceptual achievement about the pressure and buoyancy topics. In this research, pretest/ post-test quasi-experimental design with non-equivalent control group, involving a 3 (group) × 2 (time) factorial design was used. Experimental 1 Group was given the conceptual change texts on the mentioned subjects, the Experimental 2 Group was offered a learning approach based on real life contextbased learning, whereas the control group was given the traditional learning. Data for the research were collected with the “Pressure Conceptual Test”. When the results of the research were examined, it was found that the conceptual change text group's conceptual understanding scores were significantly higher than those of the context-based learning group and the traditional learning group. The context-based learning group's conceptual understanding scores were significantly higher than those of the traditional learning group.

Prasetyo, Suprapto, and Pudyastomo (2018) conducted a study on the effectiveness of flipped classroom learning model in secondary physics classroom setting. The research aimed to describe the effectiveness of flipped classroom learning model on secondary physics classroom setting during Fall semester of 2017. The research object was Secondary 3 Physics group of Singapore School Kelapa Gading. This research was initiated by giving a pre-test, followed by treatment setting of the flipped classroom learning model. By the end of the learning process, the pupils were given a post-test and questionnaire to figure out pupils' response to the flipped classroom learning model. Based on the data analysis, 89% of pupils had passed the minimum criteria of standardization. The increment level in the students' mark was analyzed by normalized n-gain formula, obtaining a normalized n-gain score of 0.4 which fulfill medium category range. Obtains from the questionnaire distributed to the students that 93% of students become more motivated to study physics and 89% of students were very happy to carry on hands-on activity based on the flipped classroom learning model. Those three aspects were used to generate a conclusion that applying flipped classroom learning model in Secondary Physics Classroom setting is effectively applicable

Li, Li, and Luo (2015) conducted a study on using a dual safeguard web-based interactive teaching approach in an introductory physics class. They modified the Just-in-Time Teaching approach and developed a dual safeguard web-based interactive (DGWI) teaching system for an introductory physics course. The system consists of four instructional components that improve student learning by including warm-up assignments and online homework. Student and instructor activities involve activities both in the classroom and on a designated web site. An experimental study with control groups evaluated the effectiveness of the DGWI teaching method. The results indicate that the DGWI method is an effective way to improve students' understanding of physics concepts, develop students' problem-solving abilities through instructor-student interactions, and identify students' misconceptions through a safeguard framework based on questions that satisfy teaching requirements and cover all of the course material. The empirical study and a follow-up survey found that the DGWI method increased student-teacher interaction and improved student-learning outcomes.

Shan (2013) conducted a study on improving student learning and views of physics in a large enrollment introductory physics class. The study examined student learning and views of physics in a large enrollment course that included IE methods with no separate, small-group recitations. In this study, a large, lecture-based course included activities that had students explaining their reasoning both verbally and in writing, revise their ideas about physics concepts, and apply their reasoning to various problems. The questions addressed were: (a) what do students learn about physics concepts and how does students learning in this course compare to that reported in the literature for students in a traditional course?; (b) do students' views of physics change and how do students' views of physics compare to that reported in the literature for students in a traditional course?; and (c) which of the instructional strategies contribute to student learning in this course? Data included: pre-post administration of the Force Concept Inventory (FCI), classroom exams during the term, pre-post administration of the Colorado Learning Attitudes About Science Survey (CLASS), and student work, interviews, and open-ended surveys. The average normalized gain ($\langle g \rangle = 0.32$) on the FCI falls within the medium-gain range as reported in the physics education literature, even though the average pre-test score was very low (30%) and this was the instructor's first implementation of IE methods. Students' views of physics remained relatively unchanged by instruction. Findings also indicate that the interaction of the instructional strategies together contributed to student learning. Based on these results, IE methods should be adopted in introductory physics classes, particularly in classes where students have low pre-test scores. It is also important to provide support for instructors new to IE strategies.

Ates (2005) conducted a study to explore two ways of teaching and learning dc circuits for university students having different cognitive styles. Results from this study indicated that the implementation of the learning cycle method enhances students' understanding of key aspects and concepts involved in dc circuits. This study also investigated the effects of learning cycle and traditional method of teaching on students' understanding of some different aspects included in resistive circuits. Results of his study revealed that the main effects of treatments on students' understanding of some aspects of circuits were significant. The learning cycle students group over scored the traditional students group in the understanding of seven IOs involved in circuits. These instructional objectives (IO) dealt with the physical aspect of the electric circuits such as the physical layout.

Baser (2006) conducted a study that employed an active learning approach that promotes conceptual change when studying direct current circuits, using free open source software (Qucs). The study involved 102 prospective mathematics teacher students. Before instruction, students' understanding of direct current electricity was determined by a subset of a previously developed multiple-choice conceptual test. All students received an active learning instruction using Qucs simulations. After instruction, the same test was administered to the students to determine the effectiveness of the instruction they received. Paired t-test analyses showed that students' progress on understanding of direct current electricity were significant. A six-week delayed post-test revealed that this observed improvement promised to be durable, at least in the short term.

Dorneles, Veit, and Moreira (2010) conducted a study that investigated the learning of students who worked with computational modeling and simulation using the software (Modellus) in the study of simple electric circuits. The quantitative results show that there were statistically significant differences in the performance of students who worked with the computational activities (experimental group) when compared to the one in which students were just exposed to a traditional method of teaching (control group). The qualitative results suggest that many students from the experimental group seemed to have achieved meaningful learning and the students' interaction among themselves and with the teacher as well during the computational activities strongly contributed to that.

Taşlıdere (2013) first investigated the effect of conceptual change-oriented instruction accompanied by concept cartoon worksheet with simulation on students' conceptual understanding and second to remedy their misconceptions of direct current electric circuits. Participants were 139 pre-service science teachers from four intact classes. A quasi-experimental design was used in the study. The experimental group studied the concept with the application of concept cartoon worksheet and simulation, and the control group studied it with traditional instruction. A tree-tired misconception test measured students' conceptual understanding and misconceptions. It was administered as pre-and-post-test. There was no significant difference between the means of pre-test scores of experimental and control groups. The main effect of treatment on post-test scores was examined via ANCOVA with pre-test scores used as a covariate. The frequency of each misconception calculated for both groups, from pre-to post-tests regarding all tiers of items. The analysis yielded a significant treatment effect on students' post-test performances. The findings indicated that the conceptual change-oriented instruction accompanied by concept cartoon worksheet and simulation is likely to be effective for conceptual understanding and decreasing most of the students' misconceptions in direct current electric circuits.

Ugur, Dilber, Senpolat, and Duzgun, (2012) investigated the effects of analogy on the elimination of students' misconceptions about direct current circuits, students' achievement and the attitudes towards physics lessons. The sample of this study consisted of 51 of 11th-grade students from two different classes. While one of the classes was the experimental group where analogy was used in the lessons, the other class was the control group where the traditional methods were employed in lessons, and this selection was made randomly. The results showed that examined teaching with analogy had a significant positive effect on the elimination of misconception and achievement although it had almost no effect on the attitudes of 11th-grade students towards physics.

Hussain, Azeem, and Shakoor (2011) conducted a study on physics teaching approaches (scientific inquiry vs traditional lecture). Their major objective was to study the effect of three levels of scientific inquiry approach and traditional approach on teaching of physics on students' performance and their proficiency to apply the physics knowledge in real life situations through a pretest posttest control group experimental design. Their study revealed that there was significant effect of guided, unguided and combination scientific inquiry on the students' achievement than traditional teaching approach in physics.

Abbasi, Hazrati, Mohammed, and Rajaeefard (2013) conducted a study on the effect of learning via module versus lecture teaching methods on the knowledge and practice of oncology nurses about safety standards with cytotoxic drugs in Shiraz University of Medical Sciences. The study was a quasi-experimental study with two intervention groups (module and lecture) and a control group. In this study, 86 nurses in Shiraz, Fars province participated and in the prescription of cytotoxic drugs to patients who were selected and randomly divided into three groups. The module group used a self-directed module, an experienced lecturer in the classroom taught the lecture group and the control group did not receive any intervention. Data in relation to knowledge and practice of oncology nurses in the three groups were collected after the intervention by using a questionnaire and checklist. The study using one-way ANOVA showed an increase in the knowledge and improvement of the practice level in the experiment groups. However, the *post hoc* test of Tukey HSD showed that the lecture and module educational methods did not have a statistically significant difference in the increase of knowledge (p = 0.22) and the improvement of the practice (p = 0.75). In conclusion, the study findings provided impetus to look beyond conventional skills teaching practices to more innovative, flexible methods.

Sadedhi, Sedaghat and Ahmadi (2014) conducted a study on comparison of the effect of lecture and blended teaching methods on students' learning and satisfaction. The study used quasi-experimental approach among the sophomore students of public health school at Tehran University of Medical Science. Four classes of the school were randomly selected and were divided into two groups. Instructions in two classes (45 students) were in the form of lecture method and in the other, two classes (48 students) were blended method with e-Learning and lecture methods. The students' knowledge about tuberculosis in two groups collected and measured by using pre-and post-test. These steps were done by sending self-reported electronic questionnaires to the students' email addresses through Google document software. At the end of educational programs, students' satisfaction and comments about two methods were collected by questionnaires. Statistical tests such as descriptive methods, paired t-test, independent t-test and ANOVA determined through the SPSS 14 software, and $p \leq 0.05$ was considered as significant difference. The mean scores of the lecture and blended groups were 13.18 ± 1.37 and 13.35 ± 1.36, respectively; the difference between the pre-test scores of the two groups was not statistically significant ($p=0.535$). Knowledge scores increased in both groups after training, and the mean and standard deviation of knowledge scores of the lectures and combined groups were 16.51 ± 0.69 and 16.18 ± 1.06, respectively. The difference between the post-test scores of the two groups was not statistically significant ($p=0.112$). Students' satisfaction in blended learning method was higher than lecture method. In conclusion, both lecture and blended methods significantly raise the students' knowledge. However, because the students' satisfaction and cost effectiveness in the blended method were more than lecture method, they suggested that the teachers should use e-learning as a complementary approach to combine theoretical teaching methods**.**

Zacharia (2003) conducted a study on beliefs, attitudes, and intentions of science teachers regarding the educational use of computer simulations and inquiry-based experiments in physics. He investigated (a) what effect the use of

Interactive Computer-based Simulations (ICBSs), the use of laboratory inquiry-based experiments (LIBEs), and the use of combinations of an ICBS and a LIBE, in a conceptually oriented physics course, have on science teachers' beliefs about and attitudes toward the use of these learning and teaching tools, as well as the effect on their intentions to incorporate these tools in their own future teaching practices, (b) science teachers' attitudes toward physics and the effect that the use of ICBSs and LIBEs have on teachers' attitudes toward physics, and (c) whether teachers' beliefs have an impact on their attitudes and whether their attitudes have an effect on their intentions. He used a pre–post comparison design and the Theory of Reasoned Action (TRA). Results confirmed the TRA model that beliefs affect attitudes and these attitudes then affect intentions and showed that science teachers' attitudes toward physics, the use of an ICBS, the use of a LIBE, and the use of a combination of an ICBS and a LIBE were highly active at the end of the study.

Bishop and Verleger (2013) conducted a study on the flipped classroom: a survey of the research. Results of this survey show that student perceptions of the flipped classroom are somewhat mixed, but are positive overall. Students tend to prefer in-person lectures to video lectures, but prefer interactive classroom activities to lectures. Anecdotal evidence suggests that student learning is improved for the flipped compared to a traditional classroom.

Brill and Galloway (2007) conducted a study on perils and promises: University instructors' integration of technology in classroom-based practices. Here they examined college-level instructors' use of and attitudes towards classroom-based teaching techniques. They employed qualitative measures with survey and interview. Findings revealed trends in current and future technology usage, the positive influence of technology on teaching and learning.

Ketelhut, Nelson, Clarke and Dede (2010) conducted a study on a multi-user virtual environment for building and assessing higher order inquiry skills in science. Their study investigated novel pedagogies for helping teachers infuse inquiry into a standards-based science curriculum. Using a multi-user virtual environment (MUVE) as a pedagogical vehicle, teams of middle-school students collaboratively solved problems around disease in a virtual town called River City. The students interacted with 'avatars' of other students, digital artefacts and computer-based 'agents' acting as mentors and colleagues in a virtual community of practice set during the time period when bacteria were just being discovered. The results indicated that students were able to conduct inquiry in virtual worlds and motivated by that process.

Gulek and Demirtas (2005) conducted a study on learning with technology: the impact of laptop usage on student achievement. They examined the impact of participation in a laptop program on student achievement. 259 middle school students were followed via cohorts. The data collection measures included students' overall cumulative grade point averages (GPAs), end-of-course grades, writing test scores, and state-mandated norm and criterion-referenced standardised test scores. The baseline data for all measures showed that there was no statistically significant difference in English language arts, mathematics, writing, and overall grade point average achievement between laptop and nonlaptop students before enrollment in the program. However, notebook students showed significantly higher achievement in nearly all measures after one year in the program. Cross-sectional analyses in year-2 and year-3 concurred with the results from the year-1. The longitudinal analysis also proved to be an independent verification of the substantial impact of laptop uses on student learning outcomes.

Bang and Luft (2013) conducted a study on secondary science teachers' use of technology in the classroom during their first five years. They examined the technology usage of beginning secondary science teachers and explored factors facilitating or inhibiting their use of technology. The researchers collected and analysed interviews and observational data from 95 teachers over a 5-year period. The results show that teachers used power point most to other software. The use of power point was statistically significant when compared to the use of lecture and procedural laboratories. One-way ANOVAs yielded several statistically significant results, in that induction treatment, teacher's gender, and SES populations were significantly correlated with the usage of technology. This study urges that the value of technology used in science classrooms should be redefined to enhance inquiry-based science teaching and learning.

Guzey and Roehrig (2009) conducted a study on teaching science with technology: case studies of science teachers' development of technology, pedagogy, and content knowledge. They examined the development of technology, pedagogy, and content knowledge (TPACK) in four in-service secondary science teachers as they participated in a professional development program focused on technology integration into K-12 classrooms to support science as inquiry teaching. In the program, probe ware, mind mapping tools (CMaps), internet applications computer simulations, digital images, and movies were introduced to the science teachers. A descriptive multicase study design employed to track teachers' development over the yearlong program. Data included interviews, surveys, classroom observations, teachers' technology integration plans, and action research study reports. The program was found to have positive impacts to varying degrees on teachers' development of TPACK.

Limniou, Schermbrucker and Lyons (2018) conducted a study on traditional and flipped classroom approaches delivered by two different teachers, the student perspective. The aim of their study was for students to express their views on teaching approaches delivered by two teachers under the perspectives of Higher Order Thinking Skills (HOTS) development, their preferences on learning material and learning activities. First year psychology students followed both the traditional and a flipped classroom approach delivered by two different teachers. One teacher introduced them to social and the other to clinical psychology. 81 students evaluated their experience on social psychology and 119 students on clinical psychology. Although all students had similar preferences on following either the traditional or the flipped classroom approach in both subject domains, a significant difference in students' views related to the teachers' contribution to teaching approach, students' HOTS development and the choice of learning material was observed. This investigation concluded the importance of the intricate relationship between the choice of learning material and activities, and the teacher's contribution to the flipped classroom approach and their expectation/behaviour toward technology.

Al-Otaibi (2017) conducted a study on effectiveness of blackboard-based blended teaching in the development of academic achievement, study skills and self-confidence among students of Princess Nourah bint Abdulrahman University. The present study aimed to investigate the effectiveness of blended teaching, based on the e-learning management system "Blackboard", in the development of academic achievement, study skills and self-confidence among the students of Princess Nourah bint Abdulrahman University (PNU). The study sample consisted of (38) female students who were specialized in primary classroom at the University. The participants were randomly selected, where the experimental group was (21) female students who were taught the course of "Science Teaching Strategies" by blended teaching based on the e-learning management system "Blackboard", and the control group was (17) ones who studied the course by the traditional method of teaching. Pre and post tests for academic achievement, the scale of study skills and the scale of self-confidence were applied to the participants. The results showed statistically significant differences at the level of ($\alpha \leq 0.05$) between the average scores of the students of the two groups in the academic achievement test in favor of the experimental group. Eta squared ($\eta 2$) was (0.75) rated very high effect. There were no statistically significant differences in both the degree of university study skills and self-confidence.

Al-Madani (2015) conducted a study on the effect of blended learning approach on fifth grade students' academic achievement in my beautiful language textbook and the development of their verbal creative thinking in Saudi Arabia. This study aims was to investigating the effect of blended learning approach compared to the traditional learning approach on fifth grade students' achievement in my beautiful language textbook and the development of their verbal creative thinking. The study consisted of 49 students among which 25 are males in the Experimental Group and 24 females in the Control Group. The study found a statistical significant difference ($\alpha \leq 0.05$) between the mean scores of the two study groups in achievement posttest and verbal creative thinking post application test. The experiment group was taught using the blended approach of learning outperformed the Control Group in both tests. Thus, learning my beautiful language textbook using the blended approach was more effective than the traditional method in terms of achievement and the development of verbal creative thinking skills. In light of this, the study recommends the adoption of blended approach in learning my beautiful language textbook, the curriculum computerization, holding series of training courses, and workshops for teachers in school districts on how to effectively implement the blended approach.

Hinkhouse (2013) conducted a study on investigating blended learning in the high school science classroom. This study used quantitative methods to measure student attitudes and learning of science content in both a treatment and control group consisting of 9th grade Physical Science classes. Students in the treatment group experienced one semester of blended learning by using online science modules to supplement their in-class learning while the control group continued to have only face-to-face instruction. The findings show no significant change in student attitudes about science and also no significant difference between the groups on a posttest measuring science knowledge. However, the treatment group exposed to the blended learning approach did show significant growth in science content knowledge from pretest to posttest while the growth by the control group was not significant. Students in the treatment group were also interviewed to gather their opinions of the blended learning experience. Responses show students were engaged by the online simulations and self-paced content but participants also suggested ways to make the blended learning experience more beneficial for student learning.

Sarıtepeci and Çakır (2015) conducted a study on the effect of blended learning environments on student's academic achievement and student engagement: A study on social studies course. The purpose of this study was to analyze effects of blended learning environment on middle school student's' engagement and academic achievement. Pretest-posttest control group quasi experimental design was utilized. The study was conducted with 52 students in experimental group and 55 students in control group. The study revealed that blended learning environment had meaningful increase in average academic achievement when compared to students in face-to-face learning environment. In addition, blended learning has a medium level effect size on students' levels of academic achievement. No meaningful statistical differences were detected for students' engagement between both groups. However, in blended learning approach, average development of student engagement showed a meaningful rise when compared to face-to-face learning approach.

Hiett (2016) conducted a study on an examination of blended learning and the traditional classroom using achievement scores. This naturalistic, quasi-experimental study examined the effect of the rotation model of blended learning at the middle school level on students' language arts performance to determine how the rotation model of blended learning compares to the traditional model of learning. The study's theoretical framework consisted of Mayer's cognitive theory of multimedia learning and Bloom's theory of mastery learning. The population consisted of 979 non-Title 1, Georgia public middle school students within the same middle school in a metropolitan school district during the 2013-2014 school year. The sample size was 237 sixth graders, 255 seventh graders, and 272 eighth graders. The specific data collected were Criteria Referenced Competency Test (CRCT) scores for all sample students. Data analysis consisted of both stepwise multiple regressions and two way ANOVA. The study found no significant difference in academic achievement of special education or regular education students. However, gifted students who participated in the blended model of instruction performed at a lower level than those who participated in the traditional model of instruction. Educational stakeholders may use this study and others like it, to make decisions on the adoption of educational models at the middle school level that are beneficial, as well as to avoid models for subgroups that might be harmful.

Mchunu and Imenda (2015) conducted a study on the effects of traditional outcomes based education (OBE) and blended teaching approaches in alleviating conceptual difficulties and alternative conceptions in grade twelve mechanics.

This paper reports the results of a study comparing the effectiveness of three instructional approaches in alleviating learning difficulties of grade 12 learners in mechanics. The research sample consisted of 140 grade 12 physical science learners drawn from four high schools in the Empangeni education district, South Africa. A quasi-experimental, non-equivalent comparison group research design was used. ANOVA and average normalized gain scores were used to analyse the data. The results showed that all the three interventions significantly alleviated conceptual difficulties and alternative conceptions of the learners in mechanics. However, the blended intervention was the most effective, followed by OBE and then the traditional approach. The comparison group showed no conceptual growth between the pre- and post-tests.

Safar and AlKhezzi (2013) conducted a study on beyond computer literacy: technology integration and curriculum transformation. This quasi-experimental research study was deployed to evaluate and identify the effect and usefulness of a blended pedagogical approach of teaching and learning on students' academic achievement, motivation, and attitudes. A total of 128 (i.e., 64 experimental group and 64 control group) undergraduate students in the College of Education (COE) at Kuwait University (KU) participated in this study. The results revealed that the students enrolled in the experimental group were significantly outscoring their counterparts in the control group. They submitted projects with better quality; earned higher final grades; attended more online training courses; took more ICDL tests; and the majority attended all classes. These findings imply that the potential of a blended approach of teaching and learning is endless. It can produce robust teaching and learning environments and experiences. It can also reveal that teaching and learning with such method or strategy, while integrating and incorporating ICT tools, can be fun.

A brief description of the conceptual framework of the study

This is the conceptual framework of this study with its respective activities:

Stage 1: The problem analysis phase;

1. Literature review on students difficulties in linear momentum and direct current across the world and in Ghana.
2. Review of integrated science Chief Examiners' report on teacher trainees' difficulties in linear momentum and direct current of Colleges of Education in Ghana.
3. Use of teacher trainees' achievement tests (linear momentum and direct current) to further probe into the issues raised in literature and Chief Examiners report of integrated science at the Colleges of Education on teacher trainees difficulties in linear momentum and direct current.
4. Use of teacher trainees' and integrated science tutors questionnaires on the usage of traditional and computer aided instructions teaching approaches in Colleges of Education to further probe into the various teaching approaches used by the integrated science tutors in teaching linear momentum and direct current.
5. Use of integrated science tutors interview schedules to probe into the types of teaching approaches integrated science tutors use in teaching linear

momentum and direct current in the Colleges of Education. Also, Teacher trainees' focus group interview schedule was used to probe into the types of teaching approaches their integrated science tutors use in teaching linear momentum and direct current.

Stage 2: The intervention phase (designing and implementation of the intervention lessons in direct current and linear momentum);

1. Outcomes of the problem analysis phase were used in designing six interventions lessons of the study in direct current and linear momentum.
2. The intervention lessons implemented on second-year teacher trainees of College-B using the lecture, question, answer, and discussion (LQAD) approach as intervention, College-C using the lecture, question, answer, discussion, power point and video (LQADPV) approach as intervention and College-D using the lecture, question, answer, discussion, power point, video and computer simulation (LQADPVS) approach as intervention.
3. Teacher trainees' focus group interview schedule was used to see the effectiveness of the interventions of the study.

The conceptual model of the study is presented in Figure 1.

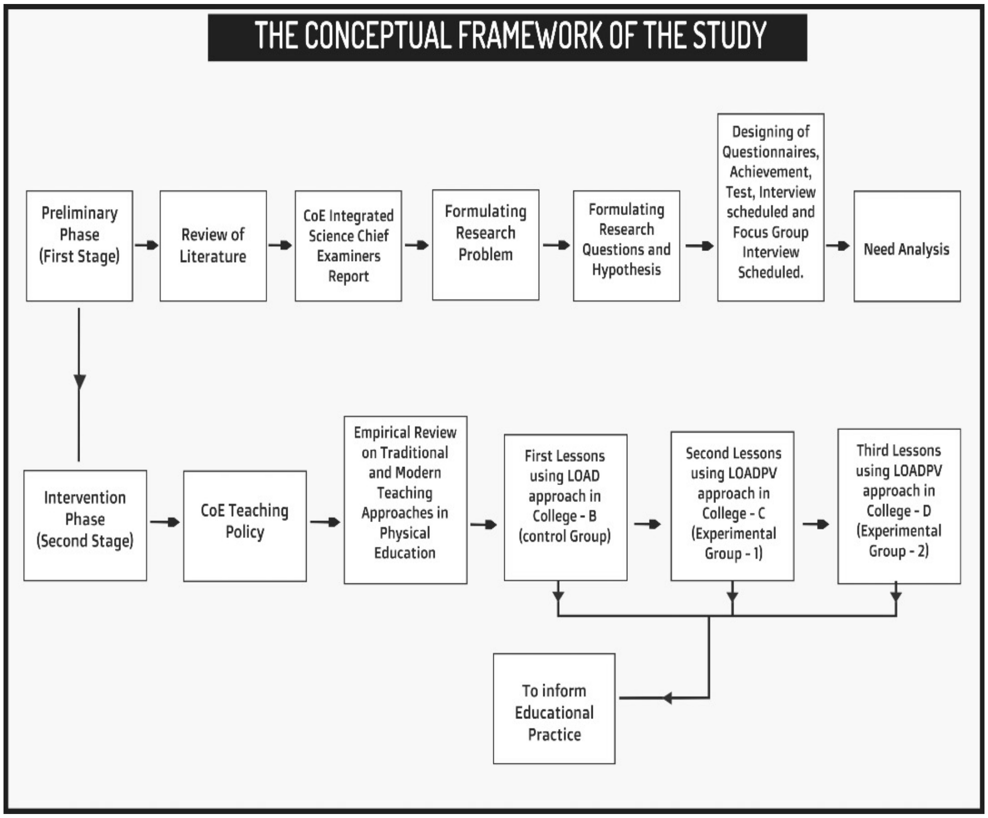

Figure 1: The Conceptual Model of the Study

Design principles of the study

Theory-1

Because the lecture, question, answer and discussion teaching methods had worked in enhancing students performances of concepts both in science and other subjects (Barnes, & Blevins, 2003;Benckert, & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Casado, 2000; Chaudhury, 2011; de Caprariis, Barman, & Magee, 2001; Holubová, 2010; G¨u´emez, Fiolhais, & Fiolhais, 2009; Hussain, Azeem, & Shakoor, 2011; Morgan, Whorton, & Gunsalus, 2000; Qualters, 2001; Perkins, & Saris, 2001; Yoder & Hochevar, 2005) the study, therefore, theorises that ‘a combination of four or more traditional teaching approaches without CAI would enhance teacher trainees' performance of linear momentum and direct current concepts.

Theory-2

Also because these approaches had worked i.e., power point, video, and computer simulation had been employed in enhancing students performances of concepts both in science and other subjects (Abbasi, Hazrati, Mohammed, & Rajaeefard, 2013; Bang & Luft, 2013; Bishop & Verleger 2013; Brill & Galloway, 2007; Gulek & Demirtas, 2005; Guzey & Roehrig, 2009; Hussain, Azeem, & Shakoor, 2011; Ketelhut, Nelson, Clarke & Dede, 2010; Sadedhi, Sedaghat & Ahmadi, 2014; Zacharia, 2003), the study, therefore, theories that 'a combination of four or more traditional approaches and three or more CAI approaches to teaching would further enhance teacher trainees' performance in linear momentum and direct current concepts.

Summary of Literature Review

This study reported different teaching approaches. These teaching approaches were grouped into traditional and modern. Some of the traditional teaching approaches were lecture, discussion, question, answer, and that of the modern teaching approaches were integration of CAI into traditional method such as video, games, animation, power point and computer simulation. The proponents of traditional and modern teaching approaches raised varied meaningful concerns on effectiveness of these teaching approaches. Some of the issues raised were that the traditional teaching approaches are more effective in enhancing students' performance of concepts to modern teaching approaches and vice versa.

However, literatures failed to give a clear-cut path as to the best plausible, precise and specific teaching approaches i.e., whether it is traditional or modern. This has brought in its wake some gaps in literature between the traditional and modern teaching approaches. To bridge this gap between traditional and modern approaches to teaching, this study will compare traditional method and combination of traditional method and computer aided instruction 1 and computer aided instruction 2 approaches. This will be done at various stages of the study in three different colleges of education to determine the best plausible teaching approach that would enhance teacher trainees' performance in linear momentum and direct current concepts.

CHAPTER THREE

RESEARCH METHODS

This chapter discusses research design, population, sample, sampling procedure, data collection procedure, research instruments, pre-testing of the research instruments, reliability of the research instruments, validity of the research instruments, scoring of the test items, the intervention lessons, arrangement of initial teaching plans and implementation of the intervention lessons, and data processing analysis.

Research Design

The purpose of this study was to investigate the effect of using traditional and combination of traditional and computer aided instruction-1 and computer aided instruction-2 approaches of teaching on teacher trainees' performances in selected concepts in linear momentum and direct current. Based on this, the pretest-posttest two-group nonequivalent quasi-experimental design was the most appropriate (Ary, Jacobs & Razavieh, 2002; Cohen, Manion & Morrison, 2007). With this design, the study employed both qualitative and quantitative methods of data collection. Scores of teacher trainees from the achievement test (i.e., on concepts in linear momentum and direct current) for both pretest and posttest and responses from integrated science tutors' questionnaire constituted the quantitative data while personal interviews made for integrated science tutors, and focus group interviews for teacher trainees made up the qualitative data. Teacher trainees' focus group interview was conducted to check teacher trainees' impressions of the effectiveness of the teaching approaches (interventions). This design was used because the subjects (teacher trainees) in the experimental and the control groups were in their natural classroom setting and selected without random assignment (Ary, Jacobs & Razavieh, 2002; Cohen, Manion & Morrison, 2007).

The study went through two phases. First, need analysis phase (preliminary phase) was done to ascertain whether the problems students encounter in linear momentum and direct current as identified in literature exist. This helped in investigating into difficulties faced by integrated science tutors in using traditional and CAI approaches to teach linear momentum and direct current and teacher trainees difficulties to learn linear momentum and direct current concepts. The second phase (intervention phase, i.e., design and implementation of six intervention lessons in linear momentum and direct current concepts) was where the experimental study took centre stage.

The study had two experimental groups and one control group. The design compared performances of the three groups using pretest and post-test to determine the effectiveness of the interventions. The two experimental groups received two different traditional and CAI interventions. Experimental group one was instructed using computer aided instruction 1, i.e., lecture, question, answer, discussion, power point and video method; Experimental group two received computer aided instruction 2, i.e., lecture, question, answer, discussion, power point, video and computer simulation method, while the control group was instructed with only traditional method i.e., lecture, question, answer and discussion method. The computer aided instruction 1 and computer aided instruction 2 constituted the combination of traditional and computer aid approaches (Collins, Deck, & McCrickard, 2008; Mann, 2009; Yu-bao, Qian-li, & Shao-tang, 2009).

Because literature had reported effectiveness of traditional and combination of traditional and CAI approaches of teaching to science instructions (refer to chapter two), the traditional approach was used without aid of computer; the computer aided instruction 1 approach was used with aid of power point and video on a computer to the traditional method. The computer aided instruction 2 approach was used with aid of power point, video and computer simulation on a computer to the traditional approach. The concepts treated with the traditional, computer aided instruction 1 and computer aided instruction 2 approaches were direct current and linear momentum. For direct current, the study looked at its applications in (electric current, resistance, parallel connections of resistances, and voltages), while for linear momentum; the study looked at its applications in (momentum, change of momentum, conservation of momentum, and collision). The same selected concepts in linear momentum and direct current were used in all the groups.

The pictorial representation of the two-group nonequivalent quasi-experimental design used in this study is shown below:

Experimental group 2	N	A	Z	B
Experimental group 1	N	A	Y	B
Control group	N	A	X	B

Where:

N = Nonequivalent

A = Pretest measure

B = Posttest measure

X = Traditional teaching approach

Y = Computer aided instruction 1

Z = Computer aided instruction 2

This design is mostly used in educational research where random assignment of subjects (teacher trainees) in a college or classroom is not practicable (Ary, Jacobs & Razavieh, 2002; Cohen, Manion & Morrison, 2007). In most colleges, schedules and classes cannot be reorganized in order to accommodate the researcher's study. This necessitated the study to use already existing intact classes in the Colleges of Education (Ary, Jacobs & Razavieh, 2002).

The main weakness of this design is that it is inferior to randomized experiments in terms of internal validity (Cohen, Manion & Morrison, 2007). This study was affected by this weakness since extraneous variables such as age, ability, maturation and previous learning experiences were not controlled. However, maturation weakness was minimized by running a delayed posttest (see Appendix F for results) in the three Colleges of Education. Another weakness of the design, also a threat to internal validity, is the interaction between the control and experimental groups especially when the groups are in the same geographical area. This weakness, however, was minimized in this study since the groups of teacher trainees used were in different colleges that were very far apart in terms of distance and so interaction between them was not practicable.

Before instruction, the teacher trainees in all groups took a pretest to measure their prior knowledge of the selected concepts in linear momentum and direct current and after instruction; the same group of teacher trainees took a post-test to determine their performances regarding the teaching approaches used. In all, six lessons were developed and implemented in the three Colleges of Education used for this study. Two lessons were developed and implemented with the traditional teaching approach to the control group (i.e., one in linear momentum and the other in direct current). The same number of lessons were developed and implemented with the other two combination of traditional and CAI teaching approaches (i.e., computer aided instruction 1, and computer instruction 2) to the two experimental groups respectively.

Population

The target population for this study was second year teacher trainees offering the General Education programme and integrated science tutors in the twelve Colleges of Education located in three out of ten regions (Colleges of Education Secretariat, 2016) in Ghana (i.e., Colleges of Education in the Volta, Greater Accra and Eastern regions).

The accessible population for the study was second year teacher trainees offering the General Education programme and integrated science tutors in the four out of the twelve Colleges of Education located in three regions in Ghana (i.e., Colleges of Education in the Volta, Greater Accra and Eastern regions).

Each of the Colleges of Education had 250 teacher trainees and 5 integrated science tutors amounting to 1000 teacher trainees and 20 integrated science tutors. The accessible population of the study was 1020 respondents.

Sampling Procedure

The sample size consisted of 105 respondents (10% of the population) selected from the four Colleges of Education in the three regions. Simple random sampling technique (paper folding) was used in selecting (1) four out of twelve colleges (i.e., 7 in Volta, 2 in Greater Accra and 3 in Eastern regions). The four Colleges of Education sampled were designated as College-A, College-B, College-C and College-D. College-A was used at the need analysis phase and the other three Colleges of Education (i.e., Colleges-B, C and D) were used for the intervention phase of the study. In each of these four Colleges of Education used in this study, there were two intact classes offering the General Education programme. In College-A, all the 5 integrated science tutors and the second year teacher trainees who were present at the time of data collection took part in the need analysis phase of the study. The number of teacher trainees who took part in the need analysis phase were 40. However, in College-B, College-C and College-D, only the teacher trainees in one out of the two intact classes in the colleges were sampled for the intervention phase of the study. In all, 60 teacher trainees (i.e., 20 teacher trainees in each of the three intact classes) from the three College of Education took part at this phase of the study.

Data Collection Instruments

Six main research instruments were employed in the study i.e., two questionnaires (for teacher trainees and integrated science tutors), two teacher trainees achievement tests (for pre-test and post-test in linear momentum and direct current), interview schedule (for integrated science tutors) and focus group interview schedule for teacher trainees. At the need analysis phase, six instruments (two questionnaires, two achievement tests and one interview schedule and one focus group interview) for teacher trainees and integrated science tutors were developed (see Appendices B, C, D, H, K and L). The items on the two questionnaires, two achievement tests and one interview schedule and one focus group interview schedule were used to empirically establish the problems faced by (1) integrated science tutors' usage of traditional and computer aided instructions approaches in teaching linear momentum and direct current and (2) teacher trainees when tutor use traditional and computer aided instructions approaches in teaching of direct current and linear momentum. The challenges, of both integrated science tutors and teacher trainees, identified at the need analysis phase were used to design the intervention lessons.

At the intervention phase, three instruments (two achievement tests and one focus group interview schedule) were used. The achievement test pre-test and post-test items were used to test the performance of teacher trainees on selected concepts in linear momentum and direct current. Focus group interview was conducted at each stage of the interventions to see the teacher trainees' impression of the interventions used.

The researcher developed the integrated science tutors' questionnaire, interview schedule and teacher trainees' focus group interview schedule after extensive review of related literature. The integrated science tutors' questionnaire (Appendix B) was made up of three items. The first item measured integrated science tutors' approaches to teaching linear momentum and direct current. The second item measured the traditional and computer aided instructions approaches employed by integrated science tutors to teach linear momentum and direct current and the last item measured challenges integrated science tutors face with traditional and computer aided instructions approaches of teaching.

The integrated science tutors' interview schedule (Appendix K) was made up of five items. The first item looks at the teaching approaches integrated science tutors use in teaching linear momentum and direct current. The second item looks at the challenges integrated science tutors face with traditional and computer aided instructions approaches (blended) of teaching linear momentum and direct current. The third item looks at supported computer aided instructions facilities in the colleges to aid teaching. The fourth item looks at professional training in computer aided instructions approaches to teaching in the colleges. The fifth item looks at integrated science teaching experience in the colleges. Teacher trainees' focus group interview schedule (Appendix L) was made up of four items. The first item measured teacher trainees' impressions about the lessons in direct current and linear momentum. The second item measured teacher trainees performances of the lessons on the various concepts treated in the direct current and linear momentum. The third item measured teacher trainees' challenges about any of the various concepts treated in the direct current and linear momentum lessons. The fourth item measured whether the researcher was able to address teacher trainees' challenges in all the concepts treated in the direct current and linear momentum lessons. In all the focus group items measured teacher trainees' general impression about the various concepts treated in direct current and linear momentum lessons in each of the three colleges used for the intervention phase.

Teacher trainees' questionnaire (Appendix C) was made up of five items. The first item measured teacher trainees' views of the teaching approaches used by integrated science tutors to teach linear momentum and direct current. The second item measured teacher trainees' views of computer aided instructions teaching approaches used by integrated science tutors to teach linear momentum and direct current. The third item measured teacher trainees' explanation on how any two of the computer aided instructions teaching approaches used by the integrated tutors was carried out. The fourth item measured teacher trainees' challenges in the direct current and linear momentum. The fifth item measured teacher trainees' specific challenges in the direct current and linear momentum.

The researcher adopted the teacher trainees' achievement test in linear momentum and direct current from standardised questions set by the Institute of Education, University of Cape Coast, the West African Senior High School certificate exams, notable physics books and some questions set by the researcher. The achievement tests for linear momentum and direct current were multiple-choice items with five options. Teacher trainees' linear momentum pre-test (Appendix D) had ten items. The first two items measured teacher trainees' conception of momentum. The second two items measured teacher trainees' application of linear momentum. The third two items measured teacher trainees' application of change in linear momentum. The fourth two items measured teacher trainees' application of conservation of linear momentum. The last two items measured teacher trainees' application of collision. Teacher trainees' direct current pre-test (Appendix H) has ten items. The first two items measured teacher trainees' application of electric current. The second two items measured teacher trainees' application of resistance concept. The third two items measured teacher trainees' application of parallel connection of resistances. The fourth two items measured teacher trainees' application of voltage. The last two items measured teacher trainees' application of voltage in parallel connection. Even though the items in the achievement tests were the same for pre-test and post-test, the items and options were reshuffled to avoid identification of patterns in answering them at the post test stage (Appendices E and I).

Validity

Items on the six main instruments used in this were shown to my team of supervisors. This was done in-order for them to go through and crosschecks to see if the items could measure the intended constructs.

Scoring of the test items

Actually, items on the two achievement tests (linear momentum and direct current) were scored dichotomously on a 1-0 scale (Appendices M and N). The researcher did the marking and scoring of the two achievement tests (linear momentum and direct current).

Pre-testing

The four out of six research instruments used in the study were pre-tested on second year teacher trainees offering the General Education programme and integrated science tutors in College-E, which was not part of the four Colleges of Education used in the main study. Through the help of the Principal and integrated science tutors of College-E, the two research questionnaires (for integrated science tutors and teacher trainees) and two achievement tests (teacher trainees) were distributed to integrated science tutors and teacher trainees to complete in their respective classrooms. Each research instrument (two questionnaires and two achievement tests) was collected from the teacher trainees' and the integrated science tutors after 60 minutes.

Sixty minutes of time was given to the integrated science tutors and teacher trainees' in-order to enable them have ample time to respond to each of the questionnaire and achievement test items. This was because the purpose of the research was not to look out for the integrated science tutors' and teacher trainees' who would finish responding to the questionnaire and test items fast (i.e. speed) but the purpose was to probe into teacher trainees' understanding of linear momentum and direct current; to see the plausible difficulties the teacher trainees faced during the teaching of linear momentum and direct current by their integrated science tutors; and also to see the difficulties integrated science tutors face with employing combination of traditional and CAI teaching approaches to teaching linear momentum and direct current concepts. Teacher trainees were involved in focus grouped interview at every stage of the study (i.e., need analysis phase, teaching with the traditional, computer aided instruction 1 and computer aided instruction 2 approaches).

Reliability

The reliability coefficient for items on the two questionnaires and the two achievement tests were determined using Cronbach Alpha reliability coefficient. This was to establish how consistent the individual items on each questionnaire and test were internally consistent. Four Cronbach Alphas run, one for the closed ended options of the integrated science tutors questionnaire, the second for the closed ended options of the teacher trainees' questionnaire, the third and fourth for the teacher trainees' achievement tests in linear momentum and direct current respectively.

For the integrated science tutors' questionnaire items, the reliability coefficient was 0.990 (see Appendix O for SPSS output). This 0.990 reliability coefficient is greater than 0.700 reliability coefficients (Cohen, Manion & Morrison, 2007), hence the science tutors' questionnaire items were internally consistent with each other. For teacher trainees' questionnaire, the reliability coefficient was 0.505. For teacher trainees test items on concepts of linear momentum, the reliability coefficient was 0.960. For teacher trainees' test on concepts of direct current, the reliability coefficient was 0.966 (see Appendix O for SPSS output).

Data Collection Procedure

An introductory letter was taken from the Head, Department of Science Education, University of Cape Coast and sent to the Principals of the colleges. This was done for the researcher to familiarise himself with the Principals, integrated science tutors and teacher trainees of the colleges. With the assistance of the Principals and the integrated science tutors of the colleges, all the second year teacher trainees of the General Education programme were gathered in the assembly hall of the four colleges. The purpose of the study was then communicated to the second year teacher trainees. Teacher trainees selected moved to their various classrooms for commencement of the study.

Need analysis phase

In College-A, where the need analysis phase of the study was done, the researcher administered four research instruments to teacher trainees (i.e., teacher trainees' questionnaire; teacher trainees' linear momentum achievement test; teacher trainees' direct current achievement test; and teacher trainees' focused group interview schedule) in turns. Two instruments (integrated science tutors' questionnaire and integrated science tutors' interview schedule) were also administered to the integrated science tutors. After the responses from the respondents were analysed, it was evident that the challenges faced by students in the concepts of linear momentum and direct current as reported in literature still exist. Again, the results further indicated that integrated science tutors do not use blended approaches of teaching often.

The intervention phase

Based on the outcomes at the need analysis phase in College-A, six intervention lessons in linear momentum and direct current were designed. The teaching approaches used in designing the six intervention lessons were: the traditional, computer aided instruction 1 and computer aided instruction 2. The traditional approach is a teaching approach that that employs lecture, question, answer and discussion methods. The computer aided instruction 1 approach is a teaching approach that employs lecture, question, answer, discussion, power point and video methods. The computer aided instruction 1 approach was a combination of traditional aided with computer instructions teaching method. The computer aided instruction 2 approach is a teaching approach that that employs lecture, question, answer, discussion, power point, video and computer simulation methods. The computer aided instruction 2 approach was another combination of traditional aided with computer instructions teaching method.

Two intervention lessons with traditional approach were implemented in College-B (control group). Another two intervention lessons with computer instruction 1 approach were implemented in College-C (experimental group 1), and the last two intervention lessons with computer aided instruction 2 approach were implemented in College-D (experimental group 2).

It is good for the researcher to train other integrated science tutors to teach the lessons in linear momentum and direct current concepts (Mansour, 2009), but to achieve the expected intended outcome of the study, the researcher rather did the teaching of the six intervention lessons in linear momentum and direct current concepts. However, because the researcher taught the six intervention lessons in linear momentum and direct current, the study was not able to minimise the researcher's biasness, which is anticipated to affect the validity of the study (Bryman, 2004; Creswell, 2012; Mansour, 2009). Nonetheless, the teaching by the researcher helped minimise an extraneous variable that two teachers might not teach the same way i.e., one teacher might teacher better than the other (Mansour, 2009).

The study further minimised the researcher biasness, by allowing one of the integrated science tutors to video record his teachings in Colleges-B, C and D. The recorded video was later viewed by the researcher to determine concepts omitted, concept not to be included right from the introduction stage through to the conclusion and evaluation stage during teaching of the six intervention lessons in linear momentum and direct current for further improvement.

The intervention lessons

1. Linear momentum: The lesson plans and concepts treated are shown in Appendices P, Q and R.
2. Direct current: The lesson plans and concepts treated are shown in Appendices S, T and U.

Arrangement of initial teaching plans and implementation of the intervention lessons

In order, not to interrupt the College-B semester academic plans, below were the initial teaching plans of the two intervention lessons in linear momentum and direct current

1. Day 1: administration of the pre-test on direct current.
2. Day 2: implementing the intervention lesson on direct current
    a. Through the one sampled pretest-posttest pre-experimental design
    b. Using the lecture, question and answer and discussion (traditional) approach
    c. Video recording of direct current lesson by an integrated science tutor of the college
    d. Administration of the post-test on direct current
3. Day 3: administration of the pre-test on linear momentum.
4. Day 4: implementing the intervention lesson on linear momentum
    a. Through the one sampled pretest-posttest pre-experimental design.
    b. Using the lecture, question, answer, and discussion (traditional) approach.
    c. Video recording of linear momentum lesson by an integrated science tutor of the college.
    d. Administration of the post-test on linear momentum.
5. Day 5: administration of focus group interview on direct current and linear momentum.

6. After two weeks of the traditional approach, to minimise maturation, delayed post-test administered (Appendices F and J)

These same initial plans implemented in College-B were also implemented in College-C (with computer aided instruction 1 approach) and College-D (with computer aided instruction 2 approach).

Data Processing and Analysis

Frequency distribution was used in analysing data for research questions one, two, and four. This was used because the research questions required identification of patterns in teacher trainees and integrated science tutors responses. To answer research question three, thematic content analysis was used and clarified using frequency distribution. Kruskal Wallis test and Games- Howell post-hoc statistics used to analyse data for the only research hypothesis of the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents analyses and discussions on research questions one, two, three, and four of the study. The analyses and discussions were grouped into two phases i.e., the need analysis phase and the intervention phase. The need analysis phase comprised the following, challenges teacher trainees face in learning linear momentum and direct current concepts, plausible combination of traditional and CAI approaches in enhancing teacher trainees' performances in linear momentum and direct current concepts, integrated science tutors' challenges in the usage of combination of traditional and CAI approach in the teaching of linear momentum and direct current concepts, while the intervention phase comprised the implementation of the various teaching approaches i.e., the traditional, computer aided instruction 1 and computer aided instruction 2 approaches (as explained in Chapter three), and focused group interview schedule in Colleges-B, C and D.

The Need Analysis Phase

Challenges teacher trainees face in linear momentum and direct current concepts

The study at this point tries to look at the challenges teacher trainees face when learning linear momentum and direct current concepts. Research question one sought to find out the challenges teacher trainees face in learning linear momentum and direct current concepts. Table 1 shows teacher trainees challenges in linear momentum and direct current in College-A.

As shown in Table 1, majority of the teacher trainees claim they face challenges in learning concepts in linear momentum and direct current (75.5%). This result is in line with (Institute of Education, 2008, 2009, 2011, 2013a, & 2013b) and other studies (Engelhardt & Beichner, 2004; George et al., 2000; Graham & Berry, 1996; Hussain, Latiff, & Yahaya, 2012; Jewett, 2008; Karim, Saepuzaman, & Perdana 2016; Marshall, 2008; McDermott, 1991). Based on these responses of teacher trainees', the study probed the teacher trainees' further to investigate the specific challenges they face with the linear momentum and direct current concepts.

Table 1: College-A teacher trainees' challenges in direct current and linear momentum concepts (N = 40)

Response	f	%
Teacher trainees who face challenges	31	77.5
Teacher trainees who don't face challenges	5	12.5
No response	4	10.0

Table 2 shows teacher trainees' specific challenges in linear momentum and direct current concepts in College A.

In Table 2, the major challenge teacher trainees' face with linear momentum and direct current concepts is the inability of their integrated science tutors to expose them to science experiments (82.50%) during lesson delivery. If this assertion of the teacher trainees concerning their integrated science tutors not being able to expose them to science experiment is true, then it will make the teaching and learning of linear momentum and direct current abstract as has already been indicated in Table 2.

Table 2: College-A teacher trainees' specific challenges in linear momentum and direct current concepts (N= 40)

Response	f	%
No response	8	20.00
No experiment or practical at the laboratory but only theories	33	82.50
Abstract concepts	10	25.00
Less contact hours with the science tutor	1	2.50
Too much formulas with linear momentum and direct current	4	10.00

Teaching Approaches of Integrated Science Tutors

Research question two sought to find out the teaching approaches colleges of education science tutors employ in the teaching of linear momentum and direct current concepts. Here data was collected in two stages. First from the teacher trainees, and secondly from the integrated science tutors. This was done to triangulate the views of integrated science tutors on their teaching approaches. This is because research had shown (Ervin, 2016) that in classroom practices, what tutors profess they practice; in most times is not always the case. Based on this assertion, Table 3 shows teacher trainees' views on the teaching approaches of integrated science tutors in College-A.

In Table 3, even though lecture, discussion, question and answers, images and project teaching approaches were very high compared to other teaching approaches, however, what is of importance here is that there has been to some extend combination of diverse teaching approaches employed by the integrated science tutors. The varied teaching approaches of integrated science tutors in College A was good and is in line with the integrated science syllabus (Institute of Education, 2014) and other studies (Adams, Dubson, Finkelstein, Reid, Wieman, & LeMaster, 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015; Khalid & Azeem, 2012; Lei & Zhao, 2007; Sarfo, Clarebout, & Louw, 2010). However, some of the diverse teaching approaches of integrated science tutors had been minimal such as games and videos. In addition, the teacher trainees' were of the view that their integrated science tutors do not employ computer simulation in their lesson delivery, which could mean that integrated science tutors do not consider computer simulation as one of the approaches of teaching.

Table 3: College-A teacher trainees' views on teaching approaches of integrated science tutors (N = 40)

Response	**F**	**%**
No response	1	2.50
Lecture	38	95.00
Discussion	31	77.50
Question and Answer	38	95.00
Project	22	55.00
Images	33	82.50
Animations	16	40.00
Videos	10	25.00

Table 3 cont……

Response	**F**	**%**
Games	1	2.50
Computer simulations	0	0.00

Table 4 shows teaching approaches of integrated science tutors in College A.

Table 4: College-A teaching approaches of integrated science tutors (N = 5)

Response	**f**	**%**
Lecture	5	100.0
Discussion	4	80.0
Question and Answer	4	80.0
Videos	3	60.0
Games	2	40.0
Project	3	60.0
Computer Simulations	0	0.00
Images	3	60.0
Animations	1	20.0

In Table 4, it shows that integrated science tutors in College-A employ diverse teaching approaches in teaching of linear momentum and direct current. This is in line with the recommendations made in the integrated science syllabus that integrated science tutors' must endeavour to employ diverse teaching approaches in teaching integrated science (Institute of Education, 2014). It is also in line also with other studies that diverse teaching approaches in lesson delivery helps demystify difficult concepts in students (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). This confirms the views of teacher trainees on integrated science tutors usage of computer simulation shown in Table 3. Also, to the researcher's surprise, the government of Ghana through the Ministry of Education and Sports had supplied PhET simulation software to the colleges but these software's has been kept at the storeroom of the ICT department and has not been utilised in the teaching and learning of linear momentum and direct current concepts in integrated science .

In Table 4, one could see that integrated science tutors have always been employing diverse teaching approaches in integrated science lessons delivery, yet teacher trainees still face difficulties in understanding concepts of direct current and linear momentum (Institute of Education, 2008, 2009, 2011, 2013a, & 2013b). Could these difficulties in teacher trainees understanding concepts of direct current and linear momentum in integrated science, possibly be due to integrated science tutors' factors (non-usage of computer simulation, and films among others) or teacher trainees' factors (inability to study, socio-economic status, choice of college, choice of programme, peer pressure among others) and institutional factors (college facilities, and training among others)?

Integrated science tutors usage of combination of traditional and CAI approaches

Research question three sought to find out the plausible combination of traditional and CAI approaches that would enhance teacher trainees' performances in linear momentum and direct current concepts. Table 4 results showed that to some extend integrated science tutors use combination of traditional and CAI approaches i.e., the use of question and answer, project (traditional) and video, and images (computer aided instructions) in teaching linear momentum and direct current.

Integrated science tutors' challenges in the usage of combination of traditional and CAI approaches

Research question four sought to find out the challenges integrated science tutors' face in employing combination of traditional and CAI approaches. Table 5 shows integrated science tutors' difficulties in traditional and comp CAI approach usage in College-A.

Table 5: Integrated science tutors' difficulties in use of combination of traditional and CAI approach in College-A (N = 5)

Methods	f	%
Integration of computer simulation	5	100.0
Infusing of computer games in power point slides	2	40.0
Infusing of animations in power point slides	1	20.0
Infusing of videos in power point slides	3	60.0

In Table 5, the major difficulties of integrated science tutors' in using combination of traditional and CAI approach to teach integrated science was integration of computer simulation (100%) and infusing of videos into power point slides (60%). With the infusing of videos into power point slides, the integrated science tutors were of the view that most times they separately teach with the power point slides without the videos and later uses a media player to show the videos to the teacher trainees. Some integrated science tutors also were of the view that they face challenges in infusing computer games (40%) into science lessons delivery.

Based on these problems in Table 5, the study probe further into the root cause of the integrated science tutors' difficulties in use of combination of traditional and CAI teaching approach through personal interview. This was what transpired between the researcher and the integrated science tutors:

Researcher: "Are there any supported CAI facilities in the college to aid teaching and learning of linear momentum and direct current?".

Respondents: "Yes but not sufficient for the whole tutors and teacher trainees".

One could see that all the five integrated science tutors were of the view that the college has supported CAI facilities that aids teaching and learning of linear momentum and direct current, however, the only challenge was the supported CAI facilities in the college were not sufficient for all the tutors and the teacher trainees respectively.

Based on the results in Table 5, the study further probed the integrated science tutors as to whether the college organises and allows them to attend seminars and workshops on supported CAI. This was what transpired between the researcher and the integrated science tutors.

Researcher: Do you frequently have CAI seminars and workshops in the college, If yes, how often?

Respondents: "Yes, once every year"

All the five integrated science tutors were of the view that every year they attend seminars and workshops on supported CAI to help enhance teaching and learning of integrated science. However, their major challenge was in the integration animations and videos into power point slides and use of computer simulation in their science lesson delivery (Table 5).

Summary of Need Analysis

The need analysis results showed that most teacher trainees faced challenges in linear momentum and direct current. Also, integrated science tutors used several teaching approaches in teaching; some of the approaches were traditional and some too CAI. Furthermore, the major challenges of integrated science tutors to effective usage of CAI approach were in the integration of computer simulation, infusing of animations and videos in power point slides. Based on challenges of teacher trainees' and integrated science tutors', the study did literature analysis of the situation to come out with the current teaching approaches done by other researches in the field such as linear momentum, direct current concepts, and traditional and combination of traditional and CAI approaches (refer to Chapter two).

The Intervention Phase

After the need analysis results and literature review, the study used lecture, question and answer and discussion (LQAD) in College-B, lecture, question and answer, discussion, power point and video (LQADPV) in College-C, and lecture, question and answer, discussion, power point, video and computer simulation (LQADPVS) in College-D in trying to see if these teaching approaches could help improve on teacher trainees performances in linear momentum and direct current concepts as has been reported in literature.

Comparison of teacher trainees' performance when taught using the traditional, computer aided instruction 1 and computer aided instruction 2 approaches

Here the study compared all the performances of teacher trainees in linear momentum and direct current concepts in Colleges-B, C, and D.

Preliminary analysis of results

Here the study presented percentage, one-sample Kolmogorov-Smirnov and Wilcoxon signed ranks results of teacher trainees' performances in linear momentum and direct current concepts in Colleges-B, C, and D.

Teaching at College-B with traditional (Control Group), College-C with computer aided instruction 1 (Experimental-1 Group) and College-D with computer aided instruction 2 approaches (Experimental-2 Group)

Here the study compared all the performances of teacher trainees in linear momentum and direct current concepts in Colleges-B, C, and D after linear momentum and direct current concepts has been taught using different interventions i.e., the traditional, computer aided instruction 1 and computer aided instruction 2 approaches. To this effect descriptive statistics of the pretest and posttest scores of students in linear momentum and direct current concepts for the various colleges used in the student and assumption testing are presented.

Results of first, second and third lessons on linear momentum

Teacher trainees' performance of momentum concept

Table 6 shows pretest and posttest results of teacher trainees' performance of momentum concept.

In Table 6, before the intervention (traditional) in College-B, with the first response, 75% and second response, 30% of teacher trainees got the item on definition of momentum right. This meant that teacher trainees seemed not to face any difficulty with the definition of momentum in the first response, but in the second response faced difficulties with the concept of momentum. After the intervention, with the first response, 90% and second response, 50% of teacher trainees got the items right. Also in Table 6, before the intervention (computer aided instruction 1) in College-C, with the first response, 70% and second response, 30% of teacher trainees got the item on definition of momentum right. This meant that teacher trainees seemed not to face difficulties with the definition of momentum in the first response, but in the second response faced difficulties with the concept of momentum. After the intervention, with the first response, 80% and second response, 45% of teacher trainees got the items right. On the surface, the traditional and computer aided instruction 1 approaches in Colleges-B and C could not help improved on teacher trainees' concept of momentum in second response i.e., when momentum of an object is reduced by half. In addition in Table 6, before the intervention (computer aided instruction 2) in College-D, with the first response, 80% and second response, 35% of teacher trainees got the item on definition of momentum right. This meant that teacher trainees seemed not to face any difficulty with the definition of momentum in first response, but faced difficulties in the second response with the concept of momentum. After the intervention, with first response, 90% and second response, 70% of teacher trainees got the items right. On the surface, the computer aided instruction 2 approach in College-D has help improved on teacher trainees' concept of momentum in second response i.e., when momentum of an object is reduced by half compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 7 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' concept of momentum.

Table 6: Pre-test and post-test results of teacher trainees performance of momentum concept (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	α	15	75.0	18	90.0
		β	5	25.0	2	10.0
	2	α	6	30.0	10	50.0
		β	14	70.0	10	50.0
College-C (computer aided instruction 1)	1	α	14	70.0	16	80.0
		β	6	30.0	4	20.0
	2	α	7	35.0	9	45.0
		β	13	65.0	11	55.0
College-D (computer aided instruction 2)	1	α	16	80.0	18	90.0
		β	4	20.0	2	10.0
	2	α	7	35.0	14	70.0
		β	13	65.0	6	30.0

(Keys: Table 6, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option A while β is options B,C,D and E and for the second response of teacher trainees, α is option C while β is options A, B, D and E)

The data in Table 6 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 7), but the p-values for first and second responses of traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 8) was computed.

In Table 8, for Colleges-B, C and D the p-values for first response (definition of momentum) and the p-value of the second response of LQADPV approach were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees definition of momentum. The statistical outcome of first response does not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al.*, 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011).

Table 7: One-Sample Kolmogorov-Smirnov test results of teacher trainees performance of momentum concept (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.2500	1.1000	1.7000	1.5000
	Std. Deviation	.44426	.30779	.47016	.51299
	Test Statistic	.463	.527	.438	.335
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.3000	1.2000	1.6500	1.5500
	Std. Deviation	.47016	.41039	.48936	.51042
	Test Statistic	.438	.487	.413	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.2000	1.1000	1.6500	1.3000
	Std. Deviation	.41039	.30779	.48936	.47016
	Test Statistic	.487	.527	.413	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

Table 8 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' performance of momentum concept.

Table 8: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' performance of momentum concept

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.083
	2	0.046
College-C (computer aided instruction 1)	1	0.157
	2	0.157
College-D (computer aided instruction 2)	1	0.157
	2	0.008

However, the p-values for second response (concept of momentum) of traditional and computer aided instruction 2 approaches were less than 0.05; thus, there was a statistically significant difference between the pre-test and post-test results of teacher trainees' performance of momentum concept.

The statistical outcome of second response agrees with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011).

Teacher trainees' application of momentum

Table 9 shows pretest and posttest results of teacher trainees' application of momentum.

In Table 9, before the intervention (traditional) for College-B, with the first response, 30% and second response, 35% of teacher trainees got the item on application of momentum right. This meant that teacher trainees seemed to face difficulties with application of momentum. After the intervention, with the first response, 40% and second response, 45% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of momentum. Also, in Table 9, before the intervention (computer aided instruction 1) for College-C, with the first response, 30% and second response, 30% of teacher trainees got the item on application of momentum right. This meant that teacher trainees seemed to face difficulties with application of momentum. After the intervention, with the first response, 40% and second response, 40% of teacher trainees got the items right.

Table 9: Pre-test and post-test results of teacher trainees application of momentum (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			f	%	f	%
College-B (traditional)	1	α	6	30.0	8	40.0
		β	14	70.0	12	60.0
	2	α	7	35.0	9	45.0
		β	13	65.0	11	55.0
College-C (computer aided instruction 1)	1	α	6	30.0	8	40.0
		β	14	70.0	12	60.0
	2	α	6	30.0	8	40.0
		β	14	70.0	12	60.0
College-D (computer aided instruction 2)	1	α	6	30.0	13	65.0
		β	14	70.0	7	35.0
	2	α	7	35.0	13	65.0
		β	14	65.0	7	35.0

(Key: Table 9, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option D while β is options A, B, C and E and for the second response of teacher trainees, α is option E while β is options A, B, C, and D.**)**

Again in Table 9, teacher trainees seemed to face difficulty with application of momentum. Thus the traditional and computer aided instruction 1 approaches could not help improved on teacher trainees' performance in their application of momentum. Furthermore, in Table 9, before the intervention (computer aided instruction 2) for College-D, with the first response, 30% and second response, 35% of teacher trainees got the item on application of momentum right. This meant that teacher trainees seemed to face difficulties with application of momentum. After the intervention, with the first response, 65% and second response, 65% of teacher trainees got the items right. Most teacher trainees seemed not to face difficulty with application of momentum. On the surface the computer aided instruction 2 approach had help improved on teacher trainees' performance in their application of momentum compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 10 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of momentum.

The data in Table 9 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 10), but the p-values for the first and second responses of traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 11) was computed.

Table 10: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of momentum (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.7000	1.6000	1.6500	1.5500
	Std. Deviation	.47016	.50262	.48936	.51042
	Test Statistic	.438	.387	.413	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7000	1.6000	1.7000	1.6000
	Std. Deviation	.47016	.50262	.47016	.50262
	Test Statistic	.438	.387	.438	.387
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.7000	1.3500	1.6500	1.3500
	Std. Deviation	.47016	.48936	.48936	.48936
	Test Statistic	.438	.413	.413	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

Table 11 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of momentum.

Table 11: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of momentum

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.157
	2	0.157
College-C (computer aided instruction 1)	1	0.157
	2	0.157
College-D (computer aided instruction 2)	1	0.008
	2	0.014

In Table 11, the p-values for first and second responses of traditional, and computer aided instruction 1in Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of momentum. The statistical outcome of the first and second responses does not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011). Thus the traditional and computer aided instruction 1 approaches in Colleges-B and C could not help in enhancing teacher trainees' application of momentum. Furthermore for College-D (computer aided instruction 2) the p-values for first and second responses were less than 0.05, this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees application of momentum. The statistical outcome of the first and second responses agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*, 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Thus the computer aided instruction 2 approach in College-D has help in enhancing teacher trainees' application of momentum compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C.

Teacher trainees' application of change in momentum

Table 12 shows pretest and posttest results of teacher trainees' application of change in momentum.

In Table 12, before the intervention (traditional) for College-B, with the first and second responses, 20% of teacher trainees got the item on application of change in momentum right. This meant that teacher trainees seemed to face difficulties with application of change in momentum. After the intervention, with the first response, 20% and second response, 35% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of change in momentum.

Table 12: Pre-test and post-test results of teacher trainees application of change in momentum (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			f	%	f	%
College-B (traditional)	1	α	4	20.0	4	20.0
		β	16	80.0	16	80.0
	2	α	4	20.0	7	35.0
		β	16	80.0	13	65.0
College-C (computer aided instruction 1)	1	α	4	20.0	4	20.0
		β	16	80.0	16	80.0
	2	α	5	25.0	7	35.0
		β	15	75.0	13	65.0
College-D (computer aided instruction 2)	1	α	6	30.0	15	75.0
		β	14	70.0	5	35.0
	2	α	7	35.0	12	60.0
		β	13	65.0	8	40.0

(Key: In Table 13, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option E while β is options A, B, C, and D and for the second response of teacher trainees, α is option E while β is options A, B, and D)

Also, in Table 12, before the intervention (computer aided instruction 1) for College-C, with the first response, 20% and second response 25% of teacher trainees got the item on application of change in momentum right. This meant that teacher trainees seemed to face difficulties with application of change in momentum. After the intervention, with the first response, 20% and second response, 35% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of change in momentum. In addition, in Table 12, before the intervention (computer aided instruction 1) for College-D, with the first response, 30% and second response 35% of teacher trainees got the item on application of change in momentum right. This meant that teacher trainees seemed to face difficulties with application of change in momentum. After the intervention, with the first response, 75% and second response, 60% of teacher trainees got the items right. Teacher trainees seemed not to face difficulty with application of change in momentum. On the surface, the computer aided instruction 2 approach in College-D has helped in enhancing teacher trainees' application of change in momentum compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 14 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of change in momentum.

Table 13: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of change in momentum (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.8000	1.8000	1.8000	1.6500
	Std. Deviation	.41039	.41039	.41039	.48936
	Test Statistic	.487	.487	.487	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7000	1.6000	1.7500	1.6500
	Std. Deviation	.47016	.50262	.44426	.48936
	Test Statistic	.438	.387	.463	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.7000	1.2500	1.6500	1.4000
	Std. Deviation	.47016	.44426	.48936	.50262
	Test Statistic	.438	.463	.413	.387
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

The data in Table 12 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 13), but the p-values for first and second responses for teacher trainees application of change in momentum in Colleges-B, C, and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 14) was computed. Table 15 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of change in momentum in Colleges-B, C, and D.

Table 14: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of change in momentum

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	1.00
	2	0.083
College-C (computer aided instruction 1)	1	0.157
	2	0.157
College-D (computer aided instruction 2)	1	0.003
	2	0.025

In Table 14, the p-value for the first and second responses for Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of change in momentum. This implies that the traditional and computer aided instruction 1 approaches could not help in enhancing teacher trainees' application of change of momentum. The statistical outcome of does not agree with claims made in other studies on traditional and CAI approaches to teaching, (Adams *et* *al*., 2006; Borota, 2010; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Also, in Table 14 for College-D, the p-values for the first and second responses were less than 0.05, this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees application of change of momentum. This implies that the computer aided instruction 2 approach has helped in enhancing teacher trainees' application of change of momentum. This statistical outcome of College-D agrees with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015).

Teacher trainees' application of conservation of momentum

Table 15 shows pretest and posttest results of teacher trainees' application of conservation of momentum.

In Table 15, before the intervention (traditional) for College-B, with first response, 15% and second response, 35% of teacher trainees got the item on application of conservation of momentum right. This meant that teacher trainees seemed to face difficulties with application of conservation of momentum. After the intervention, the first response, 20% and second response, 45% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of conservation of momentum. However, by a mare look at the percentage differences between the first and second responses, there was an increase in percentages which meant that the traditional approach had help improved on teacher trainees' performance in their application of conservation of momentum. Also, in Table 15, before the intervention (computer aided instruction 1) for College-C, with first response, 30% and second response, 25% of teacher trainees got the item on application of conservation of momentum right. This meant that teacher trainees seemed to face difficulties with application of conservation of momentum. After the intervention, the first and second responses, 45% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of conservation of momentum. Thus the approaches used in Colleges-B and C could not help upon teacher trainees' performance in their application of conservation of momentum. Furthermore, in Table 15, before the intervention (computer aided instruction 2) for College-D, with first response, 35% and second response, 40% of teacher trainees got the item on application of conservation of momentum right. This meant that teacher trainees seemed to face difficulties with application of conservation of momentum. After the intervention, the first response 55% and second response, 70% of teacher trainees got the items right. Teacher trainees do not seem to face difficulty with application of conservation of momentum; this meant that the computer aided instruction 2 approach had help improved on teacher trainees' performance in their application of conservation of momentum compared to the other approaches in Colleges-B and C. Table 16 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of conservation of momentum.

Table 15: Pre-test and post-test results of teacher trainees application of conservation of momentum (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			f	%	F	%
College-B (traditional)	1	A	3	15.0	4	20.0
		B	17	85.0	16	80.0
	2	A	7	35.0	9	45.0
		B	13	65.0	11	55.0
College-C (computer aided instruction 1)	1	A	6	30.0	9	45.0
		B	14	70.0	11	55.0
	2	A	5	25.0	9	45.0
		B	15	75.0	11	55.0
College-D (computer aided instruction 2)	1	A	7	35.0	15	75.0
		B	13	65.0	5	25.0
	2	A	8	40.0	14	70.0
		B	12	60.0	6	30.0

(Key: Table 15, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option B while β is options A, C, D and E and for the second response of teacher trainees, α is option A while β is options B, C, D and E)

The data in Table 15 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 16), but the p-values for the first and second responses were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 17) was computed.

Table 16: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of conservation of momentum (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.8500	1.8000	1.6500	1.5500
	Std. Deviation	.36635	.41039	.48936	.51042
	Test Statistic	.509	.487	.413	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7000	1.5500	1.7500	1.5500
	Std. Deviation	.47016	.51042	.44426	.51042
	Test Statistic	.438	.361	.463	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.6500	1.2500	1.6000	1.3000
	Std. Deviation	.48936	.44426	.50262	.47016
	Test Statistic	.413	.463	.387	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

Table 17 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of conservation of momentum.

Table 17: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of conservation of momentum

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.317
	2	0.157
College-C (computer aided instruction 1)	1	0.083
	2	0.046
College-D (computer aided instruction 2)	1	0.005
	2	0.014

In Table 17, the p-values for College-B first and second responses were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of conservation of momentum. The statistical outcome of first and second responses does not agree with claims made in other studies on traditional approaches to teaching, (Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011). Also, in Table 17 for College-C, the p-value for first and response was greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of conservation of momentum. This implies that the computer aided instruction 1 approach could not help enhance teacher trainees' application of conservation of momentum. However, the p-value for the second response was less than 0.05 implying that there was a statistical significance difference between the pre-test and post-test results of teacher trainees' application of conservation of momentum. The statistical outcome of first response does not agree with claims made in other studies on blended approaches to teaching but that of the second response agrees with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Furthermore, in Table 18 for College-D, the p-value for first and second responses were less than 0.05, this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees application of conservation of momentum. This implies that the computer aided instruction 2 approach has helped in enhancing teacher trainees' application of conservation of momentum. The statistical outcome of first and second responses do agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015).

Teacher trainees' application of collision

Table 18 shows pretest and posttest results of teacher trainees' application of collision. In Table 18, before the intervention (traditional) for College-B, with the first response, 20% and second response, 35% of teacher trainees got the item on application of collision right. This meant that teacher trainees seemed to face difficulties with application of collision.

Table18: Pre-test and post-test results of teacher trainees application of collision (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	A	4	20.0	7	35.0
		B	16	80.0	13	65.0
	2	A	7	35.0	8	40.0
		B	13	65.0	12	60.0
College-C (computer aided instruction 1)	1	A	6	30.0	8	40.0
		B	14	70.0	13	65.0
	2	A	7	35.0	8	40.0
		B	13	65.0	12	60.0
College-D (computer aided instruction 2)	1	A	5	25.0	13	65.0
		B	15	75.0	7	35.0
	2	A	7	35.0	14	70.0
		B	13	65.0	16	30.0

(Key: In Table 18, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option A while β is options B, C, D and E and for the second response of teacher trainees, α is option E while β is options A, B, C, and D)

After the intervention, with the first response, 35% and second response, 40% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of collision. However, by a mare look at the percentage differences between the first and second responses, there was an increase percentages meaning that the traditional approach had help improved on teacher trainees' performance in their application of collision. Also, in Table 18, before the intervention (computer aided instruction 1) for College-C, with the first response, 30% and second response, 35% of teacher trainees got the item on application of collision right. This meant that teacher trainees seemed to face difficulties with application of collision. After the intervention, with the first response, 40% and second response, 40% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of collision. The teaching approaches used in Colleges-B and C could not help in enhancing teacher trainees performance in their application of collision. Furthermore, in Table 18, before the intervention (computer aided instruction 2) for College-D, with the first response, 25% and second response, 35% of teacher trainees got the item on application of collision right. This meant that teacher trainees seemed to face difficulties with application of collision. After the intervention, with the first response, 65% and second response, 70% of teacher trainees got the items right. Teacher trainees seemed not to face difficulty with application of collision. The teaching approach used in Colleges-D compared to the teaching approaches in Colleges-B and C, has helped in enhancing teacher trainees' performance in their application of collision.

Table 19 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of collision.

Table 19: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of collision (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.8000	1.6500	1.6500	1.6000
	Std. Deviation	.41039	.48936	.48936	.50262
	Test Statistic	.487	.413	.413	.387
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (LQADPV)	Mean	1.7000	1.6000	1.6500	1.6000
	Std. Deviation	.47016	.50262	.48936	.50262
	Test Statistic	.438	.387	.413	.387
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (LQADPVS)	Mean	1.7500	1.3500	1.6500	1.3000
	Std. Deviation	.44426	.48936	.48936	.47016
	Test Statistic	.463	.413	.413	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

The data in Table 18 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 19), but the p-values for the first and second responses were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 20) was computed.

Table 20 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of collision in College.

Table 20: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of collision

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	.083
	2	.317
College-C (LQADPV)	1	.157
	2	.317
College-D (LQADPVS)	1	.005
	2	.008

In Table 20, the p-value for the first and second responses for Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of collision. The statistical outcomes of the first and second responses do not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al.*, 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Cruse, 2007; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Also, in Table 20, the p-value for the first and second responses for Colleges-D were lesser than 0.05, this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees application of collision. The statistical outcomes of the first and second responses do agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015).

Results of the second lesson (direct current)

Teacher trainees' application of current

Table 21 shows pretest and posttest results of teacher trainees' application of current. In Table 21, before the intervention (traditional) for College-B, 50% of teacher trainees got the item on an application of direct current right. This meant that half of the teacher trainees in the class seemed not to face any difficulty with an application of current. After the intervention, surprisingly 35% of teacher trainees got the items right. On the surface, a mare looking at the pre-test and post-test results indicated that there was a decrease in the percentages; hence, the traditional approach could not help improved on teacher trainees' performance in their application of current. Also, in Table 21, before the intervention (computer aided instruction 1) for College-C, 40% of teacher trainees got the item on an application of direct current right. This meant that most teacher trainees in the class seemed to face difficulty with an application of current. After the intervention, 40% of teacher trainees got the items right. On the surface, a mare looking at the pre-test and post-test results indicated that there was no difference in the percentages; hence, the computer aided instruction 1 approach could not help improved on teacher trainees' performance in their application of current. Furthermore, in Table 21, before the intervention (computer aided instruction 2) for College-D, 30% of teacher trainees got the item on an application of direct current right. This meant that most teacher trainees in the class seemed to face difficulty with an application of current. After the intervention, 75% of teacher trainees got the items right. On the surface, a mare looking at the pre-test and post-test results indicated that there was great difference in the percentages; hence, the computer aided instruction 1 approach has help improved on teacher trainees' performance in their application of current. Table 22 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of current.

Table 21: Pre-test and post-test results of teacher trainees application of current (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	α	10	50.0	7	35.0
		β	10	50.0	13	65.0
College-C (computer aided instruction 1)	1	α	8	40.0	8	40.0
		β	12	60.0	12	60.0
College-D (computer aided instruction 2)	1	α	6	30.0	15	75.0
		β	14	70.0	5	25.0

(Key: Table 21, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the response of teacher trainees, α is option B while β is options A, C, D and E)

Table 22: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of current (N = 20)

Colleges of Education	Parameters	Response	
		Pretest	Posttest
College-B (traditional)	Mean	1.5000	1.6500
	Std. Deviation	.51299	.48936
	Test Statistic	.335	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.6000	1.6000
	Std. Deviation	.50262	.50262
	Test Statistic	.387	.387
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.7000	1.2500
	Std. Deviation	.47016	.44426
	Test Statistic	.438	.463
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]

The data in Table 21 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 22), but the p-values for Colleges-B, C and D of teacher trainees application of direct current was not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 23) was computed. Table 23 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of current in Colleges-B, C and D.

Table 23: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of current

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (LQAD)	1	0.083
College-C (computer aided instruction 1)	1	1.00
College-D (computer aided instruction 2)	1	0.003

In Table 23, the p-values for Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of current. The statistical outcomes not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Again in Table 23, the p-value for Colleges-D was less than 0.05, this meant that there was a statistically significant difference between the pre-test and post-test results of teacher trainees application of current. The statistical outcomes agrees with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015).

Teacher trainees' application of resistance

Table 24 shows pretest and posttest results of teacher trainees' application of resistance. In Table 24, before the intervention (traditional) for College-B, with the first response, 50% and, the second response, 35% of teacher trainees in got the item on application of resistance right. This meant that in some aspects 50% of teacher trainees face difficulties with an application of resistance and in some other aspect 65% of teacher trainees faced difficulties with the an application of resistance. After the intervention, the first response, 35% and second response, 35% of teacher trainees got the items right. On the surface, the traditional approach could not help improved on teacher trainees' performance in their application of resistance. Also, in Table 24, before the intervention (computer aided instruction 1) for College-C, with the first response, 30% and, the second response, 30% of teacher trainees in got the item on application of resistance right. This meant that most teacher trainees face difficulties with an application of resistance. After the intervention, the first response, 40% and second response, 45% of teacher trainees got the items right. On the surface, the computer aided instruction 1 approach could not help improved on teacher trainees' performance in their application of resistance. Furthermore, in Table 24, before the intervention (computer aided instruction 2) for College-D, with the first response, 30% and, the second response, 30% of teacher trainees in got the item on application of resistance right. This meant that most teacher trainees face difficulties with an application of resistance. After the intervention, the first response, 80% and second response, 75% of teacher trainees got the items right. On the surface, the computer aided instruction 2 approach has helped improved on teacher trainees' performance in their application of resistance. Table 26 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of resistance.

The data in Table 24 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 25), but the p-values for the first and second responses for Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 26) was computed. Table 26 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of resistance in College-B, C and D. In Table 26, the p-values for the first and second responses for Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of resistance. The statistical outcome of the first and second responses do not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015).

Table 24: Pre-test and post-test results of teacher trainees application of resistance (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			f	%	f	%
College-B (traditional)	1	α	10	50.0	7	35.0
		β	10	50.0	13	65.0
	2	α	7	35.0	7	35.0
		β	13	65.0	13	65.0
College-C (computer aided instruction 1)	1	α	6	30.0	8	40.0
		β	14	70.0	12	60.0
	2	α	6	30.0	9	45.0
		β	14	70.0	11	55.0
College-D (computer aided instruction 2)	1	α	6	30.0	16	80.0
		β	14	70.0	4	20.0
	2	α	6	30.0	15	75.0
		β	14	70.0	5	25.0

(Key: Table 24, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option E while β is options A, B, C, and D and for the second response of teacher trainees, α is option C while β is options A, B, D, and E)

Table 25: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of resistance (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.5000	1.6500	1.6500	1.6500
	Std. Deviation	.51299	.48936	.48936	.48936
	Test Statistic	.335	.413	.413	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7000	1.6000	1.7000	1.5500
	Std. Deviation	.47016	.50262	.47016	.51042
	Test Statistic	.438	.387	.438	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.7000	1.2000	1.7000	1.2500
	Std. Deviation	.47016	.41039	.47016	.44426
	Test Statistic	.438	.487	.438	.463
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

Table 26: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of resistance

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.083
	2	1.00
College-C (computer aided instruction 1)	1	0.157
	2	0.083
College-D (computer aided instruction 2)	1	0.002
	2	0.003

Also, in Table 27, the p-values for the first and second responses for College-D were lesser than 0.05, this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees application of resistance. The statistical outcome of the first and second responses do agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). On the whole the computer aided instruction 2 in College-D approach has been effective in enhancing teacher trainees' application of resistance to the traditional in College-B and computer aided instruction 1 in College-C.

Teacher trainees' application of voltage in Colleges-B, C and D

Table 27 shows pretest and posttest results of teacher trainees' application of voltage.

In Table 27, before the intervention (traditional) for College-B, 20% of teacher trainees got the item on application of voltage right. This meant that teacher trainees seemed to face difficulties with application of voltage. After the intervention, 35% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of voltage. However, by a mare looking at the percentages between pre-test and post-test results, there was an increase in percentages meaning that the traditional approach had help improved on teacher trainees' performance in their application of voltage. Also, in Table 27, before the intervention (computer aided instruction 1) for College-C, 40% of teacher trainees got the item on application of voltage right. This meant that teacher trainees seemed to face difficulties with application of voltage. After the intervention, 45% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of voltage.

Table 27: Pre-test and post-test results of teacher trainees application of voltage (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	α	4	20.0	7	35.0
		β	16	80.0	13	65.0
College-C (computer aided instruction 1)	1	α	8	40.0	9	45.0
		β	12	60.0	11	55.0
College-D (computer aided instruction 1)	1	α	5	25.0	14	70.0
		β	15	75.0	6	30.0

(Key: Table 27, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. The response of teacher trainees, α is option A while β is options B, C, D and E)

Thus on the surface the traditional and computer aided instruction 1 approaches used in Colleges-B and C could not help in enhancing teacher trainees' application of voltage. Furthermore, in Table 27, before the intervention (computer aided instruction 2) for College-D, 25% of teacher trainees got the item on application of voltage right. This meant that teacher trainees seemed to face difficulties with application of voltage. After the intervention, 70% of teacher trainees got the items right. Teacher trainees seemed not to face difficulty with application of voltage. Thus on the surface, the computer aided instruction 2 approach in College-D has helped improved on teacher trainees' application of voltage compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 28 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of voltage.

The data in Table 27 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 28), but the p-values for Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 29) was computed. Table 30 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of voltage in Colleges-B, C and D. In Table 29, the p-values for Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of voltage.

Table 28: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of voltage (N = 20)

Colleges of Education	Parameters	Response	
		Pretest	Posttest
College-B (traditional)	Mean	1.8000	1.6500
	Std. Deviation	.41039	.48936
	Test Statistic	.487	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.6000	1.5500
	Std. Deviation	.50262	.51042
	Test Statistic	.387	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.7500	1.3000
	Std. Deviation	.44426	.47016
	Test Statistic	.463	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]

Table 29: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of voltage

Colleges of Education	Response	Test Statistics
		Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.083
College-C (computer aided instruction 1)	1	0.317
College-D (computer aided instruction 2)	1	0.003

The statistical outcome does not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Also, in Table 30, the p-value for College-D was less than 0.05; this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees' application of voltage. The statistical outcome does agree with claims made in other studies on traditional and CAI approaches to teaching (Adams et al, 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). On the whole the computer aided instruction 2 in approach in College-D has helped in enhancing teaching trainees' application of voltage to the traditional approach in College-B and computer aided instruction 1 approach in College-C.

Teacher trainees' application of resistance in a series circuit connection

Table 30 shows pretest and posttest results of teacher trainees' application of resistance in a series circuit connection.

In Table 30, before the intervention (traditional) for College-B, with the first response, 20% and the second response, 35% of teacher trainees got the item on application of resistance in a series circuit right. This meant that teacher trainees seemed to face difficulties with application of resistance in a series circuit. After the intervention, the first response, 30% and the second response, 35% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of resistance in a series circuit. Also, in Table 30, before the intervention (computer aided instruction 1) for College-C, with the first response, 30% and the second response, 45% of teacher trainees got the item on application of resistance in a series circuit right. This meant that teacher trainees seemed to face difficulties with application of resistance in a series circuit. After the intervention, the first response, 40% and the second response, 40% of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of resistance in a series circuit. On the surface, the traditional and computer aided instruction 1 approaches in Colleges-B and C could not help in enhancing teacher trainees' application of resistance in a series circuit connection.

Furthermore, in Table 30, before the intervention (computer aided instruction 1) for College-C, with the first response, 20% and the second response, 30% of teacher trainees got the item on application of resistance in a series circuit right. This meant that teacher trainees seemed not to face difficulties with application of resistance in a series circuit. After the intervention, the first response, 70% and the second response, 75% of teacher trainees got the items right. On the surface, the computer aided instruction 2 approach in College-D has helped in enhancing teacher trainees application of resistance in a series circuit connection compared to the traditional and computer aided instruction 1 approaches in College-B and C. Table 31 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of resistance in a series circuit.

Table 30: Pre-test and post-test results of teacher trainees application of resistance in a series circuit connection (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	α	4	20.0	7	35.0
		β	16	80.0	13	65.0
	2	α	6	30.0	7	35.0
		β	14	70.0	13	65.0
College-C (computer aided instruction 1)	1	α	6	30.0	9	45.0
		β	14	70.0	11	55.0
	2	α	8	40.0	8	40.0
		β	12	60.0	13	60.0
College-D (computer aided instruction 2)	1	α	4	20.0	14	70.0
		β	16	80.0	6	30.0
	2	α	6	30.0	15	75.0
		β	14	70.0	5	25.0

(Key: Table 30, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option E while β is options A, B, C and D and for the second response of teacher trainees, α is option D while β is options A, B, C and E)

The data in Table 30 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 31), but the p-values for first and second responses in Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 32) was computed. In Table 32, the p-values for the first and second responses of Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of resistance in a series circuit connection. The statistical outcome of the first and second responses does not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Also, in Table 32, the p-value for the first and second response of College-D was less than 0.05, this meant that there was a statistical significant difference between the pre-test and post-test results of teacher trainees application of resistance in a series circuit connection. The statistical outcome of the response agrees with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). On the whole, the computer aided instruction 2 approach in College-D has helped in enhancing teacher trainees' application of resistance in series circuit connection to the traditional and computer aided instruction 1 approaches in Colleges-B and C.

Table 31: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of resistance in a series circuit connection (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.8000	1.6500	1.7000	1.6500
	Std. Deviation	.41039	.48936	.47016	.48936
	Test Statistic	.487	.413	.438	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7000	1.5500	1.6000	1.6000
	Std. Deviation	.47016	.51042	.50262	.50262
	Test Statistic	.438	.361	.387	.387
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.8000	1.3000	1.7000	1.2500
	Std. Deviation	.41039	.47016	.47016	.44426
	Test Statistic	.487	.438	.438	.463
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

Table 32 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of resistance in a series circuit connection.

Table 32: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of resistance in a series circuit connection

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.083
	2	0.317
College-C (computer aided instruction 1)	1	0.083
	2	1.00
College-D (computer aided instruction 2)	1	0.002
	2	0.003

Teacher trainees' application of current in a parallel circuit connection

Table 33 shows pretest and posttest results of teacher trainees' application of current in a parallel circuit connection.

In Table 33, before the intervention (traditional) for College-B, with the first and responses, 20% of teacher trainees got the item on application of current in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of current in a parallel circuit connection. After the intervention, 50% with the first response which meant that about half of the teacher trainees in the class faced difficulties with an application of current in a parallel circuit connection and 35% with the second response of teacher trainees got the items right. Again, teacher trainees seemed to face difficulty with application of current in a parallel circuit connection.

Table 33: Pre-test and post-test results of teacher trainees application of current in a parallel circuit connection (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	α	4	20.0	10	50.0
		β	16	80.0	10	50.0
	2	α	4	20.0	7	35.0
		β	16	80.0	13	65.0
College-C (computer aided instruction 1)	1	α	4	20.0	10	50.0
		β	16	80.0	10	50.0
	2	α	6	30.0	9	45.0
		β	14	70.00	11	55.00
College-D (computer aided instruction 2)	1	α	7	35.0	15	75.0
		β	13	65.0	5	25.0
	2	α	6	30.0	14	70.0
		β	14	70.00	6	30.00

(Key: Table 33, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option A while β is options B, C, D and E and for the second response of teacher trainees, α is option B while β is options A, C, D and E)

Also, in Table 33, before the intervention (computer aided instruction 1) for College-C, with the first responses, 20% and second response, 30% of teacher trainees got the item on application of current in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of current in a parallel circuit connection. After the intervention, with the first and second responses, 50% got the item right which meant that about half of the teacher trainees in the class faced difficulties with an application of current in a parallel circuit connection. On the surface computer aided instruction 1 approach in College-C seemed to enhance teacher trainees' application of current in a parallel circuit connection compared to the traditional approach in College-B. Furthermore, in Table 33, before the intervention (computer aided instruction 2) for College-D, with the first responses, 30% and second response, 35% of teacher trainees got the item on application of current in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of current in a parallel circuit connection. After the intervention, with the first response 75% and second responses, 70% got the item right which meant that teacher trainees do not face difficulties with an application of current in a parallel circuit connection. On the surface computer aided instruction 2 approach in College-D seemed to enhance teacher trainees' application of current in a parallel circuit connection compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 34 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of current in a parallel circuit connection.

Table 34: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of current in a parallel circuit connection (N = 20)

Colleges of Education	Parameters	Response-1		Response-2	
		Pretest-1	Posttest-1	Pretest-2	Posttest-2
College-B (traditional)	Mean	1.8000	1.8000	1.5000	1.6500
	Std. Deviation	.41039	.41039	.51299	.48936
	Test Statistic	.487	.487	.335	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.8000	1.8000	1.7000	1.7500
	Std. Deviation	.41039	.41039	.47016	.44426
	Test Statistic	.487	.487	.438	.463
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.6500	1.2500	1.7000	1.3000
	Std. Deviation	.48936	.44426	.47016	.47016
	Test Statistic	.413	.463	.438	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]	.000[c]	.000[c]

The data in Table 33 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 34), but the p-values for the first and second responses for Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 35) was computed. Table 36 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of current in a parallel circuit connection.

Table 35: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of current in a parallel circuit connection

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.014
	2	0.083
College-C (computer aided instruction 1)	1	0.014
	2	0.083
College-D (computer aided instruction 2)	1	0.005
	2	0.005

In Table 35, the p-values for Colleges-B and C for the first response were less than 0.05 which meant that there was a statistically significant difference between the pre-test and post-test results of teacher trainees application of current in a parallel circuit connection. The statistical outcome of the first response does agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). However, the p-values for Colleges-B and C for the second response were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of current in a parallel circuit connection. The statistical outcome of second response does not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Also, in Table 35, the p-values for Colleges-D for the first and second responses were less than 0.05 which meant that there was a statistically significant difference between the pre-test and post-test results of teacher trainees application of current in a parallel circuit connection. The statistical outcome of the first response does agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). On the whole the computer aided instruction 2 approach has helped in enhancing teacher trainees' application of current in a parallel circuit connection compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C.

Teacher trainees' application of resistances in a parallel circuit connection

Table 36 shows pretest and posttest results of teacher trainees' application of resistances in a parallel circuit connection. In Table 36, before the intervention (traditional) for College-B, 30% of teacher trainees in got the item on application of resistances in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of resistances in a parallel circuit connection. After the intervention, 50% of teacher trainees got the items right. This meant that about 50% of teacher trainees face difficulty with application of resistances in a parallel circuit connection. Also, in Table 36, before the intervention (computer aided instruction 1) for College-C, 25% of teacher trainees in got the item on application of resistances in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of resistances in a parallel circuit connection. After the intervention, 50% of teacher trainees got the items right. This meant that about 50% of teacher trainees face difficulty with application of resistances in a parallel circuit connection. On the surface, the traditional and computer aided instruction 1 approaches in Colleges-B and C has enhanced 50% of teacher trainees' application of resistances in a parallel circuit connection. Furthermore, in Table 36, before the intervention (computer aided instruction 2) for College-D, 20% of teacher trainees in got the item on application of resistances in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of resistances in a parallel circuit connection. After the intervention, 70% of teacher trainees got the items right. This meant that most teacher trainees do not face difficulty with application of resistances in a parallel circuit connection. On the surface, the computer aided instruction 2 approach in College-D has helped enhanced teacher trainees' application of resistances in a parallel circuit connection compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 37 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of resistances in a parallel circuit connection.

The data in Table 36 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 37), but the p-values of traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 38) was computed. Table 38 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of resistances in a parallel circuit connection. In Table 38, the p-values of traditional, computer aided instruction 1 and computer aided instruction 1 in Colleges-B,C and D were less than 0.05, this meant that there was a statistically significant difference between the pre-test and post-test results of teacher trainees application of resistances in a parallel circuit connection implying that the traditional, computer aided instruction 1 and computer aided instruction 2 in Colleges-B,C and D approaches has help in enhancing teacher trainees application of resistance in a parallel circuit connection.

Table 36: Pre-test and post-test results of teacher trainees application of resistances in a parallel circuit connection (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			f	%	f	%
College-B (traditional)	1	A	6	30.0	10	50.0
		B	14	70.0	10	50.0
College-C (computer aided instruction 1)	1	A	5	25.0	10	50.0
		B	15	75.0	10	50.0
College-D (computer aided instruction 2)	1	A	4	20.0	14	70.0
		B	16	80.0	6	30.0

(Key: Table 36, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option A while β is options B, C, D and E)

Table 37: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of resistances in a parallel circuit connection (N = 20)

Colleges of Education	Parameters	Response-1	
		Pretest-1	Posttest-1
College-B (traditional)	Mean	1.7000	1.5000
	Std. Deviation	.47016	.51299
	Test Statistic	.438	.335
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7500	1.5000
	Std. Deviation	.44426	.51299
	Test Statistic	.463	.335
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.8000	1.3000
	Std. Deviation	.41039	.47016
	Test Statistic	.487	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]

Table 38: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of resistances in a parallel circuit connection

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.046
College-C (computer aided instruction 1)	1	0.025
College-D (computer aided instruction 2)	1	0.002

The statistical outcome agrees with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Again in Table 38, the computer aided instruction 2 approach was more significant to computer aided instruction 1 approach, and computer aided instruction 1 approach too was also more significant to traditional approach. Even though any of these approaches could be used but the computer aided instruction 2 approach is far more effective to the computer aided instruction 1 and traditional approaches.

Teacher trainees' application of voltages in parallel circuit connection

Table 39 shows pretest and posttest results of teacher trainees' application of voltages in parallel circuit connection. In Table 39, before the intervention (traditional) for College-B, 30% of teacher trainees got the item on application of voltages in parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of voltages in parallel circuit connection. After the intervention, 35% of teacher trainees got the items right. This meant that still teacher trainees face difficulty with application of voltages in parallel circuit connection. Also, in Table 39, before the intervention (computer aided instruction 1) for College-C, 30% of teacher trainees got the item on application of voltages in parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of voltages in a parallel circuit connection. After the intervention, 45% of teacher trainees got the items right. This meant that still teacher trainees face difficulty with application of voltages in parallel circuit connection. On the surface, the traditional and computer aided instruction 1 approaches in Colleges-B and C could not help in enhancing teacher trainees' application of voltages in parallel circuit connection.

Table 39: Pre-test and post-test results of teacher trainees application of voltages in parallel circuit connection (N = 20)

Colleges of Education	Response	Option	Pretest results		Posttest results	
			F	%	f	%
College-B (traditional)	1	A	6	30.0	7	35.0
		B	14	70.0	13	65.0
College-C (computer aided instruction 1)	1	A	6	30.0	9	45.0
		B	14	70.0	11	55.0
College-D (computer aided instruction 2)	1	A	6	30.0	14	70.0
		B	14	70.0	6	30.0

(Key: Table 39, the symbol α signifies correct options while that of the symbol β signify the wrong options of teacher trainees. For the first response of teacher trainees, α is option E while β is options A, B, C and D)

Furthermore, in Table 39, before the intervention (computer aided instruction 2) for College-D, 30% of teacher trainees got the item on application of voltages in a parallel circuit connection right. This meant that teacher trainees seemed to face difficulties with application of voltages in parallel circuit connection. After the intervention, 70% of teacher trainees got the items right. This meant that most teacher trainees do not face difficulty with application of voltages in a parallel circuit connection. On the surface the computer aided instruction 2 has helped in enhancing teacher trainees' application of voltages in a parallel circuit connection compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C. Table 40 shows one-sample Kolmogorov-Smirnov test between the pre-test and post-test results of teacher trainees' application of voltages in parallel circuit connection.

The data in Table 39 underwent normality test through one-sample Kolmogorov-Smirnov test (Table 40), but the p-values of traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges-B, C and D were not greater than 0.05, hence the data could not meet the normality test of which Wilcoxon signed ranks test (Table 41) was computed. Table 41 shows Wilcoxon signed rank test between the pre-test and post of teacher trainees' application of voltages in parallel circuit connection.

Table 40: One-Sample Kolmogorov-Smirnov test results of teacher trainees application of voltages in a parallel circuit connection (N = 20)

Colleges of Education	Parameters	Response-1	
		Pretest-1	Posttest-1
College-B (traditional)	Mean	1.7000	1.6500
	Std. Deviation	.47016	.48936
	Test Statistic	.438	.413
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-C (computer aided instruction 1)	Mean	1.7000	1.5500
	Std. Deviation	.47016	.51042
	Test Statistic	.438	.361
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]
College-D (computer aided instruction 2)	Mean	1.7000	1.3000
	Std. Deviation	.47016	.47016
	Test Statistic	.438	.438
	Asymp. Sig. (2-tailed)	.000[c]	.000[c]

Table 41: Wilcoxon signed ranks test between the pre-test and post-test results of teacher trainees' application of voltages in a parallel circuit connection

Colleges of Education	Response	Test Statistics Asymp. Sig. (2-tailed)
College-B (traditional)	1	0.317
College-C (computer aided instruction 1)	1	0.083
College-D (computer aided instruction 2)	1	0.005

In Table 41, the p-values for traditional and computer aided instruction 1 in Colleges-B and C were greater than 0.05, this meant that there was no statistically significant difference between the pre-test and post-test results of teacher trainees application of voltages in parallel circuit connection implying that the traditional and computer aided instruction 1 approaches have not help in enhancing teacher trainees application of voltages in a parallel circuit connection. The statistical outcome does not agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Borota, 2010; Carpenter, 2006; Chaudhury, 2011; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). Also, in Table 42, the p-value for computer aided instruction 2 in Colleges-D was less than 0.05, this meant that there was a statistically significant difference between the pre-test and post-test results of teacher trainees application of voltages in parallel circuit connection. The statistical outcome does agree with claims made in other studies on traditional and CAI approaches to teaching (Adams *et al*., 2006; Borota, 2010; Cruse, 2007; Harris & Johnson, 2003; Johnson, 2015). This implies that the computer aided instruction 2 approach in College-D has help in enhancing teacher trainees' application of voltages in a parallel circuit connection compared to the traditional and computer aided instruction 1 approaches in Colleges-B and C.

Teacher trainees' focus group interview schedule in College-B

The members of the focus group interview schedule were comprised of ten teacher trainees in College-B. The ten teacher trainees were selected randomly and interviewed. This was what transpired between the researcher and the five teacher trainees.

Researcher: “how were the two lessons on direct current and linear momentum?”

The Group: “the two lessons were ok”

Researcher: “were you able to understand the various concepts treated in direct current and linear momentum?”

The Group: “yes”

Researcher: “did anyone of you face a challenge with any of the concepts treated in direct current and linear momentum?”

The Group: “no”

Researcher: “was I able to address your difficulties in any of the concepts treated in direct current and linear momentum. Mention the exact concept with its difficulty?”

The Group: “Sir, our difficulties are with the problem solving in change of momentum, conservation of momentum, collision and current, resistances and in parallel circuit connection. Nevertheless, Sir, (from the eighth group member), your teaching was mostly teacher centred and no experiment or demonstrations, only blackboard illustrations.

From the interview, some issues came up such as the classroom atmosphere was dominated by me i.e., I employed teacher centred approach and that teacher trainees face challenges when it comes to problem solving in direct current and linear momentum. Practical was not employed here because the purpose of the study here was to use only combination traditional teaching approaches (Theory-1), i.e., lecture, question and answer and discussion approach.

Teacher trainees' focus group interview schedule in College-C

The members of the focus group interview schedule were comprised of ten teacher trainees in College-C. The ten teacher trainees were randomly picked and interviewed. This was what transpired between the researcher and the ten teacher trainees.

Researcher: "how was the lesson on direct current and linear momentum?"

The Group: "the two lessons were not bad"

Researcher: "were you able to understand the various concepts treated in direct current and linear momentum?"

The Group: "yes"

Researcher: "did anyone of you face a challenge with any of the concepts treated in direct current and linear momentum?"

The Group: "no"

Researcher: "was I able to address your difficulties in any of the concepts treated in direct current and linear momentum. Mention the exact concept with its difficulty?"

The Group:

> "Sir, the two video lessons were good. The only challenge we faced with the two videos were (1) with the linear momentum, we could not hear the instructor's voice very clearly, and (2) with the direct current, the video could not show the direction of the current. Aside these two videos

> and your explanations, we understood the concepts. However, we had wanted to see the same results as shown in the two videos performed by own hands at the laboratory".

From the interview, the two videos on direct current and linear momentum enriched the lesson. Yet what was missing was the actual experiments to confirm or refute the occurrences in the two video lessons. After the interview and the issues' raised by the teacher trainees the researcher went back to watch the video that had been recorded by one of the integrated science tutor during the intervention lessons. The video revealed the inability of the researcher to perform (experiment). Practical was not employed here because the purpose of the study here was to use only an aspect of combination of traditional and CAI approaches i.e., combined traditional approaches (i.e., lecture, question and answer and discussion) and CAI (i.e., PowerPoint and videos) were implemented in College-C. The other aspect of the combination of traditional and CAI approaches i.e., combined traditional approaches (i.e., lecture, question and answer and discussion) and CAI (i.e., PowerPoint, videos and computer simulation) were implemented in College-D.

Teacher trainees' focus group interview schedule in College-D

The members of the group for focus group interview schedule were comprised of 10 teacher trainees in College-D. The ten teacher trainees were selected randomly. This was what transpired between the researcher and the teacher trainees.

Researcher: "how were the lessons on direct current and linear momentum?"

The Group: “the two lessons were ok”

Researcher: “were you able to understand the various concepts treated in direct current and linear momentum?”

The Group: “yes”

Researcher: “did anyone of you face a challenge with any of the concepts treated in direct current and linear momentum?”

The Group: “no”

Researcher: “was I able to address your difficulties in any of the concepts treated in direct current and linear momentum. Mention the exact concept with its difficulty?”

The Group:

> “Most of the concepts treated in class were explained by you and further supported by the videos and computer simulation on direct current and linear momentum. Sir, the video lessons were very good except the instructor voice in the linear momentum, her voice was not audible enough. Also, the computer simulation was very most interesting interactive. It was fan manipulating the various current circuits and collisions through the use of the PhET simulation software. We designed different types of current circuits to see the brightness of the bulbs, the rate of current flow with their respective directions. We also wrongly connected the circuits to see the behaviour of the circuit connection and the nature of the brightness of the bulbs. We also used different masses for

both the inelastic and elastic collisions and observed different outcomes. Sir this was almost like the real experiment.

Testing of the research hypothesis of the study

Ho: There is no statistically significant difference in performance among teacher trainees taught with the traditional (use of lecture, question, answer and discussion) approach and teacher trainees taught with computer aided instruction 1 teaching approaches (use of lecture, question, answer and discussion, power point and video and computer aided instruction 2 (use of lecture, question, answer and discussion, power point, video and computer simulation).

H1: There is a statistically significant difference in performance among teacher trainees taught with the traditional (use of lecture, question, answer and discussion) approach and teacher trainees taught with computer aided instruction 1 teaching approaches (use of lecture, question, answer and discussion, power point and video and computer aided instruction 2 (use of lecture, question, answer and discussion, power point, video and computer simulation).

Here, the study used Games-Howell (post-hoc) test the very opposite of one-way ANOVA analysis in testing the statistically significant difference in post-tests performances among teacher trainees taught with the traditional teaching approaches and teacher trainees taught with computer aided instruction 1 and computer aided instruction 2.

Linear momentum

Teacher trainees' performance of momentum concept in Colleges-B, C and D

Table 42 shows Kruskal Wallis between the post-test results of teacher trainees' performance of momentum concept in Colleges-B, C and D.

Table 42: Kruskal Wallis test between the post-test scores of teacher trainees' performance of momentum concept in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	1.135	2.781
Df	2	2
Asymp. Sig.	.567	.249

In Table 42, the p-values in the Kruskal Wallis test statistics for the first and second post-test scores of teacher trainees performance of momentum concept was greater than 0.05. This meant that there was no difference between the three teaching approaches (traditional, computer aided instruction 1 and computer aided instruction 2) in the three Colleges (B, C and D). Because the p-values in the Kruskal Wallis test statistics were greater than 0.05 the study could not go ahead to conduct Games-Howell (post-hoc) test.

Therefore any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2could be employed to teach momentum. Based on this result, the study accepted the null hypothesis (Ho) but rather rejected the alternative hypothesis (H1) that there are differences in the teaching approaches used in the study.

Teacher trainees' application of momentum in Colleges-B, C and D

Table 43 shows Kruskal Wallis between the post-test results of teacher trainees' application of momentum in Colleges-B, C and D.

Table 43: Kruskal Wallis test between the post-test scores of teacher trainees' application of momentum in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	3.281	2.753
Df	2	2
Asymp. Sig.	.194	.252

In Table 43, the p-values in the Kruskal Wallis test statistics for the first and second post-test scores of teacher trainees application of momentum was greater than 0.05. This meant that there was no difference between the three teaching approaches (traditional, computer aided instruction 1 and computer aided instruction 2) in the three Colleges (B, C and D). Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2could be used to teach application of momentum.

Teacher trainees' application of change in momentum in Colleges-B, C and D

Table 44 shows Krushal Wallis test between the post-test results of teacher trainees' application of change in momentum in Colleges-B, C and D.

Table 44: Krushal Wallis test between the post-test scores of teacher trainees' application of change in momentum in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	16.778	3.337
Df	2	2
Asymp. Sig.	.000	.189

In Table 44, the p-value for the second post-test score in the Kruskal Wallis was greater than 0.05 for teacher trainees' application of change in momentum. This meant that there were no differences between the three teaching approaches (traditional, computer aided instruction 1 and computer aided instruction 2) in the three Colleges (B, C and D). Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., LQAD, LQADPV and LQADPVS could be used to teach teacher trainees application of change in momentum. However, the p-value for the first post-test score in Kruskal wallis test was less than 0.05. This meant that there were differences between the three teaching approaches (traditional, computer aided instruction 1 and computer aided instruction 2) in the three Colleges (B, C and D), but the Kruskal Wallis test could not specifically show the actual statistical differences in the three teaching approaches for the first post-test scores. To determine the actual statistical differences in the three teaching approaches for the first post-test scores, the study conducted Games-Howell (post-hoc) test (Table 45). Table 45 shows Games-Howell post-hoc test between the post-test of teacher trainees' application of change in momentum in Colleges B, C and D.

Table 45: Games-Howell post-hoc test between the post-test scores of teacher trainees' application of change in momentum, Colleges-B, C and D (N = 20)

Games-Howell

Dependent Variable	(I) Colleges	(J) Colleges	Sig.
Posttest Score-1	College-B (traditional)	College-C	1.000
		College-D	.001
	College-C (computer aided instruction 1)	College-B	1.000
		College-D	.001
	College-D (computer instruction 2)	College-B	.001
		College-C	.001

In Table 45, it shows that for the first post-test there was a statistically significant difference between College-B (traditional) and College-D (computer aided instruction 2) and between College-C (computer aided instruction 1) and College-D (computer instruction 2) approaches since their p-values were less than 0.05. This result made the study to reject the null hypothesis (Ho), but accepts the alternative hypothesis (H1) that there is a statistically significant difference in the teaching approaches. This meant that for effective enhancement in the teaching of change in momentum to teacher trainees, computer instruction 2 approach is the best plausible approach to use.

Teacher trainees' application of conservation of momentum, Colleges B, C and D

Table 46 shows Kruskal Wallis test between the post-test results of teacher trainees' application of conservation of momentum in Colleges B, C and D.

Table 46: Kruskal Wallis test between the post-test scores of teacher trainees' application of conservation of momentum, Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	11.984	3.292
Df	2	2
Asymp. Sig.	.002	.193

In Table 46, the p-value for the second post-test score in the Kruskal Wallis was greater than 0.05 for teacher trainees' application of conservation of momentum. This meant that there were no differences between the three teaching approaches (traditional, computer aided instruction 1 and computer aided instruction 2) in the three Colleges (B, C and D). Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of conservation of momentum. However, the p-value for the first post-test score in Kruskal wallis test was less than 0.05, this meant that there were differences between the three teaching approaches (traditional, computer aided instruction 1 and computer aided instruction 2) in the three Colleges (B, C and D), but the Kruskal Wallis test could not specifically show the actual statistical differences in the three teaching approaches with the first post-test score. To determine the actual statistical differences in the three teaching approaches for the first post-test scores, the study conducted Games-Howell (post-hoc) test (Table

47). Table 47 shows Games-Howell post-hoc test between the post-test of teacher trainees' application of conservation of momentum in Colleges B, C and D.

In Table 47, it shows that for the first post-test there was a statistically significant difference between College-B (traditional) and College-D (computer aided instruction 2) since their p-values were less than 0.05. This result made the study to reject the null hypothesis (Ho), but accepts the alternative hypothesis (H1) that there is a statistically significant difference in the teaching approaches. This meant that for effective enhancement in the teaching of conservation of momentum to teacher trainees, computer aided instruction 2 approach is the best plausible approach to use.

Table 47: Games-Howell post-hoc test between the post-test scores of teacher trainees' application of conservation of momentum, Colleges-B, C and D (N = 20)

Games-Howell

Dependent Variable	(I) Colleges	(J) Colleges	Sig.
Posttest Score-1	College-B (traditional)	College-C	.216
		College-D	.001
	College-C (computer aided instruction 1)	College-B	.216
		College-D	.131
	College-D (computer aided instruction 2)	College-B	.001
		College-C	.131

Teacher trainees' application of collision in Colleges B, C and D

Table 48 shows Kruskal Wallis test between the post-test results of teacher trainees' application of collision in Colleges B, C and D.

Table 48: Kruskal Wallis test between the post-test scores of teacher trainees' application of collision, Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	4.083	4.720
Df	2	2
Asymp. Sig.	.130	.094

In Table 48, the p-values for the first and second post-test scores of teacher trainees' application of collision were greater than 0.05, meaning that there was no statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2approaches in Colleges B, C and D. Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of collision.

Direct Current

Teacher trainees' application of current in Colleges B, C and D

Table 49 shows Kruskal Wallis test between the post-test results of teacher trainees' application of current in Colleges B, C and D. In Table 49, the p-value for the post-test scores of teacher trainees' application of current was less than 0.05, meaning that there was statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. However, Table 49 could not indicate the difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches, so Games-Howell post-hoc test (Table 50) was conducted to determine which of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 was most effective in enhancing teacher trainees' application of current. Table 50 shows Games-Howell between the post-test scores of teacher trainees' application of current in Colleges-B, C and D.

Table 49: Kruskal Wallis test between the post-test scores of teacher trainees' application of current in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score
Chi-Square	7.473
Df	2
Asymp. Sig.	.024

Table 50: Games-Howell test between the post-test scores of teacher trainees' application of current in Colleges-B, C and D (N = 20)

Dependent Variable: Posttest Score
Games-Howell

(I) Colleges	(J) Colleges	Sig.
College-B (traditional)	College-C	.946
	College-D	.027
College-C (computer aided instruction 1)	College-B	.946
	College-D	.063
College-D (computer aided instruction 2)	College-B	.027
	College-C	.063

In Table 50, it shows that there was a statistically significant difference between College-B (traditional) and College-D (computer aided instruction 2) since their p-values were less than 0.05. This result made the study to reject the null hypothesis (Ho), but accepts the alternative hypothesis (H1) that there is a statistically significant difference in the teaching approaches. This meant that for effective enhancement in the teaching of current to teacher trainees, computer aided instruction 2 approach is the best plausible approach to use.

Teacher trainees' application of resistance, Colleges B, C and D

Table 51 shows Kruskal Wallis test between the post-test results of teacher trainees' application of resistance in Colleges B, C and D.

Table 51: Kruskal Wallis test between the post-test scores of teacher trainees' application of resistance, Colleges-B, C and D (N = 20)

Test Statistics	Post-test score1	Post-test score2
Chi-Square	9.582	6.825
Df	2	2
Asymp. Sig.	.008	.033

In Table 51, the p-values for the first and second post-test scores (posttest-1) of teacher trainees' application of resistance were less than 0.05, meaning that there was a statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. However, Table 51 could not indicate the difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches, so Games-Howell post-hoc test (Table 52) was conducted to determine which of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 was most effective in enhancing teacher trainees' application of resistance. Table 52 shows Games-Howell test between the post-test scores of teacher trainees' application of resistance in Colleges B, C and D. In Table 52, there was a statistical difference between the traditional, computer aided instruction 1 and computer aided instruction 2 approaches. This result rejects the null hypothesis but rather accepts the alternative hypothesis.

Table 52: Games-Howell test between the post-test scores of teacher trainees' application of resistance, Colleges-B, C and D (N = 20)

Games-Howell

Dependent Variable	(I) Colleges	(J) Colleges	Sig.
Post-test score1	College-B (traditional)	College-C	.946
		College-D	.009
	College-C (computer aided instruction 2)	College-B	.946
		College-D	.024
	College-D (computer aided instruction 2)	College-B	.009
		College-C	.024
Post-test score2	College-B (traditional)	College-C	.803
		College-D	.027
	College-C (computer aided instruction 1)	College-B	.803
		College-D	.131
	College-D (computer aided instruction 2)	College-B	.027
		College-C	.131

For example, with the first post-test scores there was a statistical difference between traditional and computer aided instruction 2 and between computer aided instruction 1 and computer aided instruction 2 approaches; and with the second post-test scores there was a statistical difference between traditional and computer aided instruction 2 approaches. Thus when it comes to teaching application of resistance, computer aided instruction 1 and computer aided instruction 2 approaches seemed the best approaches with computer aided instruction 2 approach being the best of all the approaches.

Teacher trainees' application of voltage, Colleges B, C and D

Table 53 shows Kruskal Wallis test between the post-test results of teacher trainees' application of voltage in Colleges B, C and D.

Table 53: Kruskal Wallis test between the post-test scores of teacher trainees' application of voltage in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score
Chi-Square	5.113
Df	2
Asymp. Sig.	.078

In Table 53, the p-value for the post-test scores of teacher trainees' application of voltage was greater than 0.05, meaning that there was no statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of voltage.

Teacher trainees' application of resistance in a series circuit connection, Colleges B, C and D

Table 54 shows Kruskal Wallis test between the post-test results of teacher trainees' application of resistance in a series circuit connection in Colleges B, C and D.

Table 54: Kruskal Wallis test between the post-test scores of teacher trainees' application of resistance in a series circuit connection in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	5.113	7.473
Df	2	2
Asymp. Sig.	.078	.024

In Table 54, the p-value for the first post-test scores of teacher trainees' application of resistance in a series circuit connection was greater than 0.05, meaning that there was no statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of resistance. Also, in Table 54 the p-value for the second post-test scores of teacher trainees' application of resistance in a series circuit connection was less than 0.05, meaning that there was statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. However, Table 54 could not indicate the difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches for the second post-test scores, so Games-Howell post-hoc test (Table 55) was conducted to determine which of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 was most effective in enhancing teacher trainees' application of resistance in a series circuit connection. Table 55 shows Games-Howell between the post-test scores of teacher trainees' application of resistance in a series circuit connection in Colleges-B, C and D.

In Table 55 shows that there was a statistically significant difference between College-B (traditional) and College-D (computer aided instruction 2) since their p-values were less than 0.05 in the second post-test scores. This result made the study to reject the null hypothesis (Ho), but accepts the alternative hypothesis (H1) that there is a statistically significant difference in the teaching approaches. This meant that for effective enhancement in the teaching of resistance in a series circuit connection to teacher trainees, computer aided instruction 2 approach is the best plausible approach to use.

In Table 56, the p-values for the first and second post-test scores of teacher trainees' application of current in a parallel circuit connection were greater than 0.05, meaning that there was no statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of current in a parallel circuit connection.

Table 55: Games-Howell test between the post-test scores of teacher trainees' application of resistance in a series circuit connection in Colleges-B, C and D (N = 20)

Games-Howell

Dependent Variable	(I) Colleges	(J) Colleges	Sig.
Posttest Score-1	College-B (traditional)	College-C	.803
		College-D	.067
	College-C (computer aided instruction 1)	College-B	.803
		College-D	.253
	College-D (computer aided instruction 2)	College-B	.067
		College-C	.253
Posttest Score-2	College-B (traditional)	College-C	.946
		College-D	.027
	College-C (computer aided instruction 1)	College-B	.946
		College-D	.063
	College-D (computer aided instruction 2)	College-B	.027
		College-C	.063

Teacher trainees' application current in a parallel circuit connection, Colleges B, C and D

Table 56 shows Kruskal Wallis test between the post-test results of teacher trainees' application of current in a parallel circuit connection in Colleges B, C and D.

Table 56: Kruskal Wallis test between the post-test scores of teacher trainees' application of current in a parallel circuit connection, Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1	Posttest Score-2
Chi-Square	3.371	5.113
Df	2	2
Asymp. Sig.	.185	.078

Teacher trainees' application resistances in a parallel circuit connection, Colleges B, C and D

Table 57 shows Kruskal Wallis test between the post-test results of teacher trainees' application of resistances in a parallel circuit connection in Colleges B, C and D.

Table 57: Kruskal Wallis test between the post-test scores of teacher trainees' application of resistances in a parallel circuit connection, Colleges-B, C and D (N = 20)

Test Statistics	Post-test score
Chi-Square	2.136
Df	2
Asymp. Sig.	.344

In Table 57, the p-value for the post-test scores of teacher trainees' application of resistances in a parallel circuit connection was greater than 0.05, meaning that there was no statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of resistance in a parallel circuit connection.

Teacher trainees' application of voltages in a parallel circuit connection, Colleges B, C and D

Table 58 shows Kruskal Wallis test between the post-test results of teacher trainees' application of voltages in parallel circuit connection in Colleges B, C and D.

Table 58: Kruskal Wallis test between the post-test scores of teacher trainees' application of voltages in parallel circuit connection in Colleges-B, C and D (N = 20)

Test Statistics	Posttest Score-1
Chi-Square	5.113
Df	2
Asymp. Sig.	.078

In Table 58, the p-value for the post-test scores of teacher trainees' application of voltages in a parallel circuit connection was greater than 0.05, meaning that there was no statistical difference between traditional, computer aided instruction 1 and computer aided instruction 2 approaches in Colleges B, C and D. Based on this result, the study accepts the null hypothesis but rather rejects the alternative hypothesis. This meant that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used to teach teacher trainees application of voltage in a parallel circuit connection.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter is made up of summary, key findings, conclusions, recommendations and suggestions for further research.

Summary

This study was conducted to investigate how traditional and combined traditional and CAI approaches can be used to enhance teacher trainees performance of selected science concepts in integrated science. The study used four research questions and tested one null hypothesis at 0.05 level of significance. In all 100 teacher trainees and 5 integrated science tutors were randomly sampled using simple random sampling procedures from four Colleges of Education from the Volta, Greater Accra and Eastern regions of Ghana. The study went through two phases i.e., need analysis phase and intervention phase. At the need analysis phase the study tried to find out whether the problems raised in literature still exists in the colleges of education. The study used 40 teacher trainees and 5 integrated science tutors at this phase. At the intervention phase, the study used a two-group non-equivalent quasi-experimental pretest-posttest design with 20 teacher trainees in one intact class from each of the three Colleges of Education.

The design used a combination of quantitative and qualitative methods of collecting data. The quantitative data comprised of teacher trainees and integrated science tutors questionnaire items and pretest-posttest scores from achievement tests. The qualitative data comprised of teacher trainees focus group interview schedule and integrated science tutors interview schedule. These were used to find out the plausible traditional and CAI approaches of integrated science tutors and to find out the teacher trainees impression of the study interventions. The main limitation of the study was that the sample size was not large enough that might contributed to the data of the study not meeting the assumptions of the parametric test.

Key findings

Research question one sought to find out the challenges teacher trainees faced in the learning of linear momentum and direct current concepts. The findings were that majority of teacher trainees face challenges in linear momentum and direct current i.e., the teacher trainees saw linear momentum and direct current abstract and were not able to perform experiment at the laboratory.

Research question two sought to find out the teaching approaches colleges of education science tutors use in teaching linear momentum and direct current. The findings were that integrated science tutors use diverse teaching methods , however, traditional teaching methods (i.e., discussion, lecture, and question and answer methods) were more compared to modern teaching methods (i.e., games, animations, video, power point and computer simulation).

Research question three sought to find out from both teacher trainees and integrated science tutors, the plausible combination of traditional and CAI approaches that would enhance teacher trainees' performances of linear momentum and direct current. The study shows that the plausible combination of traditional and CAI approaches were lecture, question and answer, discussion and images.

Research question four sought to find out the challenges integrated science tutors' face in using combination of traditional and CAI approaches in teaching linear momentum and direct current. The findings were integration of computer simulation, infusion of computer games, animations and videos into power point slides.

Research hypothesis compared traditional, computer aided instruction 1 and computer aided instruction 2 approaches of the study. The findings were that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 can be used in teaching teacher trainees' definition of momentum, applications of (momentum, change in momentum, conservation of momentum, collision, current, voltage, resistance in series, current in parallel circuit connection, and resistance in parallel circuit connection). Also, the computer aided instruction 1 and computer aided instruction 2 approaches improved teacher trainees' applications of (resistance and resistance in series circuit connection).

Conclusions

Based on the findings of this study, the following conclusions were drawn. Firstly, the study showed that teacher trainees face challenges in learning direct current and linear momentum. Some of the challenges were that the teacher trainees saw linear momentum and direct current abstract and were not exposed to experiment. This confirms what literature alludes to challenges faced by students when it comes to learning direct current and linear momentum (Coppens, Cock & Kautz, 2012; Engelhardt & Beichner, 2004; Institute of Education, 2008, 2009, 2011, 2013a, & 2013b; McDermott, 1991).

Secondly, the study showed that most integrated science tutors use traditional teaching methods than modern teaching methods in teaching selected concepts in linear momentum and direct. Some of the traditional teaching methods most integrated science tutors uses were discussion, lecture, and question and answer. This finding is consistent with literature on challenges students faced when it comes to learning direct current and linear momentum (Alorvor & el Sadat, 2011; Barnes & Blevins, 2003; Benckert & Pettersson, 2008; Bligh, 2000; Carpenter, 2006; Chaudhury, 2011; G¨u´emez, Fiolhais & Fiolhais, 2009; Hussain, Latiff, & Yahaya, 2012; Holubová, 2010; Kock, Taconis, Bolhuis, & Gravemeijer, 2015; Qualters, 2001).

Thirdly, the study showed that perceived plausible combination of traditional and CAI approaches integrated science tutors use were a combination of traditional (i.e., lecture, discussion, question and answer) and images. This agrees with literature on traditional and CAI approaches (Beauchamp, 2004; Cogill, 2002; Sean *et al*.**,** 2000; Lane, & Peres, 2006; Perkins, Lancaster, Loeblein, Parson, & Podolefsky, 2010).

Fourthly, the study showed that integrated science tutors faced challenges in using combination of traditional and CAI approaches in teaching linear momentum and direct current. The challenges were integration of computer simulation and infusion of computer games, animations and videos into power point slides. This is in line with literature on challenges tutors faced when it comes to learning direct current and linear momentum (Beauchamp, 2004; Cogill, 2002; Sean *et al*., 2000; Lane, & Peres, 2006; Perkins, Lancaster, Loeblein, Parson, & Podolefsky, 2010).

Finally, the study compared traditional, computer aided instruction 1 and computer aided instruction 2 approaches of the study. It showed that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2could be used in teaching teacher trainees' definition of momentum, applications of (momentum, change in momentum, conservation of momentum, collision, current, voltage, resistance in series, current in parallel circuit connection, and resistance in parallel circuit connection). Also, the traditional, computer aided instruction 1 and computer aided instruction 2 approaches could help improved teacher trainees' applications of (resistance and resistance in series circuit connection).

Recommendations

Based on the findings of this study, the following recommendations were made:

1. For researchers to conduct research geared toward concept development in linear momentum and direct current there is a need to do need analysis on challenges tutors and students face related to the concepts and methods employed in teaching and learning the concepts respectively before undertaking an experimental study.

2. It is recommended that any of these approaches i.e., traditional, computer aided instruction 1 and computer aided instruction 2 could be used in teaching teacher trainees' definition of momentum, applications of (momentum, change in momentum, conservation of momentum, collision, current, voltage, resistance in series, current in parallel circuit connection, and resistance in parallel circuit connection).
3. It is also recommended that to further enhance teacher trainees' conceptions in definitions, explanations, applications of resistance and resistance in series circuit connection, integrated science tutors can use computer aided instruction 1, and computer aided instruction 2 approaches.
4. It is finally recommended that educational policy makers in Ghana such as Ministry of Education (MoE), National Council for Tertiary Education (NCTE), National Accreditation Board (NAB), Ghana Education Service (GES), Curriculum Research Development Division (CRDD), Teacher Education Division (TED) and other stakeholders in Ghana when designing the country educational policies should consider the computer aided instruction 1 and computer aided instruction 2 approaches to further enhance pupils, students, and teacher trainees conceptions in other subject areas, through may be workshops, refreshable course among others.

Suggestions for further Research

It is suggested that for more in-depth research into similar study, qualitative case study design should be used in order to unearth more hidden strengths and weaknesses of teacher trainees with respect to the interventions of the study.

It is suggested that any further study in this area should not assume standardized based entering requirements of teacher trainees into colleges of education, but should rather look at the individual teacher trainees entering grades and aggregates into the colleges of education and analyses be done with respect to the teacher trainees entering grades and their performance in all the stages of the study.

It is suggested that any further study in this area could consider gender (male and female students). That is the effect of traditional, computer aided instruction 1 and computer aided instruction 2 approaches on male and female students' performances.

It is suggested that any further study in this area could consider single sexed and mixed schools. That is the effect of the traditional, computer aided instruction 1 and computer aided instruction 2 approaches on single sexed and mixed schools' performances.

It is suggested that any further study in this area could consider less and high endowed schools. That is the effect of traditional, computer aided instruction 1 and computer aided instruction 2 approaches on less and high endowed schools' performances.

It is suggested that any study in this area could consider teacher related factors and how the teacher related factors impacts on teacher trainees' performance as one of the findings of this study showed that any of these approaches traditional, computer aided instruction 1 and computer aided instruction 2 can be used in teaching linear momentum and direct current.

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APPENDICES

Appendix A

Maturation Test Analysis of Teacher Trainees performance of Direct Current and Linear Momentum

Post-test and delayed post-test of teacher trainees performance of momentum concept in Colleges-B, C and D

Table 59 Shows Wilcoxon signed rank test which is the very opposite of ANOVA to determine differences in the three teaching approaches (LQAD, LQADPV and LQADPVS).

Table 59: Wilcoxon signed rank test between the post-test and delayed post-test scores of teacher trainees' performance of momentum concept, applications of (momentum, change in momentum, conservation of momentum and collision) Colleges-B, C and D (N = 20)

Concepts	Test	Intervention	Posttest	Delayed Posttest	Sig
Momentum	Wilcoxon Rank Test	LQAD	18	17	0.317
		LQADPV	16	18	0.317
		LQADPVS	16	16	1.00
Application of momentum	Wilcoxon Rank Test	LQAD	14	16	0.564
		LQADPV	14	12	0.564
		LQADPVS	15	13	0.157
Application of change in momentum	Wilcoxon Rank Test	LQAD	14	16	0.564
		LQADPV	14	12	0.564
		LQADPVS	15	13	0.157
Application of conservation of momentum	Wilcoxon Rank Test	LQAD	12	13	1.00
		LQADPV	14	12	0.317
		LQADPVS	13	12	0.317

Table 59 cont.….

Concepts	Test	Intervention	Posttest/20	Delayed Posttest/20	Sig
Application of collision	Wilcoxon Rank Test	LQAD	14	13	0.157
		LQADPV	15	13	0.157
		LQADPVS	14	12	0.083

In Table 59, the p-values in the Wilcoxon rank test for the posttest and delayed posttest scores of teacher trainees performance on momentum concept, applications of (momentum, change in momentum, conservation of momentum and collision) were greater than 0.05. This meant that there was no statistically significant difference between the posttest and delayed posttest score of the three teaching approaches (LQAD, LQADPV and LQADPVS) in the three Colleges (B, C and D). This meant that after some months of intervention, the LQAD, LQADPV and LQADPVS approaches there was still no differences between the posttest and delayed postest score of teacher trainees' performance on momentum concept, applications of (momentum, change in momentum, conservation of momentum and collision).

Teacher trainees' application of current, Colleges B, C and D

Table 60 shows Wilcoxon rank test between the post-test and delayed post-test scores of teacher trainees' application of current, Colleges-B, C and D**.**

Table 60: Wilcoxon rank test between the post-test and delayed post-test scores of teacher trainees' applications of current, resistance, voltage, resistance in a series circuit connection, current in a parallel circuit connection, resistances in a parallel circuit connection and voltages in a parallel circuit connection Colleges-B, C and D (N = 20)

Concepts	Test	Intervention	Posttest	Delayed Posttest	Sig
Application of current	Wilcoxon Rank Test	LQAD	13	14	0.157
		LQADPV	14	13	0.157
		LQADPVS	14	13	0.157
Application of resistance	Wilcoxon Rank Test	LQAD	16	16	1.00
		LQADPV	18	16	0.157
		LQADPVS	18	17	0.317
Application of voltage	Wilcoxon Rank Test	LQAD	14	16	0.564
		LQADPV	14	12	0.564
		LQADPVS	15	13	0.157
Application of resistance in a series circuit connection	Wilcoxon Rank Test	LQAD	12	13	1.00
		LQADPV	14	12	0.317
		LQADPVS	13	12	0.317
Application of current in a parallel circuit connection	Wilcoxon Rank Test	LQAD	14	12	0.564
		LQADPV	15	13	0.157
		LQADPVS	12	13	1.00
Application of resistances in a parallel circuit connection	Wilcoxon Rank Test	LQAD	14	12	0.317
		LQADPV	13	12	0.317
		LQADPVS	14	12	0.564

Table 60 cont…

Concepts	Test	Intervention	Posttest	Delayed Posttest	Sig
Application of voltages in a parallel circuit connection	Wilcoxon Rank Test	LQAD	14	16	0.564
		LQADPV	14	12	0.564
		LQADPVS	15	13	0.157

In Table 60, the p-values in the Wilcoxon rank test for the posttest and delayed posttest scores of teacher trainees applications of current, resistance, voltage, resistance in a series circuit connection, current in a parallel circuit connection, resistances in a parallel circuit connection and voltages in a parallel circuit connection were greater than 0.05. This meant that there was no statistically significant difference between the posttest and delayed posttest score of the three teaching approaches (LQAD, LQADPV and LQADPVS) in the three Colleges (B, C and D). This meant that after some months of intervention, the LQAD, LQADPV and LQADPVS approaches there was still no differences between the posttest and delayed postest score of teacher trainees' performance on momentum concept, applications of current, resistance, voltage, resistance in a series circuit connection, current in a parallel circuit connection, resistances in a parallel circuit connection and voltages in a parallel circuit connection.

Appendix B

Integrated Science Tutors Questionnaire

Dear Colleague,

The purpose of this questionnaire is to gather data on your observations on how **combination of Traditional and CAI Approaches are used in teaching in your college**. Your thoughtful and truthful responses would be greatly appreciated. Please respond to each item to the best of your knowledge. Your name is not required. Your responses will be kept completely confidential. Thank you for taking time to complete this questionnaire.

Instructions

Please tick [√] in the appropriate space provided below. Tick as many that apply.

1. Kindly tick the approaches to teaching you normally employ in teaching of linear momentum and direct current

☐ Lecture

☐ Discussion

☐ Question and Answer

☐ Project

☐ Images

☐ Animations

☐ Videos

☐ Games

☐ Computer Simulations

Specify any other(s) ____

2. Which of these approaches in teaching of linear momentum and direct current is/are combination of traditional and CAI in nature?

☐ 3. Lecture

☐ Discussion

☐ Question and Answer

☐ Project

☐ Images

☐ Animations

☐ Videos

☐ Games

☐ Computer Simulations

Specify any other(s) ____

3. Which of these combination of traditional and CAI teaching approaches poses challenges to you?

☐ Lecture

☐ Discussion

☐ Question and Answer

☐ Project

☐ Images

☐ Animations

☐ Videos

☐ Games

☐ Computer Simulations

Specify any other(s) ____

Appendix C

Teacher Trainees Questionnaire

Dear Teacher Trainees,

The purpose of this questionnaire is to gather data on your observations on how **your integrated science tutors use combination of traditional and CAI approaches in teaching**. Your thoughtful and truthful responses will be greatly appreciated. Please respond to each item to the best of your knowledge. Your name is not required. Your responses will be kept completely confidential. Thank you for taking time to complete this questionnaire.

Instructions

Please tick [√] in the appropriate space provided below and supply answers where required.

Teacher Trainees combination of traditional and CAI Approaches Usage

Please tick [√] the appropriate option provided below.

1. Kindly list the combination of traditional and CAI approaches your integrated science tutors use to teach linear momentum and direct current.

☐ Lecture

☐ Discussion

☐ Question and Answer

☐ Project

☐ Images

☐ Animations

☐ Videos

☐ Games

☐ Computer Simulations

Specify any other(s)

____

2. Explain how any two of these combination of traditional and CAI approaches to teaching employed by your integrated science tutors was carried out

……………………………………………………………………………………

……………………………………………………………………………………

………………………………

3. Kindly Tick the teaching approaches your integrated science tutors use to teach linear momentum and direct current

☐ Lecture

☐ Discussion

☐ Questions and Answers

☐ Project

☐ Images

☐ Animations

☐ Videos

☐ Games

☐ Computer Simulations

Specify any other(s) ____

Appendix D

Teacher Trainees challenges in Direct Current and Linear Momentum Concepts

1. In your view, do you face any challenge in understanding linear momentum and direct current? **Underline** the any of the responses.

   Yes No

2. If yes in 3 above, in your view as a teacher trainee, list the challenges you face in understanding linear momentum and direct current

   …………………………………………………………………………………

   …………………………………………………………………………………

Appendix E

Pre-Test Item

Teacher Trainees performance of Linear Momentum

INSTRUCTION: The questions in this section are numbered 1-10 with five multiple choice responses, Circle only one and most Appropriate response.

1. Momentum is a quantity that involves?

   A. Mass and velocity

   B. Mass and acceleration.

   C. Velocity and acceleration.

   D. Force and inertia.

   E. Force and velocity.

2. A green ball moving to the right at 3 m/s strikes a yellow ball moving to the left at 2 m/s. What phenomenon would occur if the balls are equally massive and the collision is perfectly elastic?

   A. The green ball will move to the left at 3 m/s while the yellow ball moves right at 2 m/s.

   B. The green ball will move to the left at 2 m/s while the yellow ball moves right at 3 m/s.

   C. The green ball will stop while the yellow ball moves right at 2 m/s.

   D. The yellow ball will stop while the green ball moves left at 3 m/s.

   E. Both balls will stick together and move to the right at 1 m/s.

3. If a moving object cuts its speed in half, how much momentum will it have?
    A. The same amount as before
    B. Twice as much as before
    C. Half as much as before
    D. Four times as much as before
    E. One fourth as much as before
4. A 1-kg ball moving horizontally to the right at 3 m/s strikes a wall and rebounds, moving horizontally to the left at the same speed. What is the magnitude of the change in momentum of the ball?
    A. 0 kg-m/s
    B. 2 kg-m/s
    C. 3 kg-m/s
    D. 4 kg-m/s
    E. 6 kg-m/s
5. A 100-kg man is stuck, motionless, in the middle of a frictionless ice pond. Because it's cold, he's wearing a coat. He wants to get off the pond. Since he has studied physics and knows about conservation of momentum, he decides to throw his 2-kg coat. If he throws the coat at 25 m/s, what will his speed be?
    A. 0 m/s
    B. 0.5 m/s
    C. 2 m/s

D. 25.5 m/s

E. 50 m/s

6. A school bus traveling at 40 km/hr has a mass of 15 kg. What is the momentum of the bus?

A. 1.351 kgm/s

B. 26.1 kgm/s

C. 0.74 kgm/s

D. 166.67 kgm/s

E. 3.9 kgm/s

7. A 12,000 kg railroad car is traveling at 2 m/s, and then suddenly it strikes wall that changes it velocity to 3.08 m/s, what is the change in momentum of the railroad car?

A. 312000000 kgm/s

B. 2.182 kgm/s

C. 0.458 kgm/s

D. 35000 kgm/s

E. 12,000 kgm/s

8. A 25 g bullet is fired from a gun with a speed of 230 m/s. If the gun has a mass of 0.9 kg. What is the recoil speed of the gun?

A. 6.4 m/s

B. 512.4 m/s

C. 638.89 m/s

D. 627.6 m/s

E. 628.8 m/s

9. In an elastic collision, a 5 kg ball traveling at 5 m/s hits a 7 kg ball at rest. The 5 kg ball transfers all its momentum over to the 7 kg ball. What is the total momentum of the 2 balls before they collide?

   A. 0 kgm/s

   B. 35 kgm/s

   C. 25 kgm/s

   D. 30 kgm/s

   E. 28 kgm/s

10. A body of mass 2 kg moves with a velocity of 30 m/s, find its momentum

   A. 15 kgm/s

   B. 45 kgm/s

   C. 0.067 kgm/s

   D. 0.00 kgm/s

   E. 60 kgm/s

Appendix F

Post-Test Item

Teacher Trainees performance of Linear Momentum

INSTRUCTION: The questions in this section are numbered 1-10 with five multiple-choice responses, Circle only one and most Appropriate response.

1. If a moving object cuts its speed in half, how much momentum will it have?
   A. The same amount as before
   B. Twice as much as before
   C. Half as much as before
   D. Four times as much as before
   E. One fourth as much as before
2. A 100-kg man is stuck, motionless, in the middle of a frictionless ice pond. Because it's cold, he's wearing a coat. He wants to get off the pond. Since he has studied physics and knows about conservation of momentum, he decides to throw his 2-kg coat. If he throws the coat at 25 m/s, what will his speed be?
   A. 0 m/s
   B. 0.5 m/s
   C. 2 m/s
   D. 25.5 m/s
   E. 50 m/s

3. In an elastic collision, a 5 kg ball traveling at 5 m/s hits a 7 kg ball at rest. The 5 kg ball transfers all its momentum over to the 7 kg ball. What is the total momentum of the 2 balls before they collide?
   - A. 0 kgm/s
   - B. 35 kgm/s
   - C. 25 kgm/s
   - D. 30 kgm/s
   - E. 28 kgm/s
4. Momentum is a quantity that involves?
   - A. Mass and velocity.
   - B. Mass and acceleration.
   - C. Velocity and acceleration.
   - D. Force and inertia.
   - E. Force and velocity.
5. A green ball moving to the right at 3 m/s strikes a yellow ball moving to the left at 2 m/s. What phenomenon would occur if the balls are equally massive and the collision is perfectly elastic?
   - A. The green ball will move to the left at 3 m/s while the yellow ball moves right at 2 m/s.
   - B. The green ball will move to the left at 2 m/s while the yellow ball moves right at 3 m/s.
   - C. The green ball will stop while the yellow ball moves right at 2 m/s.
   - D. The yellow ball will stop while the green ball moves left at 3 m/s.

E. Both balls will stick together and move to the right at 1 m/s.

6. A 1-kg ball moving horizontally to the right at 3 m/s strikes a wall and rebounds, moving horizontally to the left at the same speed. What is the magnitude of the change in momentum of the ball?

   A. 0 kg-m/s

   B. 2 kg-m/s

   C. 3 kg-m/s

   D. 4 kg-m/s

   E. 6 kg-m/s

7. A school bus traveling at 40 km/hr has a mass of 15kg. What is the momentum of the bus?

   A. 1.351 kgm/s

   B. 26.1 kgm/s

   C. 0.74 kgm/s

   D. 166.67 kgm/s

   E. 3.9 kgm/s

8. A 12,000 kg railroad car is traveling at 2 m/s, and then suddenly it strikes a wall that changes it velocity to 3.08 m/s, what is the change in momentum of the railroad car?

   A. 312000000 kgm/s

   B. 2.182 kgm/s

   C. 0.458 kgm/s

   D. 35000 kgm/s

E. 12,000 kgm/s

9. A body of mass 2 kg moves with a velocity of 30 m/s, find its momentum

A. 15 kgm/s

B. 45 kgm/s

C. 0.067 kgm/s

D. 0.00 kgm/s

E. 60 kgm/s

10. A 25 g bullet is fired from a gun with a speed of 230 m/s. If the gun has a mass of 0.9 kg. What is the recoil speed of the gun?

A. 6.4 m/s

B. 512.4 m/s

C. 638.89 m/s

D. 627.6 m/s

E. 628.8 m/s

Appendix G

Delayed Post-test Item

Teacher Trainees applications of Linear Momentum concepts

INSTRUCTION: The questions in this section are numbered 1-10 with five multiple-choice responses, Circle only one and most Appropriate response.

1. In an elastic collision, a 10 kg ball traveling at 5 m/s hits a 2 kg ball travelling at 6 m/s. What is the momentum of each ball before they collide?
   A. 0kgm/s, 50kgm/s
   B. 35kgm/s, 12kgm/s
   C. 25kgm/s, 12mkgm/s
   D. 30kgm/s, 50kgm/s
   E. 50kgm/s, 12kgm/s
2. A school bus traveling at 5 m/s has a mass of 5kg. What is the momentum of the bus?
   A. 1.0kgm/s
   B. 0.0kgm/s
   C. 25kgm/s
   D. 166.5kgm/s
   E. 3.9kgm/s
3. If a moving object increased its speed by two, how much momentum will it have?
   A. The same amount as before
   B. Twice as much as before

C. Half as much as before

D. Four times as much as before

E. One fourth as much as before

4. A 5-kg man is stuck, motionless, in the middle of a frictionless ice pond. Because it's cold, he's wearing a coat. He wants to get off the pond. Since he has studied physics and knows about conservation of momentum, he decides to throw his 4-kg coat. If he throws the coat at 100 m/s, what will his speed be?

   A. 0. 0125 m/s

   B. 0.5 m/s

   C. 2 m/s

   D. 80 m/s

   E. 50 m/s

5. Momentum is a quantity that involves?

   A. Mass and velocity.

   B. Mass and acceleration.

   C. Velocity and acceleration.

   D. Force and inertia.

   E. Force and velocity.

6. A green ball moving to the right at 8 m/s strikes a yellow ball moving to the left at 9 m/s. What phenomenon would occur if the balls are equally massive and the collision is perfectly elastic?

A. The green ball will move to the left at 8 m/s while the yellow ball moves right at 9 m/s.

B. The green ball will move to the left at 8 m/s while the yellow ball moves right at 9 m/s.

C. The green ball will stop while the yellow ball moves right at 9 m/s.

D. The yellow ball will stop while the green ball moves left at 8 m/s.

E. Both balls will stick together and move to the right at 1 m/s.

7. A 4-kg ball moving horizontally to the right at 1 m/s strikes a wall and rebounds, moving horizontally to the left at the same speed. What is the magnitude of the change in momentum of the ball?

A. 8 kg-m/s

B. 6 kg-m/s

C. 0 kg-m/s

D. 4 kg-m/s

E. 2 kg-m/s

8. A body of mass 2 kg moves with a velocity of 30 m/s, find its momentum

A. 15 kgm/s

B. 45 kgm/s

C. 0.067 kgm/s

D. 0.00 kgm/s

E. 60 kgm/s

9. A 5 kg bullet is fired from a gun with a speed of 230m/s. If the gun has a mass of 3kg, what is the recoil speed of the gun?

   A. 6.4m/s

   B. 512.4m/s

   C. 638.89m/s

   D. 627.6m/s

   E. 383.33m/s

10. A 9000kg car is traveling at 5m/s then suddenly it strikes a wall car and its velocity changed to 2.22m/s, what is the change in momentum of the two railroad cars?

    A. 312000000kgm/s

    B. 2.182kgm/s

    C. 25020kgm/s

    D. 35000kgm/s

    E. 13,000kgm/s

Appendix H

Pre-test Item

Teacher Trainees performance of Direct Current

INSTRUCTION: The questions in this section are numbered 1-10 with five multiple-choice responses, Circle only one and most Appropriate response.

1. Three resistances of 10 Ω, 15 Ω and 30 Ω are connected in parallel. The total resistance of the combination is?
   A. 5 Ω
   B. 10 Ω
   C. 0.2 Ω
   D. 55 Ω
   E. 4500 Ω
2. An electric heater is constructed by applying a potential difference of 110 V to a nichrome wire of total resistance 5 Ω. Find the current carried by the wire.
   A. 105 A
   B. 22 A
   C. 115 A
   D. 550 A
   E. 0.045 A

3. A 6 volts power pack sends a current of 2 amperes through a resistor. What is the resistance?

   A. 12 Ω

   B. 8 Ω

   C. 0.33 Ω

   D. 4.8 Ω

   E. 3 Ω

4. If a 24V and a 10V battery are series opposing, the voltage is?

   A. 14V

   B. 10 V

   C. 24V

   D. 34V

   E. 12 V

5. A series circuit consists of three resistors. Two resistors are 1.4 Ω each. The total resistance is 12 Ω. The value of the third resistor?

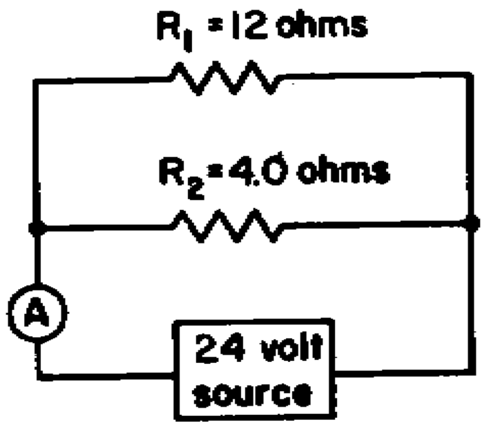
   A. 0.92 Ω

   B. 92 Ω

   C. 920 Ω

   D. 9.2 Ω

   E. 1.0 Ω



6. From the diagram above, what is the voltage across R2?
   A. 12V
   B. 3V
   C. 6V
   D. 2V
   E. 24V
7. From the diagram above, what is the current through R1?
   A. 2A
   B. 12A
   C. 3A
   D. 6A
   E. 24A
8. A circuit has a potential difference of 3V and current of 5A. What is the resistance?
   A. 5/8 Ω
   B. 3/4 Ω
   C. 3/5 Ω
   D. 3/8 Ω
   E. 1/5 Ω
9. The resistance of a series circuit consisting of four branches is 120 Ω. If the resistance of two branches is 18 Ω each and the third branch is 60 Ω respectively, what is the fourth resistance of the other?
   A. 18 Ω
   B. 36 Ω
   C. 42 Ω
   D. 64 Ω
   E. 24 Ω

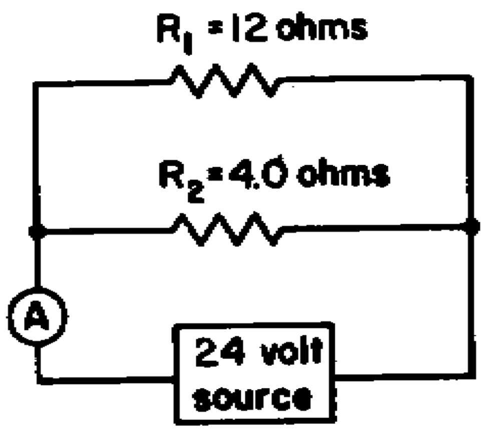
10. A current of 16 amperes divides between two branches in parallel of resistances 8 Ω and 12 Ω respectively. The current in each branch is?
    A. 6.4 A, 6.9 A
    B. 6.4 A, 9.6 A
    C. 4.6 A, 6.9 A
    D. 4.6 A, 9.6 A
    E. 6.4 A, 9.5 A

Appendix I

Post-test Item

Teacher Trainees performance of Direct Current

INSTRUCTION: The questions in this section are numbered 1-10 with five multiple-choice responses, Circle only one and most Appropriate response.



1. From the diagram above, what is the voltage across R2?
   A. 12 V
   B. 3 V
   C. 6 V
   D. 2 V
   E. 24 V
2. From the diagram above, what is the current through R1?
   A. 2 A
   B. 12 A
   C. 3 A
   D. 6 A
   E. 24 A

3. Three resistances of 10 Ω, 15 Ω and 30 Ω are connected in parallel. The total resistance of the combination is?

   A. 5 Ω

B. 10 Ω

C. 0.2 Ω

D. 55 Ω

E. 4500 Ω

4. An electric heater is constructed by applying a potential difference of 110 V to a nichrome wire of total resistance 5. Find the current carried by the wire.

   A. 105 A

   B. 22 A

   C. 115 A

   D. 550 A

   E. 0.045 A

5. A 6 volts power pack sends a current of 2 amperes through a resistor. What is the resistance?

   A. 12 Ω

   B. 8 Ω

   C. 0.33 Ω

   D. 4.8 Ω

   E. 3 Ω

6. The resistance of a series circuit consisting of four branches is 120 Ω. If the resistance of two branches is 18 Ω each and the third branch is 60 Ω respectively, what is the resistance of the other?
   A. 18 Ω
   B. 36 Ω
   C. 42 Ω
   D. 64 Ω

E. 24 Ω

7. A current of 16 amperes divides between two branches in parallel of resistances 8 Ω and 12 Ω respectively. The current in each branch is?
   A. 6.4 A, 6.9 A
   B. 6.4 A, 9.6 A
   C. 4.6 A, 6.9 A
   D. 4.6 A, 9.6 A
   E. 6.4 A, 9.5 A
8. If a 24V and a 10V battery are series opposing, the voltage is?
   A. 14V
   B. 10 V
   C. 24V
   D. 34V
   E. 12 V
9. A series circuit consists of three resistors. Two resistors are 1.4 Ω each.

   The total resistance is 12 Ω. The value of the third resistor?
   A. 9.2 Ω
   B. 92 Ω
   C. 920 Ω
   D. 0.92 Ω
   E. 1.0 Ω
10. A circuit has a potential difference of 3V and current of 5A. What is the resistance?
   A. $\frac{15}{8}$ Ω
   B. $\frac{3}{4}$ Ω
   C. $\frac{3}{5}$ Ω

D. $\frac{3}{8}\ \Omega$

E. $\frac{1}{5}\ \Omega$

Appendix J

Delayed Post-test Items

Teacher Trainees applications of Direct Current concepts

INSTRUCTION: The questions in this section are numbered 1-10 with five multiple-choice responses, Circle only one and most Appropriate response.

1. Three resistances of 5 Ω, 20 Ω and X Ω are connected in parallel. If the total resistance of the combination is 10 Ω, what is the resistance value of X?
    A. 35 Ω
    B. 10 Ω
    C. 0.2 Ω
    D. 55 Ω
    E. 6.66 Ω
2. An electric heater is constructed by applying a potential difference of 22 V to a wire of total resistance 15. Find the current carried by the wire.
    A. 110 A
    B. 7.00 A
    C. 115 A
    D. 1.46 A
    E. 0.68 A
3. A 17 volts power pack sends a current of 13 amperes through a resistor. What is the resistance?
    A. 221 Ω

B. 1.31 Ω

C. 0.74 Ω

D. 4.8 Ω

E. 3 Ω

4. If a 0.2V and a 2V battery are in series, the voltage is?

A. 10V

B. 0.4 V

C. 24V

D. 0.1V

E. 2.2V

5. A series circuit consists of three resistors. Two resistors are 1.4 Ω each and 12 Ω. The value of the total resistor?

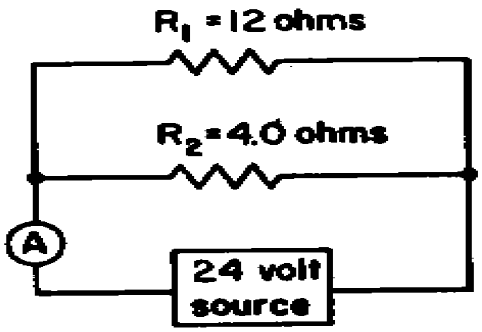
A. 9.2 Ω

B. 92 Ω

C. 14.8 Ω

D. 0.92 Ω

E. 9.12 Ω



6. From the diagram above, what is the voltage across R1?
   A. 12V
   B. 3V
   C. 6V
   D. 2V
   E. 24V
7. From the diagram above, what is the current through R2?
   A. 2A
   B. 12A
   C. 3A
   D. 6A
   E. 24A
8. A circuit has a potential difference of 3V and current of 5A. What is the resistance?
   A. $\frac{15}{8}\ \Omega$
   B. $\frac{3}{4}\ \Omega$
   C. $\frac{3}{5}\ \Omega$
   D. $\frac{3}{8}\ \Omega$
   E. $\frac{1}{5}\ \Omega$
9. The resistance of a series circuit consisting of four branches is 120 Ω. If the resistance of three branches is 8 Ω, 10 Ω and 10 Ω respectively, what is the resistance of the other?
   A. 18 Ω
   B. 36 Ω
   C. 42 Ω
   D. 64 Ω

E. 92 Ω

10. A current of 16 amperes divides between two branches in parallel of resistances 8 Ω and 12 Ω respectively. The current in each branch is?

    A. 6.4 A, 6.9 A
    B. 6.4 A, 9.6 A
    C. 4.6 A, 6.9 A
    D. 4.6 A, 9.6 A
    E. 6.4 A, 9.5 A

Appendix K

Interview Guide for Integrated Science Tutors

1. Which teaching approaches do you normally use in teaching linear momentum and direct current?
2. Are there any supported modern facilities to aid in the teaching of linear momentum and direct current in the college?
3. Do you frequently have professional training in modern teaching approaches in the College? If yes, how often?

Appendix L

Focus group interview Guide for Teacher Trainees

1 What are your impressions about the just ended lessons in direct current and linear momentum?

2 Were the various concepts treated in the direct current and linear momentum lessons clear to you?

3 Were your challenges in the just treated concepts in direct current and linear momentum addressed?

4 What challenges did you face concerning the just treated concepts in the direct current and linear momentum?

Appendix M

Pre-test Marking Schemes

Pre-test Marking Scheme

Teacher Trainees performance of Linear Momentum and Direct Current

Linear Momentum (Appendix D)			Direct Current (Appendix H)		
SN	Responses	Scores/Marks	SN	Responses	Scores/Marks
1	A	1	1	A	1
2	A	1	2	B	1
3	C	1	3	E	1
4	E	1	4	A	1
5	B	1	5	D	1
6	D	1	6	E	1
7	E	1	7	A	1
8	A	1	8	C	1
9	C	1	9	E	1
10	E	1	10	B	1

Appendix N

Post-test Marking Scheme

Teacher Trainees performance of Linear Momentum and Direct Current

Linear Momentum (Appendix E)			Direct Current (Appendix I)		
SN	Responses	Scores/Marks	SN	Responses	Scores/Marks
1	C	1	1	E	1
2	B	1	2	A	1
3	C	1	3	A	1
4	A	1	4	B	1
5	A	1	5	E	1
6	E	1	6	E	1
7	D	1	7	B	1
8	E	1	8	A	1
9	E	1	9	D	1
10	A	1	10	C	1

Appendix O

Delayed Post-test Marking Scheme

Teacher Trainees performance of Linear Momentum and Direct Current

Linear Momentum (Appendix F)			Direct Current (Appendix J)		
SN	Responses	Scores/Marks	SN	Responses	Scores/Marks
1	E	1	1	E	1
2	E	1	2	D	1
3	B	1	3	B	1
4	D	1	4	E	1
5	A	1	5	C	1
6	A	1	6	E	1
7	A	1	7	D	1
8	E	1	8	C	1
9	E	1	9	E	1
10	C	1	10	B	1

Appendix P

Reliability Results of Instruments

Integrated Science Tutors Questionnaire Results

Reliability Statistics (N = 3)

Cronbach's Alpha
.990

Item Statistics (N = 5)

Questions	Mean	Std. Deviation
Q1 teaching approaches of integrated science tutors	11.0000	1.58114
Q2 integrated science tutors views of blended teaching approaches	16.0000	1.58114
Q3 integrated science tutors challenges in blended teaching approaches	20.8000	1.30384

Item-Total Statistics

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted

Q1 teaching approaches of integrated science tutors	36.8000	8.200	.994	.976
Q2 integrated science tutors views of blended teaching approaches	31.8000	8.200	.994	.976
Q3 integrated science tutors challenges in blended teaching approaches	27.0000	10.000	.970	1.000

Scale Statistics (N = 3)

Mean	Variance	Std. Deviation
47.8000	19.700	4.43847

Teacher Trainees Questionnaire Results

Reliability Statistics (N = 5)

Cronbach's Alpha
.505

Item Statistics (N = 40)

Items	Mean	Std. Deviation
Q1 teacher trainees views on blended approaches science tutors use in teaching direct current and linear momentum	6.0000	3.04665
Q2 teacher trainees explanation of blended approaches science tutors use in class	3.1750	3.71337
Q3 teacher trainees views of teaching approaches of their science tutors	5.5500	3.07971
Q4 teacher trainees challenges in understanding concepts in direct current and linear momentum	1.3250	.65584

Q5 teacher trainees list of challenges in understanding concepts in direct current and linear momentum	2.4750	1.41399

Scale Statistics (N = 5)

Mean	Variance	Std. Deviation
18.5250	58.717	7.66272

Teacher Trainees performance of Linear Momentum Test Item Results

Reliability Statistics (N = 10)

Cronbach's Alpha
.960

Item-Total Statistics

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1 teacher trainees performance of momentum	15.6000	13.200	.391	.972
Q2 teacher trainees application of collision	15.0500	12.050	.857	.954
Q3 teacher trainees performance of momentum	15.1500	11.503	.921	.951

Q4 teacher trainees application of change in momentum	15.0500	12.050	.857	.954
Q5 teacher trainees application of conservation of momentum	15.0000	12.632	.728	.959
Q6 teacher trainees application of momentum	15.1500	11.503	.921	.951
Q7 teacher trainees application of change in momentum	15.0500	12.050	.857	.954
Q8 teacher trainees application of conservation of momentum	15.2000	11.432	.903	.952
Q9 teacher trainees application of collision	15.2000	11.432	.903	.952
Q10 teacher trainees application of momentum	15.2000	11.432	.903	.952

Scale Statistics (N = 10)

Mean	Variance	Std. Deviation
16.8500	14.661	3.82891

Teacher Trainees performance of Direct Current Test Item Results

Reliability Statistics (N = 10)

Cronbach's Alpha
.966

Item-Total Statistics

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1 teacher trainees application of resistances in a parallel circuit connection	15.2500	12.829	.922	.960
Q2 teacher trainees application of current	15.4500	13.208	.720	.968
Q3 teacher trainees application of resistance	15.4500	13.208	.720	.968
Q4 teacher trainees application of voltage	15.1500	13.397	.862	.963

Q5 teacher trainees application of resistances in a series circuit connection	15.2500	12.829	.922	.960
Q6 teacher trainees application of voltage in a parallel circuit connection	15.2500	12.829	.922	.960
Q7 teacher trainees application of current in a parallel circuit connection	15.1500	13.397	.862	.963
Q8 teacher trainees application of resistance	15.3000	12.853	.873	.962
Q9 teacher trainees application of resistance in a series circuit	15.1500	13.397	.862	.963

Q10 teacher trainees application of current in a parallel circuit connection	15.1500	13.397	.862	.963

Scale Statistics (N = 10)

Mean	Variance	Std. Deviation
16.9500	16.155	4.01936

Appendix O

Normal lesson on Linear Momentum (using traditional approach)

References:

Day/Date/Time	Topic	R.P.K / Specific Objectives	Teacher and Learner Activities	Teaching and Learning Materials	Core Points	Evaluation
	Linear Momentum	**R.P.K** (5 min): Students are aware of mass, speed, and velocity **Specific Objectives** By the end of the lesson, students would be able to (1) explain momentum, (2) list two types of momentum, (3)	Introduction (5 min): Teacher group students into three and reviews students previous knowledge i.e. (1) what physical quantity did we learn last week? (2) Each group should elaborate on each of the three physical quantities. Students: (1) mass, speed and velocity (2) mass; quantity	Chalk and blackboard		

		explain linear momentum, (4), explain and apply change of momentum in novel situation (5) apply the principle of linear momentum in novel situation, (6) explain and apply conservation of momentum in novel situation, (7) explain and apply collision in novel situation	of substance an object contains, speed; distance with time, velocity; displacement with time.			
	Subtopic		**Body (60 min)**			
	1. Momentum		Teacher guides and discusses with students the concept of momentum (5 min)		Momentum is the product of mass and velocity M = mass*velocity S.I unit = kgm/s	What is momentum? A moving car has a mass of 2.0g, covered

						a distance of 100km in 40min. what is the momentum of this car?
	2. Types of momentum		Teacher elicits and discusses with students the types of momentum (5 min)		The types of momentum are linear and angular	List the types of momentum
	3. Linear momentum		Teacher elicits and discusses with students about linear momentum (5 min)		Linear momentum is movement of an object that has mass and velocity in a straight line	Explain linear momentum
	4. Change of momentum		Teacher guides and discusses with students about change of momentum (5 min)		Change of momentum occurs when the initial momentum m1u1 is subtracted from the final momentum m1v1	A 1-kg ball moving horizontally to the right at 3 m/s strikes

						a wall and rebounds, moving horizontally to the left at the same speed. What is the magnitude of the change in momentum of the ball?
	5. Principle of linear		Teacher guides and discusses with			In your own words state

	momentum		students about principle of linear momentum (5 min)			the principle of linear momentum
	6. Conservation of momentum		Teacher guides and discusses with students on the concept conservation of momentum (35min).		Momentum is conserved when momentum before the impact is same as momentum after impact	A 100-kg man is stuck, motionless, in the middle of a frictionless ice pond. Because it's cold, he's wearing a coat. He

						wants to get off the pond. Since he has studied physics and knows about conservation of momentum, he decides to throw his 2-kg coat. If he throws the

						coat at 25 m/s, what will his speed be?
	7. Collision 8. Types of collision		Teacher guides and discusses with students on the concept collision (35min).		Collision occurs when two or more objects collides either head-on, sideways etc The types of collision are elastic and inelastic Elastic collision: m1u1 +m2u2 = m1v1 + m2v2 Inelastic collision: m1u1 +m2u2 = (m1 + m2)v	In your own words explain collision How many types of collision, do we have? List them A green ball moving to the right at 3

						m/s strikes a yellow ball moving to the left at 2 m/s. What phenomenon would occur if the balls are equally massive and the collision is elastic?
		Application students can			**Conclusion (5min)** lesson was taught	

		apply it to their daily life in playing, talking, eating food, walking among others				

Appendix P

Prototype Lesson on Linear Momentum (using computer aided instruction 1 approach)

References:

Day/Date/Time	Topic	R.P.K / Specific Objectives	Teacher and Learner Activities	Teaching and Learning Materials	Core Points	Evaluation
	Linear Momentum	**R.P.K** (5 min): Students are aware of mass, speed, and velocity **Specific Objectives** By the end of the lesson, students would be able to (1) explain momentum, (2) list two types of momentum, (3) explain linear momentum, (4), explain and apply change of momentum in novel situation (5) apply the principle of linear momentum in novel situation, (6) explain and apply conservation of momentum in	Introduction (5 min): Teacher group students into three and reviews students previous knowledge i.e. (1) what physical quantity did we learn last week? (2) Each group should elaborate on each of the three physical quantities. Students: (1) mass, speed and velocity (2) mass; quantity of substance an object contains, speed; distance with time, velocity; displacement with time.			

		novel situation, (7) explain and apply collision in novel situation				
	Subtopic		**Body (60 min)**			
	1. Momentum		Teacher uses PowerPoint, guides and discusses with students the concept of momentum (5 min)	projector, desktops at the College computer laboratory	Momentum is the product of mass and velocity M = mass*velocity S.I unit = kgm/s	What is momentum? A moving car has a mass of 2.0g, covered a distance of 100km in 40min. what is the momentum of this car?
	2. Types of momentum		Teacher uses PowerPoint, elicits and discusses with students the types of momentum (5 min)	projector, desktops at the College computer laboratory	The types of momentum are linear and angular	List the types of momentum
	3. Linear momentum		Teacher uses PowerPoint, elicits and discusses with students about linear momentum (5 min)	projector, desktops at the College computer laboratory	Linear momentum is movement of an object that has mass and velocity in a	Explain linear momentum

					straight line	
	4. Change of momentum		Teacher uses PowerPoint, elicits and discusses with students about change of momentum (5 min) Teacher showed a downloaded change of momentum video lesson in class (10min) After the video teacher and discusses with students on the concept change of momentum (10min).		Change of momentum occurs when the initial momentum m1u1 is subtracted from the final momentum m1v1	A 1-kg ball moving horizontally to the right at 3 m/s strikes a wall and rebounds, moving horizontally to the left at the same speed. What is the

						magnitude of the change in momentum of the ball?
	5. Principle of linear momentum		Teacher uses PowerPoint, guides and discusses with students about principle of linear momentum (5 min)	projector, desktops at the College computer laboratory		In your own words state the principle of linear momentum
	6. Conservation of momentum		Teacher uses PowerPoint, guides and discusses with students about concept conservation of momentum (5 min). Teacher showed a downloaded conservation of momentum video lesson in class (10min)		Momentum is conserved when momentum before the impact is same as momentum after impact	A 100-kg man is stuck, motionless, in the middle of a frictionless

			After the video teacher and discusses with students on the concept of conservation of momentum (10min)			ice pond. Because it's cold, he's wearing a coat. He wants to get off the pond. Since he has studied physics and knows about conservation of

						momentum, he decides to throw his 2-kg coat. If he throws the coat at 25 m/s, what will his speed be?
	7. Collision 8. Types of Collision		Teacher uses PowerPoint, guides and discusses with students about concept collision (5 min). Teacher showed a	projector, desktops at the College computer laboratory and a downloaded linear	Collision occurs when two or more objects collides either head-on, sideways etc	In your own words explain collision How many types of collision, do

			downloaded collision video lesson in class (10min) After the video teacher and discusses with students on the concept collision kind of collision (10min).	momentum video lesson	The types of collision are elastic and inelastic Elastic collision: m1u1 +m2u2 = m1v1 + m2v2 Inelastic collision: m1u1 +m2u2 = (m1 + m2)v	we have? List them A green ball moving to the right at 3 m/s strikes a yellow ball moving to the left at 2 m/s. What phenomenon would occur if the balls are equally massive and the collision is elastic?
		Application students can apply it to their daily life in playing, talking, eating food, walking among others			**Conclusion (5min)** lesson was taught	

Appendix Q

Linear Momentum lesson (using computer aided instruction 2 approach)

References:

Day/Date/Time	Topic	R.P.K / Specific Objectives	Teacher and Learner Activities	Teaching and Learning Materials	Core Points	Evaluation
	Linear Momentum	**R.P.K** (5 min): Students are aware of mass, speed, and velocity **Specific Objectives** By the end of the lesson, students would be able to (1) explain momentum, (2) list two types of momentum, (3) explain linear momentum, (4), explain and apply change of momentum in novel situation (5) apply the	Introduction (5 min): Teacher group students into three and reviews students previous knowledge i.e. (1) what physical quantity did we learn last week? (2) Each group should elaborate on each of the three physical quantities. Students: (1) mass, speed and velocity (2) mass; quantity of substance an object contains, speed; distance with time, velocity; displacement with			

		principle of linear momentum in novel situation, (6) explain and apply conservation of momentum in novel situation, (7) explain and apply collision in novel situation	time.			
	Subtopic		**Body (60 min)**			
	1. Momentum		Teacher uses PowerPoint, guides and discusses with students the concept of momentum (5 min)	projector, desktops at the College computer laboratory	Momentum is the product of mass and velocity M = mass*velocity S.I unit = kgm/s	What is momentum? A moving car has a mass of 2.0g, covered a distance of 100km in 40min. what is the momentum of this car? An object has a momentum of 15kgm/s moving with a linear

						velocity of 40km/h. Determine the mass of the object
	2. Types of momentum		Teacher uses PowerPoint, elicits and discusses with students the types of momentum (5 min)	projector, desktops at the College computer laboratory	The types of momentum are linear and angular	List the types of momentum
	3. Linear momentum		Teacher uses PowerPoint, elicits and discusses with students about linear momentum (5 min)	projector, desktops at the College computer laboratory	Linear momentum is movement of an object that has mass and velocity in a straight line	Explain linear momentum
	4. Change of momentum		Teacher showed a downloaded video lesson on change of momentum in class (10min) Teacher demonstrated the use of PhET simulation on change of momentum in class (5min)		Change of momentum occurs when the initial momentum m1u1 is subtracted from the final momentum m1v1	A 1-kg ball moving horizontally to the right at 3 m/s strikes

			Teacher asked the students to play with the PhET simulation on change of momentum (10min)			a wall and rebounds, moving horizontally to the left at the same speed. What is the magnitude of the change in momentum of the ball?
	5. Principle of linear		Teacher elicits from students the types of	projector, desktops at		In your own words state

	momentum		collision (5 min)	the College computer laboratory		the principle of linear momentum
	6. Conservation of momentum		Teacher showed a downloaded video lesson on conservation of momentum in class (10min) Teacher demonstrated using the PhET simulation, conservation of momentum (5min) Teacher asked the students to play with the PhET simulation on conservation of momentum (10min)		Momentum is conserved when momentum before the impact is same as momentum after impact	A 100-kg man is stuck, motionless, in the middle of a frictionless ice pond. Because it's cold, he's wearing a coat. He wants to get

						off the pond. Since he has studied physics and knows about conservation of momentum, he decides to throw his 2-kg coat. If he throws the coat at 25

						m/s, what will his speed be?
	7. Collision 8. Types of collision		Teacher showed a downloaded video lesson on collision in class (10min) Teacher demonstrated the use of PhET simulation on collision in class (5min) Teacher asked students to play with the PhET simulation on collision (10min) After the video and PhET simulation on linear momentum teacher discusses with students on the concept collision and types of collision	projector, desktops at the College computer laboratory a downloaded video lesson on collision and PhET simulation on collision	Collision occurs when two or more objects collides either head-on, sideways etc The types of collision are elastic and inelastic Elastic collision: m1u1 +m2u2 = m1v1 + m2v2 Inelastic	In your own words explain collision A green ball moving to the right at 3 m/s strikes a yellow ball moving to the left at 2

			(10min)		collision: m1u1 +m2u2 = (m1 + m2)v	m/s. What phenomenon would occur if the balls are equally massive and the collision is elastic? How many types of collision, do we have? List them A green ball

						moving to the right at 3 m/s strikes a yellow ball moving to the left at 2 m/s. What phenomenon would occur if the balls
		Application students can apply it to their daily life in playing, talking, eating food, walking among others			**Conclusion (5min)** lesson was taught	

Appendix R

Normal Lesson on Direct Current (using traditional approach)

References:

Day/Date/Time	Topic	R.P.K / Specific Objectives	Teacher and Learner Activities	Teaching and Learning Materials	Core Points	Evaluation
	Direct Current	**R. P. K (5min)**: students have been using batteries, torch lights, phones, watches in their homes **Specific Objective** By the end of the lesson, students would be able to (1) define current, (2) explain direct current, (3) explain potential difference	Introduction (5 min): Teacher group students into three and reviews students' previous knowledge i.e. (1) what powers your phones, watches, and torches to function effectively	Chalk and blackboard		

		of a cell, (4) explain electromotive force (5) explain ohms law, (6) explain electric circuit, (7) list two types of electric circuits, (8) explain series electric circuit, (9) explain parallel electric circuit (10) apply series electric circuit in novel situation, (11) apply parallel electric circuit in novel situation	in your homes? Students: batteries, cells			
	Subtopic		**Body (60 min)**			
	1. Curren t		Teacher guides and discusses with students the concept of current (5		Current occurs when an electric charge moves within a time frame	What is current? An electric cable has a charge of 60C. This

			min)		I = Q/t S.I unit = Ampere	charge was moved between two apartments in 20 minutes. Determine the current on the cable.
	2. Direct current		Teacher elicits and discusses with students' direct current (5 min)		Direct current occurs when an electric charge in a conductor moves in one direction (i.e. the flow of charges from the negative terminal to the positive terminal)	When is a current said to be direct, explain
	3. potenti al differe nce		Teacher elicits and discusses with students the		Potential difference occurs when a unit charge is moved from	Explain Potential difference

			concept of potential difference (5 min)		one point to another point in closed circuit Pd = IR I = current R = resistance S.I unit = Volt	
	4. electro motive force		Teacher elicits and discusses with students the concept of electromotive force (5 min)		Electromotive force occurs when a unit charge is moved from one point to another point in opened circuit. emf = I(R + r) I = current R = resistance r = internal resistance	Explain electromotive force

					S.I unit = Volt	
	5. ohms law		Teacher elicits and discusses with students the ohms law (5 min)		At constant temperature and pressure, the voltage across a resistor is directly proportional to the current. V = IR I = current R = Constant S.I unit = ohm	Explain ohms law An electric heater is constructed by applying a potential difference of 110 V to a nichrome wire of total resistance 5.

						Find the current carried by the wire A 6 volts power pack sends a current of 2 amperes through a resistor. What is the

						resistance?
	6. electric circuit		Teacher guides and discusses with students on electric circuit (35min).			
	7. types of electric circuits		Teacher elicited from students the types of electric circuits		The types of electric circuits are series and parallel.	How many types of electric circuits do we have? List them Three

						resistances of 10 ohms, 15 ohms and 30 ohms are connected in parallel. The total resistance of the combination is?
		Application			**Conclusion (5min)** lesson taught	

Appendix S

Prototype Lesson on Direct Current (using computer aided instruction 1 approach)

References:

Day/Date/Time	Topic	R.P.K / Specific Objectives	Teacher and Learner Activities	Teaching and Learning Materials	Core Points	Evaluation
	Direct Current	**R. P. K (5min)**: students have been using batteries, torch lights, phones, watches in their homes **Specific Objective** By the end of the lesson, students would be able to (1) define current,	Introduction (5 min): Teacher group students into three and reviews students' previous knowledge i.e. (1) what powers your phones, watches, and torches to function effectively	Chalk and blackboard, desktop and projector		

		(2) explain direct current, (3) explain potential difference of a cell, (4) explain electromotive force (5) explain ohms law, (6) explain electric circuit, (7) list two types of electric circuits, (8) explain series electric circuit, (9) explain parallel electric circuit (10) apply series electric circuit in novel situation, (11) apply parallel electric circuit in novel situation	in your homes? Students: batteries, cells			
	Subtopic		**Body (60 min)**			

	1. Current		Teacher used PowerPoint guides and discusses with students the concept of current (5 min)	Chalk, blackboard, desktop, projector	Current occurs when an electric charge moves within a time frame I = Q/t S.I unit = Ampere	What is current? An electric cable has a charge of 60C. This charge was moved between two apartments in 20 minutes. Determine the current on the cable.
	2. Direct current		Teacher showed to students a video lesson on current in one direction (10min) After watching the	Chalk, blackboard, desktop, projector, and downloaded direct current video lesson	Direct current occurs when an electric charge in a conductor moves in one direction (i.e. the flow of charges from the negative terminal to the positive	When is a current said to be direct, explain

			video lesson on current in one direction, teacher then elicited and discussed with students on direct current (5 min)		terminal)	
	3. potential difference		Teacher elicited and discussed with students the concept of potential difference (5 min)	Chalk, blackboard, desktop, projector, and downloaded direct current video lesson	Potential difference occurs when a unit charge is moved from one point to another point in closed circuit Pd = IR I = current R = resistance	Explain Potential difference

					S.I unit = Volt	
	4. electromotive force		Teacher elicited and discusses with students the concept of electromotive force (5 min)	Chalk, blackboard, desktop, projector, and downloaded direct current video lesson	Electromotive force occurs when a unit charge is moved from one point to another point in opened circuit. emf = I(R + r) I = current R = resistance r = internal resistance S.I unit = Volt	Explain electromotive force
	5. ohms law		Teacher elicited and discussed with students the ohms law (5 min)	Chalk, blackboard, desktop, projector, and downloaded direct current	At constant temperature and pressure, the voltage across a resistor is directly	Explain ohms law An electric

				video lesson	proportional to the current. V = IR I = current R = Constant S.I unit = ohm	heater is constructed by applying a potential difference of 110 V to a nichrome wire of total resistance 5. Find the current carried by the wire

						A 6 volts power pack sends a current of 2 amperes through a resistor. What is the resistance?
	6. electric circuit		Teacher elicited, guided and discussed with students on electric	Chalk, blackboard, desktop, projector, and downloaded direct current		

			circuit (5 min)	video lesson		
	7. types of electric circuits		Teacher elicited from students the types of electric circuits (5 min)	Chalk, blackboard, desktop, projector, and downloaded direct current video lesson	The types of electric circuits are series and parallel.	How many types of electric circuits do we have? List them Three resistances of 10 ohms, 15 ohms and 30 ohms are connected in parallel. The total

						resistance of the combination is?
		Application			**Conclusion (5min)** lesson yet to be taught	

Appendix T

Prototype Lesson on Direct Current (using computer aided instruction 2 approach)

References:

Day/Date/Time	Topic	R.P.K / Specific Objectives	Teacher and Learner Activities	Teaching and Learning Materials	Core Points	Evaluation
	Direct Current	**R. P. K (5min)**: students have been using batteries, torch lights, phones, watches in their homes **Specific Objective** By the end of the lesson, students would be able to (1) define current,	Introduction (5 min): Teacher group students into three and reviews students' previous knowledge i.e. (1) what powers your phones, watches, and torches to function effectively	Chalk and blackboard, desktop and projector		

		(2) explain direct current, (3) explain potential difference of a cell, (4) explain electromotive force (5) explain ohms law, (6) explain electric circuit, (7) list two types of electric circuits, (8) explain series electric circuit, (9) explain parallel electric circuit (10) apply series electric circuit in novel situation, (11) apply parallel electric circuit in novel situation	in your homes? Students: batteries, cells			
	Subtopic		**Body (60 min)**			

	1. Current		Teacher used PowerPoint guides and discusses with students the concept of current (5 min)	Chalk, blackboard, desktop, projector	Current occurs when an electric charge moves within a time frame I = Q/t S.I unit = Ampere	What is current? An electric cable has a charge of 60C. This charge was moved between two apartments in 20 minutes. Determine the current on the cable.
	2. Direct current		Teacher showed to students a video lesson on current in one direction (10min) Teacher demonstrated to student	Chalk, blackboard, desktop, projector, downloaded direct current video lesson and the PhET simulation on direct current	Direct current occurs when an electric charge in a conductor moves in one direction (i.e. the flow of charges from the negative terminal to the positive	When is a current said to be direct, explain

			the PhET simulation on direct current and asked students to play with the PhET simulation on direct current and to design their own electric circuits(15min). After watching the video lesson on current in one direction and playing with the PhET		terminal)	

			simulation on direct current, teacher then elicited and discussed with students on direct current (5 min)			
	3. potential difference		Teacher elicited and discussed with students the concept of potential difference (5 min)	Chalk, blackboard, desktop, projector, downloaded direct current video lesson and the PhET simulation on direct current	Potential difference occurs when a unit charge is moved from one point to another point in closed circuit Pd = IR I = current R = resistance S.I unit = Volt	Explain Potential difference

	4. electromotive force		Teacher elicited and discusses with students the concept of electromotive force (5 min)	Chalk, blackboard, desktop, projector, downloaded direct current video lesson and the PhET simulation on direct current	Electromotive force occurs when a unit charge is moved from one point to another point in opened circuit. emf = I(R + r) I = current R = resistance r = internal resistance S.I unit = Volt	Explain electromotive force
	5. ohms law		Teacher elicited and discussed with students the ohms law (5 min)	Chalk, blackboard, desktop, projector, downloaded direct current video lesson and the PhET	At constant temperature and pressure, the voltage across a resistor is directly proportional	Explain ohms law An electric heater is

				simulation on direct current	to the current. V = IR I = current R = Constant S.I unit = ohm	constructed by applying a potential difference of 110 V to a nichrome wire of total resistance 5. Find the current carried by the wire

						A 6 volts power pack sends a current of 2 amperes through a resistor. What is the resistance?
	6. electric circuit		Teacher elicited, guided and discussed with students on electric circuit (5 min)	Chalk, blackboard, desktop, projector, downloaded direct current video lesson and the PhET simulation		

				on direct current		
	7. types of electric circuits		Teacher elicited from students the types of electric circuits (5 min)	Chalk, blackboard, desktop, projector, downloaded direct current video lesson and the PhET simulation on direct current	The types of electric circuits are series and parallel.	How many types of electric circuits do we have? List them Three resistances of 10 ohms, 15 ohms and 30 ohms are connected in parallel. The total resistance of

						the combination is?
		Application			**Conclusion (5min)** lesson yet to be taught	