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Effect of a Computer Mediated Systems Teaching Approach on Attitude Towards Mathematics of Engineering Students

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Abstract
This paper reports a study which investigated the effect of a Computer Mediated Systems Teaching Approach (CMSTA), used to teach mathematics to engineering students in a Nigerian Polytechnic, on the students' attitude towards the subject. Specifically, the study determined (a) the Attitude Towards Mathematics (ATM) disposition of the students taught mathematics using the CMSTA and those not taught with the same approach and (b) which gender's ATM dispositions is more favourable amongst the students taught mathematics using the CMSTA. From a sample of 485 subjects (with 274 in the experimental and 211 in control groups) initially targeted to be used, 470 subjects (with 267 in the experimental and 203 in control groups) and 445 subjects (with 256 in the experimental and 189 in control groups) were eventually used for the pretest and posttest respectively. A four stage procedure was adopted for the experiment where treatment administration lasted for 12 weeks. Pretest and posttest administration of the Attitude Towards Mathematics Inventory (ATMI) on the subjects yielded the data used. While significant difference was found between the ATM disposition of the experimental and control groups, none was found between the male and female students taught mathematics using the CMSTA. It was concluded that the CMSTA was able to foster the subjects' ATM positively. It was therefore recommended that mathematics teacher/lectures in Nigerian Polytechnics in particular and other tertiary institutions in general should (a) adopt/adapt the CMSTA to teach and (b) endeavor to understand how Information and Communication Technologies help the goals of teaching mathematics in their institutions so as to enable them take advantage of it.
Keywords: Computer Mediated Systems Teaching Approach, Attitude Towards Mathematics.

1. Introduction

From the inception of use of computers to enhance the teaching/learning process, which dates back to the 1950s (O'shea & self, 1983), terms such as Computer Assisted Training (CAT), Computer Based Training (CBT), Computer Assisted Instruction (CAI), Computer Assisted Learning (CAL), etc have come to be generously used to portray various efforts in the deployment of computer to enhance the teaching/ learning process. Leinonen (2005) categorizes the use of computers in education into the following five major phases:

- The Programming, Drill and Practice phase which was from the late 1970s to the early 1980s.
- The Computer Based Training (CBT) with multimedia phase which was popular from the late 1980s to the early 1990s
- The Internet Based Training (IBT) phase which began in the early 1990s to the early 2000s
- The e-Learning phase which was from the early 2000s to the late 2000s
- The Social Software plus Free and Open content phase which started from the late 2000s

The changing phases of the use of computers to enhance the teaching/learning process chronicled above conforms to observations from literatures on curriculum studies that a major area of concern in the deployment of technology in education is how best to utilize technological advancements to prepare students for a society that is increasingly being technologically driven.

It is therefore not surprising that all over the world; computers are widely accepted and used as worthy tools in educational institutions. In developed countries, students have unlimited access to computers, where these computers are not only being used for knowledge propagation but as powerful thinking aids for enhancement of cognitive development and resolution of affective issues that might interfere with attainment of educational goals. However, in many developing countries, most schools use 19th century technologies and methods to teach (Commonwealth Secretariat, 1991). This situation, which is still prevailing, is perturbing because in this global information revolution era, schools are no longer expected to "continue to offer a curriculum based on a view of information which dates back to the time when knowledge seem stable and bounded" (Commonwealth Secretariat, 1991).

It is observed that the above concern on the teaching situation in many developing countries is very much prevalent in Nigeria. This is particularly pertinent to the current situation regarding the teaching/learning of mathematics at the various tiers of Nigeria's education system, which has been bedeviled by students' apparent negative attitude towards the subject, amongst other problems. It is believed that the opportunities afforded by new, improved and emerging technological developments in the field of Information and Communications Technology (ICT) have the potential of providing the much needed impetus for addressing these problems. The use of the Computer Mediated Systems Teaching Approach (CMSTA) to teach mathematics to engineering students in Nigerian Polytechnics, whose effect was investigated in this study, is hinged on the premise that computers are not only veritable means of enhancing students mathematics learning process, but can also be used to positively foster their attitude towards the subject.

Literature review revealed that researches on the use of computers in Nigeria's education system were not focused on their effect on the engineering students Attitude Towards Mathematics (ATM). Therefore, this study is an effort to close the existing dearth of research work on the effect of computer usage on engineering students ATM with particular focus on Nigerian Polytechnic engineering students. Thus, it is hoped that this study will provide mathematics lecturers teaching mathematics to engineering students with a framework on how they could possibly use computers to help them positively foster their students ATM. Also, it is hoped that when put to use, the CMSTA will go a long way to positively foster the ATM of the students, which by extension will facilitate the rate at which learning will take place.

This study covered Engineering Mathematics Curricula (EMC) of both the National Diploma (ND) and Higher National Diploma (HND) levels. EMC of other levels such as those of post – HND, Pre – ND and non – engineering disciplines were excluded in this study. Consequently, only the ND and HND engineering students' ATM were focused on.

2. Conceptual Framework

2.1 Computer Mediated Systems Teaching Approach (CMSTA)

Literature search reveals that no single definition of the concept of Computer Mediated Systems Teaching Approach (CMSTA) exists. However definition exists for a related term, Computer Mediated Communication (CMC), which by extension could be considered a related concept. Therefore, in this work the concept of CMSTA is defined with substantial recourse to that of the CMC. This is because teaching, in all its ramifications, is an activity which is basically communicative in nature.

CMC has been defined as any communicative transaction which occurs through the use of two or more networked computers (McQuail, 2005). Traditionally, the term CMC was used in reference to communications that occur via computer – mediated formats such as instant messages, e-mails, chat rooms. Later on, the term was it applied to other forms of text-based interaction such as text messaging (Thurlow et. Al., 2004). Popular forms of CMC include e-mail, video, audio or text chat (text conferencing including instant messaging), bulletin boards, list-servs, Massively Multiplayer Online Games (MMOs) and Weblogs (blogs).

From the above, CMSTA is herein conceptualized to signify the ways in which telecommunication technologies could be merged with computers and computer networks to give teachers new tools to support teaching. In other words, CMSTA describes the ways teachers could use computer systems and networks to transfer, store and retrieve information for the purpose of supporting the teaching process. Implied in this conception is the notion that computers and computer network is a taken as a single entity which is primarily a medium for supporting the teaching/learning process rather than being the teacher. In order to support the teaching/learning process, CMSTA entails the use electronic mail and real-time chat capabilities to deliver instructions and facilitate student-to-student as well as student-to-teacher interactions across a desk, classroom or across the world.

CMSTA is comparable to other approaches of teaching in the sense that it has several aspects which are universal to all forms of teaching. These include (but not limited to) synchronicity, persistence or recordability and anonymity. For example, it uses instant messaging which is synchronous in nature, but lacks complete persistent since contents are easily lost when the dialog box is closed unless a message log had been set up or had been manually copy-pasted. On the other hand, CMSTA usage of e-mails and message boards make it low in synchronicity since response time varies, but high in persistence since messages sent and received are saved. Aspects that distinguish CMSTA from other approaches include transience, its multimodal nature and its relative lack of governing codes of conduct, which is similar to the case of the CMC as noted by McQuail (2005). Therefore, the CMSTA could be considered as capable of overcoming physical and social limitations inherent in the conventional form of teaching approach and thus allow the interaction of people who are not physically sharing the same space.

From the above, it can be seen that the CMSTA can be carried out synchronously or asynchronously or by a combination of both modes, just as with the case of the CMC which has been divided into synchronous and asynchronous modes. The synchronous mode of using the CMSTA entails that all participants (both students and teacher) are online at the same time, while the asynchronous mode of usage occurs without time constraints In more advanced economies of the world where computers and computer network are being deployed to support the teaching/learning process, these uses are enabling and promoting the paradigm shifts from teacher – centered teaching system approach to that of the student-centered learning system as well as the merging of informal dialogues, invisible colleges, oral presentations, and scholarly publications into a kind of dialogic or even multilogic virtual university.

Two issues of importance found in literature which are central to the use of the CMSTA revolves around how to incorporate existing and emerging knowledge about teaching/learning and how educators can use CMSTA productively as we move into an era that is becoming more technological laden. In literature, these issues were discussed from various perspectives relating to both classroom and distance learning. These perspectives include accommodation of different learning styles, empowerment of learners, regardless of physical challenges or social/cultural differences and learners' use of the same tools and methods that professionals use. The general implication arising from these discussions is that teachers using CMSTA must adopt an interdisciplinary, project- oriented approach to teaching/learning. All of these can potentially create authentic practice. On this basis, it was posited by some (e.g. McQuail, 2005; Thurlow et al., 2004) that computer usage in teaching/learning process has the potential of changing the process in two main ways, viz:

- generating improved technological tools that allow students to use a fuller range of interactive methodologies, and
- encouraging teachers and administrators to pay more attention to the instructional design of courses.

Both factors above can improve the quality and quantity of the materials students practice during learning and this was what was envisaged when the CMSTA was to be deployed in the teaching of mathematics to engineering students of Nigerian Polytechnics.

2.2 Attitude Towards Mathematics

As far back as 1945, Strauss (1945) posited that attitude has profound influence on people's behavior. He contends that it influences people's perception of objects and other people, exposure to and comprehension of information, choice of friends, etc. Literature search reveals that the concept of attitude has been differently comprehended by different researchers. It is therefore not surprising that while some researchers have defined it conceptually, others defined it operationally. Definitions of attitude encountered in literature include those of Thomas and Znaniecki (1927), Bain (1928), Warren (1931), Allport (1935), Katz and Scotland(1959), Krech and Crutchfield (1984).

According to Thomas and Znaniecki (1927), attitude is a process of individual consciousness which determines real or possible activity of the individual in the social world. Bain (1928) defines attitude as the relatively stable overt behavior which affects a person's status. Warren (1931) asserts that when a certain type of experience is constantly repeated, a change of set is brought about which affects many central neurons and tends to spread over other parts of the central nervous system. These changes in the general set of the central nervous system temper the process of reception which leads to the formation of certain general modes of receiving and integrating stimuli. In terms of the subjective life, these general sets are called attitudes.

Allport (1935) defines attitude as a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon an individual's response to all objects and situations with which it is related. While Katzand and Scotland (1959) defines it as a tendency or a predisposition to evaluate an object or symbol of that object in a certain way – evaluation consists of attributing goodness/badness or desirable/undesirable qualities to an object; Krech and Crutchfield (1984) defines attitude as an enduring organization of motivational, emotional, perceptual and cognitive processes with respect to some aspect of the individual's world.

Sharma (2011) asserts that two most common distinct aspects used to define attitude are: as set of readiness and as effect and evaluation. According to Sharma (2011), as set of readiness, attitude will be conceived as a tendency (or a set of readiness) to respond to some social object. For those who hold this conception, their definitions of attitude had the component of readiness or disposition to act. Those who conceive of attitude as effect and evaluation define the term on the basis of its effects and influences on evaluation. The definitions of Krech and Crutchfield (1984) and Katz and Scotland (1959) above are in this category.

It is clear from the above that whatever conception of attitude one holds; this psychological construct influences our choice of action, responses to challenges, incentives and rewards. It is therefore not surprising that Neale (1969) declared that in the field of mathematics education, research on attitude has been motivated by the belief that it plays a crucial role in learning mathematics. The conceptions of attitude towards mathematics (ATM) encountered in literature are in tandem with the ones held on attitude, i.e. just like attitude has been differently comprehended by different researchers, so has ATM.

Neale (1969) defines ATM as an aggregated measure of "a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless". In later studies, Ma & Kishor (1997) extended Neale's (1969) definition of attitude towards mathematics to include students' affective responses to the easy/difficult dimension as well as the important/unimportant dimension of mathematics.

In general, attempts have been made to explicitly or by inference define ATM in one of the three following ways, with each based on the definition of attitude:

- McLeod (1992) and Haladyna et. al., (1983) are of the opinion that ATM is just a positive or negative emotional disposition towards mathematics. This view point is based on the simple definition which describes attitude as the positive or negative degree of affect associated with a certain subject.
- Based on a bi-dimensional definition, in which behaviours do not appear explicitly Daskalogianni & Simpson (2000) defines ATM as the pattern of beliefs and emotions associated with mathematics.
- From a multidimensional perspective which takes emotional response, beliefs regarding the subject and behaviour related to the subject as the three components of attitude into cognisance, emerges the point of view where ATM is defined in a more complex way by the emotions that an individual associates with mathematics (which, however, have a positive or negative value), the individual's beliefs towards mathematics and how he/she behaves (Hart, 1989).

Kulm (1980) posits that it is probably not possible to offer a definition of ATM that would be suitable for all situations and that even if one were agreed on, it would probably be too general to be useful. In this way, the definition of ATM has to assume the role of a 'working definition' (Daskalogianni & Simpson, 2000). This position implies that ATM should be seen as functional to the researcher's self-posed problems. As long as the definition of ATM is not simply borrowed from the context in which it appears in social psychology, but is rather outlined as an instrument capable of taking into account peculiar problems in mathematics education; then it may be considered useful in the context of mathematics education. This is in line with the position of Ruffell et. al., (1998), who see attitude as an observer's construct. This is also the position held in this work.

3. Theoretical Framework

Increasing recognition of the potentials of computer usage in the teaching/learning process has encouraged innovative approaches to the design of both classroom and distance teaching/learning. These innovative approaches have contributed to a movement away from the duplication of traditional instructional methods, both in the classroom and at a distance (Turoff 1995) towards more resource-based ones that no longer emphasizes the teacher as the main source of knowledge (Smith and Kelly, 1987; Beaudoin, 1990; Gunawardena, 1992). Garrison (1993) and Crotty (1994) held that this perspective within technology use in education aligns itself with the principles of constructivism. It is thus the held in this study that the pedagogical basis for the use of computers to enhance the teaching/learning process can be located within the principles of constructivism. Therefore, the principles of constructivism as it relates to the deployment of computers to enhance the teaching/learning process forms the theoretical framework upon which this study depends.

As a theory based on observation and scientific study about how people learn, constructivism holds that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences, i.e. we are active creators of our own knowledge. Fosnot (1989) defines constructivism by reference to the following four principles:

- learning, in an important way, depends on what we already know
- new ideas occur as we adapt and change our old ideas
- learning involves inventing ideas rather than mechanically accumulating facts
- meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas

Von Glasersfeld (1995) observes that constructivism is often misconstrued as a learning theory that compels students to "reinvent the wheel." He therefore clarifies that rather than compelling students to reinvent the wheel, constructivism taps into and triggers the student's innate curiosity about the world and how things work. In other words, Von Glasersfeld (1995) is of the view that constructivism does not make students to reinvent the wheel but helps them understand how it turns, how it functions. According to the constructivist, students learn by applying their existing knowledge and real-world experience, learning to hypothesizing, testing their theories, and ultimately drawing conclusions from their findings.

In the classroom, the constructivist view of learning means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure he/she understands the students' preexisting conceptions, and guides the activity to address them and then build on them. According to Von Glasserfeld (1995), some of these are the discernible qualities which makee a constructivist teacher and a constructivist classroom to be markedly different from a traditional or direct instruction classroom. He further explains that a constructivist teacher is able to flexibly and creatively incorporate ongoing experiences in the classroom into the negotiation and construction of lessons with small groups and individuals. The environment is democratic, the activities are interactive and student centered, and the students are empowered by the teacher, who in this case, operates as a facilitator/consultant.

Constructivist classrooms are structured so that learners are immersed in experiences within which they may engage in meaning-making, inquiry, action, imagination, invention, interaction, hypothesizing and personal reflection. In this perspective, the teacher is no longer considered as an expert, who knows the answers to the questions he/she has constructed, while the students are asked to identify their teacher's constructions rather than to construct their own meanings. In a constructivist classroom, students are encouraged to use prior experiences to help them form and reform interpretations.

From the above, it could be said that in a constructivist classroom, the teacher and the student share responsibility in the teaching/learning process and decision making and there is demonstrable mutual respect. This is a democratic and interactive process which allows students to be active and autonomous learners. A constructivist classroom is therefore a student-centered classroom. This consists of learner-centered, active instruction. In such a classroom, the teacher provides students with experiences that allow them to hypothesize, predict, manipulate objects, pose questions, research, investigate, imagine, and invent. The teacher's role is to facilitate this process.

Negotiation is an important aspect of a constructivist classroom. It unites teachers and students in a common purpose. Smith (1993) confirms that negotiating curriculum means "custom-building classes every day to fit the individuals who attend". Boomer (1992) explains that negotiating the curriculum means deliberately planning to invite students to contribute and to modify the educational program, so that they will have a real investment both in the learning journey and the outcomes. Cook (1992), in explaining why negotiating the curriculum with students is important, posits that learners will work harder and better, and what they learn will mean more to them if they are discovering their own ideas, asking their own questions, and fighting hard to provide answers for themselves. Out of negotiation comes a sense of ownership in learners for the work they are to do, and therefore a commitment to it. A constructivist teacher therefore is expected to offer his/ her students options and choices in their work. Rejecting the common practice of telling students what to do, he/she engages their trust and invites them to participate in a process which will allow them to be involved in decisions about their learning.

Gray (1997) summarily provides the characteristics of a constructivist classroom as follows:

- the learners are actively involved
- the environment is democratic
- the activities are interactive and student-centered
- the teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous

Furthermore, in the constructivist classroom, students work primarily in groups and learning and knowledge are interactive and dynamic. There is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. This is contrary to the traditional classroom in which students work primarily alone, with learning being achieved through repetition, and the subjects are strictly adhered to and are guided by a textbook.

Constructivist approaches can also be used in the CMSTA. In this case, tools such as discussion forums, wikis and blogs can enable learners to actively construct knowledge. What is essentially involved in constructivist strategies and activities is a process approach to learning. For, according to Applebee (1993), "rather than emphasizing characteristics of the final products, process-oriented instruction focuses on the language and problem-solving strategies that students' need to learn in order to generate those products".

Langer& Applebee (1987) opine that in a process approach, a context is created within which students are able to explore new ideas and experiences. Within this context, the teacher's role in providing information decreases and is replaced by a strengthened role in eliciting and supporting students' own thinking and meaning-making abilities, where ideas are allowed to develop in the learner's own mind through a series of related, supportive activities; where taking risks and generating hypotheses are encouraged by postponing evaluation; and where new skills are learned in supportive instructional contexts.

Constructivist activities in any subject area can range from very simple to sophisticated and complex, depending on the teacher's learning objectives. The possibilities for constructivist activities are limitless. It is important, however, regardless of subject area, to provide enough activities for students' choice and to encourage student-generated activities. In the constructivist classroom, the teacher's role is to prompt and facilitate discussion. Thus, the teacher's main focus should be on guiding students by asking questions that will lead them to develop their own conclusions on the subject. In this regard, Jonassen (1999) identified three major roles for teachers, who are expected to act as facilitators, to support students in constructivist learning environments. These are:

- Modeling
- Coaching
- Scaffolding

While constructivism is clearly gaining popularity as a new paradigm for learning, many question how the philosophy can be operationalized. They argue that it does not provide a method, approach or particular pedagogy. In response to this, numerous researchers, educators and authors have actively engaged themselves in using constructivist principles to design and implement new learning environments. Towards this end, technology is increasingly being touted as an optimal medium for the application of constructivist principles to learning. It is against this backdrop that the CMSTA adopted the constructivist philosophy. The CMSTA aligned with Jonassen's (1999) model for developing Constructivist Learning Environments (CLEs) around a specific learning goal, which may take one of the following several forms (from least to most complex):

- Question or issue
- Case study
- Long-term Project
- Problem (multiple cases and projects integrated at the curriculum level)

Jonassen (1999) recommends making the learning goals engaging and relevant but not overly structured. Learning is driven in CLEs by the problem to be solved; students learn content and theory in order to solve the problem. This is different from traditional objectivist teaching where the theory would be presented first and problems would be used afterwards to practice theory. This was taken into consideration during the use of the CMSTA.

4. Problem Statement

It was observed that (i) new technologies are failing to penetrate the Nigerian education system (Nnoli and Sulaiman, 2001) despite Nigeria's National Policy on Education's (FGN, 2004) categorical emphasizes that 'modern educational techniques shall be increasingly used and improved upon at all levels of the educations system', (ii) the teaching of mathematics to engineering students in most tertiary institutions in Nigeria is largely performed using traditional approaches (i.e. talk and chalk) despite the fact that the use of multimedia courseware in engineering has rapidly gained popularity (Reagan and Shepard, 1996), (iii) mathematics teaching in Nigeria is lagging behind the teaching of other subjects like physics, chemistry and biology in term of experimentation. For, it is highly uncommon to see mathematics teachers carrying out mathematical teaching experiments despite the fact that it has been established that experiments help students in their learning (Bourne et al, 1996). These shortcomings might have been responsible for some observed apparent negative ATM dispositions exhibited by many engineering students in Nigeria. Negative ATM dispositions are capable of constituting stumbling blocks to students' full understanding of the applications of mathematics in engineering profession. Based on the belief that computer usage in the teaching/learning process is capable of not only increasing students' mathematics achievement, but can also foster their attitude towards the subject positively; this study was therefore undertaken with the hope that the use of the CMSTA will address this problem.

5. Objectives of the Study

This study was mainly undertaken to take advantage of new and emerging technologies in the field of Information and Communications Technology (ICT) to study the effect of a CMSTA on ATM of engineering students. Specifically, the study determined:

1. The ATM dispositions of the students taught mathematics using the CMSTA and those not taught with the same approach.
2. The gender whose ATM disposition was more favourable amongst the students taught mathematics using the CMSTA.

6. Research Questions

1. What are the ATM dispositions of the students taught mathematics using the CMSTA and those not taught with the same approach?
2. Which gender's ATM disposition is more favourable amongst the students taught mathematics using the CMSTA?

7. Research Hypotheses

Ho_1: There is no significant difference between the ATM dispositions of the students taught mathematics using the CMSTA and those not taught with the same approach.

Ho_2: Gender difference of the ATM dispositions of the students taught mathematics using the CMSTA is not significant.

8. Methodology

8.1 Research Design

This quasi – experimental research adopted the pretest-posttest Non Equivalent Groups Design (NEGD) approach.

8.2 Sample and Sampling Procedure

Both control and experimental groups were drawn Kaduna Polytechnic. Situated in the northwest of Nigeria, this institution is the largest of its kind in terms of students and staff population, courses offered, infrastructure and facilities. It is therefore believed that generalization of results obtained from sample drawn from the institution suffices. Subjects targeted for use were students of National Diploma I & II (i.e. NDI & NDII) as well as Higher National Diploma I & II (i.e. HNDI & HNDII) levels. They were spread across the seven departments of the two schools that made up the college of engineering of the Polytechnic. The treatment was administered during the second semester of the 2010/2011 academic session. Only ND I and HND I students take second semester mathematics courses. Consequently, the study sample were drawn from ND I and HND I. The experimental group was drawn from departments in the School of Industrial Engineering while the control group was drawn from the School of Natural Resources Engineering. In each school, one HNDI and one NDI class were randomly chosen. Table 1 shows the detail breakdown of subjects targeted and those eventually used.

The differences between the subjects earmarked for use as samples and those eventually used was attributed to the fact that because the subjects were allowed to take the instruments home and return two days later, not all respondents returned theirs. Despite this, it can be seen that approximately 97% and 92% of the subjects targeted responded during the pretests and posttests respectively. This implies that the minimum response rate was not less than 92%. Nworgu (1991) posits that where all response rates are less than 70%, the results could differ considerably. Therefore, the response rate obtained for the study was considered adequate for valid analysis.

Table 1. Experimental and Control Groups Subjects

Group	**Department**	**Level**	**Sex**	**Targeted**	**Used**	
					Pretest	**Posttest**
Experimental	Chemical Engineering	HND I	M	114	113	111
			F	31	31	28
			Total	**145**	**144**	**139**
	Computer Engineering	ND I	M	105	99	97
			F	24	24	20
			Total	**129**	**123**	**117**
	Sub Total			**274**	**267**	**256**
Control	Civil Engineering	HND I	M	109	105	95
			F	11	10	8
			Total	**120**	**115**	**103**
	Mineral Resources Engineering	ND I	M	74	71	71
			F	17	17	15
			Total	**91**	**88**	**86**
	Sub Total			**211**	**203**	**189**
Grand Total				**485**	**470**	**445**

A combination of the convenience, purposive and random sampling procedures was adopted to select the samples used. The convenience sampling procedure was adopted when Kaduna Polytechnic was chosen as the institution where the study was conducted. For, one of the researchers is a staff of the institution and therefore using students of the institution will be most convenient for the research team. Purposive sampling procedure was employed in the determination of the level whose students were used, since only students that offer mathematics courses in the semester in which the experiment was carried out could be used. The random sampling procedure was used to assign the schools into both the control and experimental groups. It was also employed to choose the levels used in each group.

8.3 Instrumentation

The Attitude Towards Mathematics Inventory (ATMI), developed by Tapia and Marsh II (2004) to investigate the underlying dimensions of ATM was adapted and used. ATMI is a 40-item instrument constructed to address confidence, value, enjoyment and motivation. All items in the ATMI were constructed using a Likert-scale format with the following anchors: 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree and 5 for strongly agree. The total score obtainable by a respondent ranges from 40 to 200, with higher scores correlating with higher levels of positive ATM. An ATMI score of between 40 and 79 was adjudged totally negative ATM; 80 and 119, just negative ATM; 120 and 159, positive ATM and 160 and 200, totally positive ATM. From this categorization, it follows that the minimum score for a respondent to be adjudged to have positive ATM is 120.

Tapia and Marsh II (2004) reported that the Cronbach alpha coefficient obtained for the ATMI was 0.97, indicating a high degree of internal consistency for group analyses. They further reported that each of its 40 items had an item-to-total correlation above 0.50, with the highest being 0.82. This suggested that all items contributed significantly and that they are homogeneous.

Despite the high degree of internal consistency reported for the ATMI as recounted above, the need to determine the reliability coefficient of the ATMI used in relation to this study became pertinent since adaptation of the instrument demands that some of items have to be modified while others will be discarded and replaced. A pilot test was thus carried out during the first semester of the 2010/2011 academic session. The data obtained from the pilot study was analyzed to determine the difficulty and discrimination indices of each item as well as the reliability coefficient of the instrument. After analyses, items with difficulty index below 0.2 were discarded for being too difficult while those with indices ranging from 0.2 to 0.35 were selected for the inclusion in the final instrument with some modifications or reframing. Items with indices ranging from 0.36 to 0.64 were selected without any modification, while those with indices above 0.65 were modified and accepted. Ebel's (1975) criteria for evaluating discrimination indices were used to select final items for inclusion. Accordingly, items with discrimination indices of: (i) 0.40 and above were adjudged very good, (ii) 0.30 – 0.39 were adjudged reasonably good, (iii) 0.20 – 0.29 were considered marginally items that need improvement and (iv) below 0.19 were considered poor items which were discarded. The reliability coefficient of the ATMI used was determined by subjecting the scores obtained from the pilot study to the Kuder-Richardson Formula 21 where a reliability coefficient of 0.90 was obtained, suggesting that the ATMI used was quite a reliable measuring instrument for this study.

8.3 Treatment and Treatment Procedure

The control group was taught mathematics using the traditional approach while the experimental group was taught with the CMSTA. The CMSTA, which was patterned in line with Nordin et. al.'s (2005) eLearning instructional approach design model, has three main features, viz: Mathematics Teaching Approaches (MTA), Lesson Sequencing Approaches (LSA), and Modularization of MTA and LSA. MTA has six features, viz: the expository, modeling, coaching, articulation, reflection and exploration approaches. LSA has three components, viz: scaffolding, increasing complexity and increasing diversity. Each module has four main submodules built into each mathematics course materials taught, viz: Teacher, Revision, Exercise and Reinforcement submodules. After assignment of subject to experimental and control groups, administration of the treatment lasted for 12 weeks.

8.4 Data Collection and Analysis Procedures

The ATMI was administered at the beginning and end of the second semester of the 2010/2011 academic session as pretest and posttest respectively by the researchers. The Mean, Standard Deviation, Standard Error of the Mean and t-test statistics were used for data analyses. The hypotheses were tested at the 95% confidence level.

9. Results

Table 2: Descriptive Statistics of ATMI score by Group, Gender and Test-Type

Group	Gender	Test	N	Min	Max	Mean	SD	Se
Experimental	Male	Pretest	212	58	185	137.71	29.66	2.04
		Posttest	208	85	182	147.12	20.19	1.40
	Female	Pretest	55	60	184	142.53	31.54	4.25
		Posttest	48	86	186	144.67	21.25	3.07
	Both	Pretest	267	58	185	138.70	30.06	1.84
		Posttest	256	85	186	146.66	20.38	1.27
Control	Male	Pretest	176	58	188	140.36	29.50	2.22
		Posttest	166	58	187	137.48	27.90	2.17
	Female	Pretest	27	87	181	144.11	24.15	4.65
		Posttest	23	88	180	138.39	20.55	4.29
	Both	Pretest	203	58	188	140.86	28.82	2.02
		Posttest	189	58	187	137.59	27.07	1.97

Table 2 shows that the pretest means of ATMI scores of the experimental group, considered by gender or as a whole ranged from 137.71 to 142.53. Also, posttest means of their ATMI scores ranged from 144.67 to 147.12. Based on the grading criteria stated in subsection 8.3, it follows that the ATM disposition of the experimental group was positive before and after being taught mathematics using the CMSTA. However, it could be seen that in all three cases, the posttest mean scores are higher. Similarly, the pretest means of ATMI scores of the control group ranged from 140.36 to 144.11 and that of their posttests ranged from 137.46 to 138.39. This also implies that the ATM disposition of the control group was positive. These results therefore answer research question one, i.e. the ATM dispositions of the experimental and control groups were positive, before and after treatment administration.

Also, Table 2 shows that the posttest means of the ATMI scores of the male and female subjects in the experimental group differ by 2.45 in favour of the males. On this basis, it could be concluded that the ATM disposition of the male students taught mathematics using the CMSTA is more favourable than that of their female counterparts. This result answers research question two.

Table 3: Independent t-test analysis of significance between experimental and control group's pretest and posttest mean ATMI scores

Variable	Test	Group	N	Mean	SD	t	df	p
ATMI Scores	Pretest	Experimental	267	138.70	30.06	-0.78	468	0.43
		Control	203	140.86	28.82			
	Posttest	Experimental	256	146.66	20.38	4.03	443	0.00*
		Control	189	137.59	27.07			

*p < .05

Table 3 shows that while the difference between the experimental and control group's pretest mean ATMI scores was not significant, it was significant in the case of posttest scores.

Table 4: Paired t-test analysis of significance between the pretest and posttest mean ATMI scores by group

Variable	Group	Test	N	Mean	SD	df	t	p
ATMI Scores	Experimental	Pretest	256	136.77	29.19	255	-14.48	0.00*
		Posttest	256	146.66	20.38			
	Control	Pretest	189	137.58	27.11	188	-0.12	0.90
		Posttest	189	137.59	27.07			

*p < .05

From Table 4, it could be seen that while the difference between the pretest and posttest mean ATMI scores of the experimental group was significant, it was not significant for the control group. Based on the results from both Tables 3 and 4, **Ho$_1$** was therefore rejected.

Table 5: Independent t-test analysis between the male and female pretest and posttest mean ATMI scores of experimental group

Variable	Group	Test	Gender	N	Mean	SD	df	t	p
ATMI Scores	Experimental	Pretest	Male	212	137.71	29.66	265	-1.06	0.29
			Female	55	142.53	31.54			
		Posttest	Male	208	147.12	20.19	254	0.75	0.45
			Female	48	144.67	21.25			

Table 5 shows that the differences between the experimental group's male and female pretest as well as posttest mean ATMI scores were not significant. Therefore **Ho$_2$** was upheld.

10. Findings and Discussion of Results

The following are the findings arising from the data analysis carried out:

1. The ATM disposition of the students taught mathematics using the CMSTA was significantly more positive than that of those not taught with the same approach.
2. Gender difference in the ATM dispositions of the students taught mathematics using the CMSTA was not significant.

The rejection of **Ho$_1$** may be attributed to the effect of treatment on the experimental group. This line of reasoning is supported by the fact that (i) no significant difference was found between the pretest and posttest mean ATMI scores of the control group while in the case of the experimental group, the difference was significant and (ii) no significant difference was found between the experimental and control groups pretest mean ATMI scores whereas in the case of the posttest, the difference was significant.

This result contradicts that obtained by Taylor (2008) who examined the effects each treatment had on students' mathematics anxiety and mathematics attitude in addition to the main purpose of her study, which was to look at differences in student achievement in a web-based, computer-assisted curriculum in remedial mathematics classes as compared to classes that use a traditional lecture method of instruction. She (Taylor, 2008) reported no statistically significant differences for the experimental group from pretest to posttest, statistically significant differences for the control group from pretest to posttest, and no statistically significant differences between both groups from pretest to posttest. She however reported that while statistical significant difference did not occur for the experimental group, their attitudes toward mathematics did improve. She further reported that on the other hand, the control group showed statistical significance, but their scores showed that their ATM was not as good at the end of the semester. This also contradicts the results obtained in this study which indicates that the ATM of both the experimental and control groups were positive.

The retention of **Ho$_2$** may be attributed to the effect of treatment on the experimental group, which seems to be homogenous. It should be observed that in some cases, the mean of the ATMI scores were higher for females while in other cases the reverse was the case. Therefore, the retention of **Ho$_2$** can be taken to signify that the treatment neutralizes gender difference in the subject's ATM. This line of reasoning is supported by the fact that both male and female subjects in the experimental group were exposed to the same treatment at the same time and under the same condition throughout the treatment period. Therefore, it is only natural that since the treatment has impacted on the experimental group as can be seen from the rejection of the **Ho_1**, both genders would have contributed approximately equally towards the result.

This result is in affirmation with similar findings from previous research (e.g. Sánchez, Ursini, and Orendain, 2004; Pajares and Graham, 1999 and Ma and Kishor, 1997). Sánchez, Ursini, and Orendain (2004), who were interested in studying gender differences in ATM and mathematics taught with computers, detected a general tendency to a positive ATM and towards mathematics taught with computers but they found no significant gender differences in this. Earlier, Pajares and Graham (1999) as well as Ma and Kishor (1997) found that although males possess higher Self-efficacy, have more positive ATM and tend to obtain better results than girls; there is no significant difference among gender in terms of ATM.

11. Conclusion and Recommendations

Research on the effects of computer-based teaching revealed that the positive effects of computer usage for teaching to supplement regular instruction includes its propensity to make students learn more in less time, obtain higher grades on posttests and have improve attitudes toward learning (Kinney et. al. 2004; Kulik & Kulik, 1986). In addition it was found that students benefited from computer-mediated learning when all of them meet at the same time with the same instructor, which gives them a sense of community that make them to be more likely to meet the course objectives on schedule (Kinney & Robertson, 2003). Mediated learning offers students an alternative to the direct-instruction approach learned in traditional lecture classes (Lundell et al., 2001). In view of the above and results obtained from this study, it was generally concluded that the treatment was able to foster the subjects' ATM positively. Consequently, the following recommendations were put forward:

1. The CMSTA of teaching should be adopted/adapted widely by mathematics teachers/lecturers in Nigerian Polytechnics in particular and other tertiary institutions in general to teach engineering students mathematics.
2. Use of ICT in teaching should be integrated into the mathematics education curricular of all levels of education in Nigeria.
3. There should a policy that will encourage mathematics educators, ICT experts and community members to collaborate to create a formal plan to help achieve the goals of integrating Use of ICT in teaching into the mathematics education curriculum of Nigeria.
4. Mathematics teachers/lecturers in Nigerian Polytechnics in particular and other tertiary institutions in general should be supported by their institutions' authorities to continuously engage in professional development in the area of computer usage and applications in teaching.
5. An awareness program should be developed for reluctant students to explain the benefits of using computers, software and the internet in the teaching/learning process.

12. Implications of the Findings

All stake holders in the Nigerian education system in general and the Polytechnic sector in particular should put all hands on deck to begin to ensure that the full benefits of ICT integration into the teaching/learning process are fully harnessed. Based on the positive effects of technology integration into mathematics classroom teaching practices on students' ATM, mathematics lecturers in Nigerian Polytechnics should be encouraged to develop teaching strategies which incorporates ICT usage that will help them positively foster their students attitudes' towards the subject.

13. Contributions of the Study to Knowledge

It is believed that this study has:

1. added to the body of knowledge on the positive effect of deploying computers to enhance teaching and learning of mathematics in Nigeria thereby reducing the existing dearth of research work in this area.
2. provided mathematics teachers/lecturers teaching mathematics to engineering students in Nigerian Polytechnics with a framework which will assist them develop their customised computer application packages for the purpose of helping to foster their students ATM positively.
3. contributed to literature which education policy makers in Nigeria may use to come up with new policies on computer usage in the teaching/learning process.

14. Limitations of the Study

There may be many other possible limitations of this study; one considered worthy of noting is that the length of the study was limited to one semester. A lengthier period of study may have produced a different result.

15. Areas for Further Research

A similar research on the effects of the CMSTA on ATM of (a) other science and technology students and (b) social science and business studies students in Nigerian Polytechnics, Colleges of Education and University students should be undertaken.

References

Allport, G. W. (1935). Attitudes. In C. Murchison (Ed.). *A handbook of social psychology*. Worcester, MA: Clark University Press.

Applebee, A. N. (1993). *Literature in the secondary school: Studies of curriculum and instruction in the United States.* Urbana, Il: National Council of Teachers of English.

Bain, R. (1928). An attitude on attitude research. *American Journal of Sociology.* 33, 940-957. [Online] Available: http://www.brocku.ca/MeadProject/Bain/Bain_1928.html (January, 2010).

Beaudoin, M. (1990). The instructor's changing role in distance education. The *American Journal of Distance Education* 4 (2), 21-29.

Bourne J.R., A.J.Brodersen, J. O.Campbell, M. M.Dawant, & R. G.Shiavi (1996). A Model for On-Line Learning Networks in Engineering Education. *Journal of Engineering Education*. 85(3), 253 – 262.

Common Wealth Secretariate (1991): *MicroComputers In Schools: Policy And Implementation Guidelines.* London: Common Wealth Secretariat Education Programme Human Resource Development Group.

Cook, J. (1992). Negotiating the curriculum: Programming for learning. In G. Boomer, N. Lester, C. Onore, & J. Cook. (Eds.), (1992), *Negotiating the curriculum: Educating for the 21st century*. London: The Falmer Press.

Crotty, T. (1994). Integrating distance learning activities to enhance teacher education toward the constructivist paradigm of teaching and learning. *Proceedings of the Distance Learning Research Conference*, Texas. In E. Pigliapoco, G. Torrisi, M. Messina & A. Bogliolo. (2012). LoL Classroom: A Virtual University Classroom Based on Enhanced Chats. *European Journal of Open, Distance and Learning (EURODL)*. [Online] Available: http://www.eurodl.org/index.php?article=337(5 April, 2011).

Daskalogianni, K. & Simpson, A. (2000). Towards a definition of attitude: the relationship between the affective and the cognitive in pre-university students. *Proceedings of the 24th Conference of the International Group for the Psychology of Mathematics Education (PME)* 24, 2, 217-224, Hiroshima, Japan. (ERIC Document Reproduction Service No. ED 452032). [Online] Available: www.eric.ed.gov/ERICWebPortal/detail?accno=ED452032 (2 November, 2010).

Ebel, R. L. (1975). *Evaluation in Education*. Cape Town: Maskew Miller Publishers.

FGN (Federal Republic of Nigeria). (2004). *National Policy on Education* (Revised). Lagos: NERC Press.

Fosnot, C. T. (1989). *Enquiring teachers, enquiring learners: A constructivist Approach for Teaching*. New York: Teachers College Press.

Garrison, R. (1993). Quality and access in distance education: Theoretical considerations. In D. Keegan (ed.): *Theoretical Principles of Distance Education*, New York: Routledge.

Gray, A. (1997). Contructivist Teaching and Learning SSTA Research Centre Report #97-07. In P. Wang (2011, March). Constructivism and Learner Autonomy in Foreign Language Teaching and Learning: To what Extent does Theory Inform Practice? *Theory and Practice in Language Studies*, 1 (3), 273-277.

Gunawardena, C. N. (1992): Changing faculty roles for audiographics and online teaching. *The American Journal of Distance Education* 4(3), 38-46.

Haladyna, T., Shaughnessy, J., & Shaughnessy, M. (1983). A causal analysis of attitude toward Mathematics. *Journal for Research in Mathematics Education,* 14 (1), 19-29.

Hart, L. (1989). Describing the Affective Domain: Saying What We Mean. In D. McLeod & V. Adams. (Eds.) (1989). *Affect and Mathematical Problem Solving: A New Perspective.* New York: Springer.

Jonassen, D. H. (1999): Constructing Learning Environments on the Web: Engaging Students in Meaningful Learning. *Proceedings of EdTech 99: Educational Technolgy Conference and Exhibition 1999.* Thinking Schools, Learning Nations.

Katz, D., & Scotland, E. (1959). A Preliminary Statement to Theory of Attitude Structure and Change. In S. Koch (Ed.), *Psychology: A Study of a Science*. New York: McGraw-Hill.

Kinney, D. P, J. Stottlemyer, J.Hatfield, & D. F. Robertson (2004). A comparison of the characteristics of computer-mediated and lecture students in developmental mathematics. *Research and Teaching in Developmental Education.* (21), 14-28.

Kinney, D. P., & D. F. Robertson (2003). Technology makes possible new models for delivering developmental mathematics instruction. *Mathematics and Computer Education.* 37, 315-328.

Krech, D. & Crutchfield, R. S. (1984). *Theory and Problems of Social Psychology*. New York: McGraw-Hill.

Kulik, C. L., & J. Kulik (1986). Effectiveness of computer-based education in colleges. *Association of Electronic Data Systems (AEDS) Journal*. 19, 81-108.

Kulm, G. (1980). Research on Mathematics Attitude. In R.J. Shumway (Ed.), *Research in mathematics education* (pp.356-387). Reston, VA: NCTM. TMME Monograph3, 168.

Langer, J., & Applebee, A. N. (1987). *How writing shapes thinking: A study of teaching and learning*. National Council of Teachers of English. [Online] Available: http://wac.colostate.edu/book/langer_applebee/. (29 August, 2008).

Le Fevre, J., Kulak, A., & Heymans, L. (1992). Factors influencing the selection of university majors varying in mathematical content. *Canadian journal of behavioural science,* 24(3), 276-289.

Lundell, D. B., , J. L. Higbee, C. Chung, D. Ghere, & D. R. Kinney (2001). Setting the pace: Theoretical perspectives for developmental education. In M. R. Hay & N. L. Ludman (Eds.), *Selected conference papers* (pp. 45-49). Dowagiac, MI: National Association for Developmental Education.

Ma, X. & Kishor, N. (1997). Assessing the Relationship Between Attitude Toward Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal for Research in Mathematics Education,* 28(1), 26-47.

Ma, X. & N. Kishor (1997). Assessing the Relationship Between Attitude Toward Mathematics and Achievement in Mathematics: A Meta-Analysis. J*ournal for Research in Mathematics Education.* 28(1), 26-47.

McLeod, D. (1992). Research on affect in mathematics education: a reconceptualization. In D.Grows (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp.575-596). New York: McMillan Publishing Company.

McQuail, D. (2005). *Mcquail's Mass Communication Theory*. (5th ed). London: SAGE Publications.

Means, B., & Olson, K. (1995). Leadership for technology implementations. In *Technology's role in education reform: Findings from a national study of innovating schools.* Washington, DC: Office of Educational Research and Improvement, U.S. Department of Education.

Neale, D. (1969, December). The role of attitudes in learning mathematics. *The Arithmetic*, 631-641.

Nnoli, O. & I. Sulaiman (2001). *Reassessing the Future of Education in Nigeria*. Nigeria: Education Tax Fund.

Nordin, N. M; Zaman, H. B & Din, R (2005): Integrating Pedagogy and Instructional Design in the eLearning Approach for the Teaching of Mathematics. *Proceedings of the Second International Conference on eLearning for Knowledge-Based Society,* August 4-7, 2005, Bangkok, Thailand.

Nworgu, B. G. (1991). *Educational Research: Basic issues and methodology.* Ibadan: Wisdom Publishers.

Pajares, F., & L. Graham (1999). Self-Efficacy, Motivation Constructs and Mathematics Performance of Entering Middle School Students. *Contemporary Educational Psychology*. 24, 124-139.

Reagan, M. & S. Sheppard (1996). Interactive Multi-media Courseware and the Hands-on Learning Experience: An Assessment Study. *Journal of Engineering Education*. 85 (3), 123-131.

Ruffell, M., Mason, J., & Allen, B. (1998). Studying attitude to mathematics. Educational *Studies in Mathematics,* 35: 1-18.

Sánchez, G. J., S. Ursini, & M. Orendain (2004). Attitudes Towards Mathematics And Mathematics Taught With Computers: Gender Differences. *PME*. 28.

Sharma, T. (2011). Attitudes and Beliefs of Rural Markets Structure. In Concept of *Attitude for Social Marketing – An Introductions.* [Online] Available: http://www.scribd.com/doc/53528525/54/CONCEPT-OF-ATTITUDE

Smith, K. (1993). Becoming the "guide" on the side. *Educational Leadership*, 51(2), 35-37.

Smith, P., & Kelly, M. (1987). *Distance Education and the Mainstream*. London: Croom Helm.

Spielberger, C. D. (1972). Conceptual and methodological issues in anxiety research. *Current trends in theory and research,* 2, 481–493.

Strauss, A. (1945). The Concept of Attitude in Social Psychology. *Journal of Psychology,* 19, 329-339. [Online] Available: http://www.brocku.ca/MeadProject/Strauss/Strauss_1945.html (30 May 2009).

Tapia, M., & G. E. Marsh (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly.* 8(2), 16-18.

Taylor, J. M. (2008, Fall). The effects of a computerized-algebra program on mathematics achievement of college and university freshmen enrolled in a developmental mathematics course. *Journal of College Reading and Learning*. 39(1).

Thomas, W. I., & Znaniecki, F. (1927). *The Polish Peasant in Europe and America.* New York: Dover Pubs. In P. Brock (1960). Review of The Polish Peasant in Europe and America by William I. Thomas and Florian Znaniecki. *Slavic and East European Journal*, 4, 187-189. [Online] Available: http://www.brocku.ca/MeadProject/Thomas/Reviews/Polish_Peasant/Brock_1960.html (17 June, 2006).

Thurlow, C., Lengel, L. & Tomic, A. (2005): *Computer mediated communication: Social interaction and the internet.* London: Sage.

Turoff, M. (1995). Designing a virtual classroom. *Paper presented at the International Conference on Computer Assisted Instruction.* [Online] Available: http://www.njit.edu/Department/ccc/vc/Papers/design.html.

von Glasersfeld, E. (1995). A constructivist approach to teaching. In L. P. Steffe and Gale (ed.): *Constructivism in Education*. Hillsdale, NJ: Erlbaum.

Warren, C. (1931). In A. Strauss (1945), The Concept of Attitude in Social Psychology. *Journal of Psychology,* 19, 329-339. [Online] Available: http://www.brocku.ca/MeadProject/Strauss/Strauss_1945.html (30 May 2009).