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Effects of Multiple Intelligence-Based and Computer Assisted Instructions on Secondary School Students' Attitude to Mathematics in Onitsha Education Zone

OKIGBO, Ebele Chinelo[1] & NWAFOR, Benjamin Amobi[2]
Department of Science Education, Nnamdi Azikiwe University,
Awka, Anambra State. Emails: e.c.okigbo@unizik.edu.ng[1], moscoben@yahoo.com[2]

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Abstract
The study investigated the effects of multiple intelligence-based and computer-assisted instructions (MII & CIA) on secondary school students' attitude to Mathematics. Two research questions guided the study and three hypotheses were tested at 0.05 alpha level. Quasi-experimental design was used in the study, specifically, the pretest-posttest non-randomized control group design was used in the study. The study population comprised 5,561 SS2 students offering mathematics selected using purposive and random sampling techniques. The instrument used for data collection is Mathematics Attitude Scale (MAS) validated by experts. The reliability of MAS was established using Cronbach Alpha which respectively yielded coefficients of internal consistency 0.76. The research questions were answered using mean and standard deviation while analysis of covariance was used to test the null hypotheses. The findings of the study showed that students taught Mathematics using CAI followed by those taught using MII had higher mean attitude score than those taught using DTI. Also, there was a significant difference between the mean attitude score of students taught Mathematics using MII, CAI and Direct Teacher Instruction (DTI) in favour of CAI followed by MII. It was recommended that mathematics teachers should adopt the use of CAI in teaching mathematics in order to reduce the abstraction associated with mathematics concepts and develop a more positive attitude in students towards the subject.

Keywords: *Multiple-intelligence, Attitude, Statistics, Computer, Mathematics*

Introduction

Mathematics is the study of numbers and how they are related to each other and to the real world. It is also a science that deals with numbers and it involves operations among numbers. It is the abstract science of numbers, quantities and space either as abstract concepts (pure mathematics) or as applied to other disciplines (applied mathematics) (Okeke and Okigbo, 2021). Mathematics is just like building block for everything in our daily lives, including mobile devices, computer software, architecture, arts, money, engineering and even sports. It is one of the main subjects of our everyday life. This is because, information on Mathematics helps us make better choices throughout everyday life and this makes life simpler.

Mathematics helps man to understand the world and provides him with an effective way of building mental discipline. It encourages logical reasoning, critical thinking, creative thinking, abstract or spatial thinking, problem-solving ability, and even effective communication skills. According to Duru and Okeke (2020), the subject of Mathematics is of central importance to the post-modern society of today because it provides the vital underpinning of the knowledge of economy. It is essential in the physical sciences, technology, business, financial services and many areas of Information and Communications Technology (ICT). Mathematics also offers children at the beginning of education, a powerful way of communicating as they learn to explore and explain their ideas using symbols, diagrams, spoken and written language. Thus, Paksu (2020) opined that studying Mathematics stimulates curiosity, fosters creativity and equips children with the skills they need in life beyond school. It is therefore important that mathematics is taught using student-oriented instructional strategies that actively engages the students in the learning process unlike direct teacher instruction.

Direct teacher instruction (DTI), often referred to as “chalk and talk” method or traditional approach, involves direct instruction by the teacher whose primary role is to pass knowledge to students and conduct testing and assessment (Abah, 2020). Essentially, the elements of drills, rote memorization and inability to cater for every student are the features that makes this method unstable for a lot of subject areas. These features, according to Abah, may not provide students with valuable skills or even with a body of knowledge that lasts much beyond the end of the term. There are also concerns, as observed amongst researchers (Caleb, 2017; Usman, Yew and Sale, 2019) that the techniques employed within the conventional approach tend to encourage “studying to the test” among students who are only required to “regurgitate” what they learnt as a display of proficiency during test or examination.

The lack of inquiry and problem-solving in the conventional approach such as direct teacher instruction (DTI) has driven educationist into propounding many new inquiry-based and problem-based instructional strategies. In reality, the often highlighted features of direct teacher instruction do not cut across board for all classrooms when implementing the approach. Non-traditional methods, commonly known as innovative/modern/blended teaching methods, are methods that involve the use of the technology, animation, special effects or are generally interactive and blended in nature (for example, the use of computers and videos to enhance delivery content). Among such instructional approaches are multiple intelligence-based instruction (MII) and computer assisted instruction (CAI).

Multiple Intelligence-based Instruction (MII) is a learner-centered learning strategy arising from the theory of multiple intelligence by Garder, which focuses on identifying learners' intelligence, talent, and learning preferences and providing the best way for learning (Jack and Japhet, 2020). MII is an instructional approach that incorporates all the different intelligences in the instructional process with the teacher identifying the areas of strength and emphasizing learning at the domain of intelligence. In using multiple intelligence-based instruction, Fatokun and Samuel (2019) opined that, the teacher makes a check-list of different intelligence and plan learning to emphasize each intelligence so as to enable students improve learning when learning experience is presented in their intelligence of strength. According to Yi and Jeng-Feng (2018), multiple intelligence-based instruction also involves the use of such instructional strategies as lectures, debates, large-and-small group discussions, books, nature visits, experimental verification, worksheets, manuals, brainstorming, writing activities, games and puzzles, sharing time, class exercises, use of examples, questioning techniques and stimulus variation.

In the present study, the instructional strategies that were employed to ensure that learning is emphasized in students’ area of strength in intelligence are: class exercise, use of examples and problem-solving, stimulus variation, scaffolding and questioning techniques. Class exercise involves giving students related problems to solve. The use of examples involved the teacher solving questions deductively and inductively while giving students similar problems that are structured to emphasize certain intelligences, to solve. Stimulus variation involved using various attention producing behaviour patterns from the part of the teacher that model different intelligences, in order to sustain interest in the lesson and attention of students. Scaffolding involved teaching students how to solve a problem by walking them through the steps. The use of questioning techniques involved the teacher using a pre-planned or emerging questions to engage the students in different domains of intelligence by asking questions related to the concept being taught. The questions are structured so that students who have intelligence in different domains are moved to answer.

In multiple intelligence-based instruction, students become more active and involved learners and are able to demonstrate and share their strengths. In Gardner's view, learning is both a social and psychological process. According to Gardner (1999), when students understand the balance of their own multiple intelligences they begin to manage their own learning and value their individual strengths. Ability of students to manage their own learning is related to the self-paced learning which is common with computer assisted instruction.

Computer-assisted instruction (CAI) refers to instruction presented on a computer. It involves the use of specific software programme on computers in the classroom (Ahmadu, Gambari, Abdul-Rasaq and Alabi, 2017). The CAI programs are individualized or self-paced in order to accommodate differences in student ability or speed. According to Caleb (2017), CAI programs use tutorials, drill and practice, simulation, and problem solving approaches to present topics, and they test the student's understanding. Examples of CAI applications include guided drill and practice exercises, computer visualization of complex objects, and computer-facilitated communication between students and teachers. The strategy is based on the principle of machine on one hand and principles of programs med instruction on the other.

Computer projected instruction simply involves the use of computer and its accompanying accessories to project the contents of instruction unto a screen. The projection is done in such a way that it catches the students' attention and embedded with features that aid easy assimilation such as animations, simulations and other forms of multi-media such as flash cards, motion pictures or cartooned texts from mathhelp.com. Thus, in the present study, the content of instruction would projected on the screen using a computer and projection screen via a projector. The projection is programmed according to the time of instruction and would be accessible to students after class. With its numerous benefits, computer assisted instructions tend to change students' attitude towards a subject.

Attitude is a psychological construct, a mental and emotional entity that inheres in or characterizes a person (Kele, 2018). It is complex and an acquired state through experiences. According to Ndifor and Ngeche (2017), attitude is an individual's predisposed state of mind regarding a value and it is precipitated through a responsive expression towards oneself, a person, place, thing, or event (the attitude object) which in turn influences the individual's thought and action. Attitude as most simply understood in this study is therefore, the feelings individuals have about themselves and the world. Attitude can be formed from a person's past and present.

Attitude can be positive or negative. Positive attitude indicates positive disposition of the mind towards a person, object or thing while negative attitude denotes negative disposition. Attitude towards a subject such as mathematics can be influenced by such factors as students' previous scores, the teachers, students' self-efficacy or career aspirations. To measure attitude in this study, the researcher administered a Mathematics Attitude Scale (MAS). According to

Gbemisola (2015), students who have succeeded in Mathematics or have had good grades in Mathematics may maintain a positive attitude irrespective of their gender.

Gender is the range of characteristics pertaining to, and differentiating between femininity and masculinity (Obimalume, 2021). Depending on the context, this may include sex-based social structures and gender identity. There are no gender differences in mathematics ability, accordingly, Kele (2018) examined the brain development of young boys and girls in a study and found that there are no gender differences in mathematics ability. However, a study by Sule and Sardauna (2018) on gender gaps in mathematics and reading revealed that on average, both gender perform differently in Mathematics and reading skills on tests. According to the authors, on average, males excel in Mathematics, while females excel in reading skills and this could shape students attitude towards mathematics. There is therefore the need to further explore the gender gaps in students' attitude towards mathematics.

Purpose of the Study

The purpose of the study was to determine the effects of multiple intelligence-based and computer-assisted instructions on secondary school students' attitude to Mathematics in Onitsha Education Zone of Anambra state, Nigeria. Specifically, the study determined the:

1. mean attitude scores of students taught Mathematics using multiple intelligence-based instruction (MII), computer assisted instruction (CAI) and those taught using direct teacher instruction (DTI).
2. mean attitude scores of male and female students taught Mathematics.
3. interaction effect of instructional approaches (MII, CAI, DTI) and gender on students' attitude towards Mathematics.

Research Questions

1. What are the mean attitude scores of students taught Mathematics using multiple intelligence-based instruction (MII), computer assisted instruction (CAI) and those taught using direct teacher instruction (DTI)?
2. What are the mean attitude scores of male and female students taught Mathematics using MII, CAI and those taught using DTI?

Hypotheses

1. There is no significant difference between the mean attitude scores of students taught Mathematics using multiple intelligence-based instruction (MII), computer assisted instruction (CAI) and those taught using direct teacher instruction (DTI).
2. There is no significant difference between the mean attitude scores of male and female students taught Mathematics using MII, CAI and those taught using DTI.
3. There is no interaction effect of instructional approaches (MII, CAI, DTI) and gender on students' attitude towards Mathematics.

Method

The study adopted quasi-experimental research design; specifically, the pretest-posttest non randomized control group design was used. The study was conducted specifically in Onitsha Education Zone. The population of the study comprised 5,561 (2,448 males, 3,113 females) senior secondary year two (SS2) students offering Mathematics in Onitsha Education Zone. The sample size for the study is 209 SS2 students offering Mathematics in Onitsha Education Zone of Anambra State. The sample was drawn using a multi-stage sampling procedure. First, three coeducational schools were chosen purposively. The choice of purposive sampling is to ensure that only coeducational schools were selected to take care of gender variables and to have three different school from three local government areas. Purposive sampling was also used to ensure that the schools selected from each local government area are comparable and have similar characteristics in terms of human and material resources. At the second stage, simple random sampling (balloting) was used to assign the three selected schools into experimental groups one and two and control group. At the third stage, two intact class of Mathematics students was randomly selected. The experimental group one has 68 students (39 males and 29 females), experimental group two has 77 students (33 males and 44 females) and the control group has 64 students (22 males and 42 females).

The instrument used for data collection was Mathematics Attitude Scale (MAS). MAS was adapted from Nwanze and Okoli (2021). The adaptation involved the removal of chemistry and its replacement with Mathematics in the items and other words such as 'chemists' to mathematicians, chemical to mathematical. Some of the sentences were also modified to suit the subject area of Mathematics. MAS is made up 30 items designed with a four response options ranging from strongly agree (4), agree (3), disagree (2) to strongly disagree (1). There are 14 negative statements and 16 positive statements in MAS. The scoring of the negative statement is the opposite of the weight of the response from strongly agree to strongly disagree that is 1,2,3 and 4 respectively. Thus, the highest possible score will be 120 and the minimum score will be 30. MAS was validated by lecturers from the Departments of Science Education and Educational Foundations in Nnamdi Azikiwe University, Awka and one other in the Department of Computer and Mathematics Education, Enugu state university of science and technology, Enugu. The reliability of MAS was established using Cronbach Alpha method. The reliability coefficient obtained for MAS was 0.76.

The experiment was carried out in the schools in two phases. The first phase involved the briefing/training of the three research assistants who are the regular classroom Mathematics teachers in the schools. The training was done in three contacts in one week. The second phase involved the treatment using the different lesson plans prepared for the experimental groups and control group. The pretest was administered without any revisions or feedback given to the students. The multiple intelligence instruction was carried in the regular classroom of the students using instructional materials that incites each intelligence as described by Gardner. In the CAI group the same content was taught. The teacher used computer to project the lesson on a screen. The lessons were characterized with tutorial videos, motion pictures. There were exercises or questions that helped the students to evaluate their learning and monitor their progress. The attempts made on each quiz or question was related as a feedback to the teacher and researcher. The control group was taught using the direct teacher instruction. No use was made of computers and students were not exposed to varied instructional situations and classroom conditions.

Mathematics attitude scale was administered in the first week immediately before the treatment. After the treatment, MAS was administered again as posttest. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).

Results

Research Question 1: What are the mean attitude scores of students taught Mathematics using multiple intelligence-based instruction (MII), computer assisted instruction (CAI) and those taught using direct teacher instruction (DTI)?

Table 1: Mean Attitude Scores of Students taught Mathematics using Multiple Intelligence-based Instruction (MII), Computer Assisted Instruction (CAI) and Direct Teacher Instruction (DTI)

Source of Variation	n	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gained Mean
MII	68	26.15	3.78	56.06	7.16	29.91
CAI	77	31.49	4.63	64.42	10.03	32.93
DTI	64	31.44	3.90	43.80	11.73	12.26

Table 1 reveals that the students taught Mathematics using MII has pretest mean attitude score of 26.15 and posttest mean attitude score of 56.06 with gained mean a attitude score of 29.91, and those taught using CAI having pretest mean attitude score of 31.49 and posttest mean score of 64.42 with gained mean 32.93 while those taught using DTI has pretest mean attitude score of 31.44, posttest mean of 43.80 and gained mean of 12.26. Students taught Mathematics using MII had the most homogeneous score in their pretest (3.78) followed by those taught using DTI (3.90) whereas students taught using CAI had the most heterogeneous score in their pretest (4.63). In the posttest, students taught mathematics using MII also had the most homogeneous score (7.16) followed by CAI (10.03) while students taught using DTI had the least homogeneous scores (11.73).

Research Question 2: What are the mean attitude scores of male and female students taught Mathematics using MII, CAI and those taught using DTI?

Table 2: Mean Attitude Scores of Male and Female Students taught Mathematics using MII, CAI and DTI

Method	Gender	n	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gained Mean
MII	Male	39	25.18	2.88	57.08	5.60	31.90
	Female	29	27.45	4.45	54.69	8.76	27.24
CAI	Male	33	29.36	1.69	67.15	11.99	37.79
	Female	44	33.09	5.45	62.36	7.79	29.27
DTI	Male	22	32.41	3.84	47.00	13.75	14.59
	Female	42	30.93	3.87	42.12	10.30	11.19

Table 2 indicates that male students taught Mathematics using MII have gained mean attitude score of 31.90 while female students have a gained mean score of 27.24 with males having a higher mean gain score and a more homogeneous score in the posttest. Male students taught Mathematics using CAI have a gained mean attitude score of 37.79 while female students have gained mean score of 29.27 with males having a higher mean gain attitude score and a less homogeneous score in the posttest. Again, male students taught Mathematics using DTI have a gained mean attitude score of 14.59 while female students have gained mean score of 11.19 with males having a higher mean gain attitude score and a less homogeneous score in the posttest. The male students had higher mean gain attitude score in all the groups.

Hypothesis 1: There is no significant difference between the mean attitude scores of students taught Mathematics using multiple intelligence-based instruction (MII), computer assisted instruction (CAI) and those taught using direct teacher instruction (DTI).

Table 3: ANCOVA on Difference between the Mean Attitude Scores of Students taught Mathematics using MII, CAI and DTI

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	15970.648[a]	6	2661.775	28.789	.000	
Intercept	13699.915	1	13699.915	148.173	.000	
Pretest	195.075	1	195.075	2.110	.148	
Method	13283.897	2	6641.949	71.837	.000	Sig.
Gender	633.067	1	633.067	6.847	.010	Sig.
Method * Gender	90.996	2	45.498	.492	.612	Not Sig.
Error	18676.730	202	92.459			
Total	675703.000	209				
Corrected Total	34647.378	208				

Table 3 shows that there was a significant main effect of the treatment on students' attitude toward mathematics; F (2, 202) = 71.837, P =0.00 < .05. Therefore, the null hypothesis is rejected meaning that, there is a significant difference between the mean attitude scores of students taught Mathematics using multiple intelligence-based instruction (MII), computer assisted instruction (CAI) and those taught using direct teacher instruction (DTI). The order of the significance of difference was determined using Scheffe PostHoc analysis and presented in Table 4.

Table 4: Scheffe PostHoc on Significant Difference between in Attitude towards Mathematics in MII, CAI and DTI Groups

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
MII	CAI	-10.095*	1.822	.000	-13.688	-6.501
	DTI	9.994*	1.957	.000	6.135	13.852
CAI	MII	10.095*	1.822	.000	6.501	13.688
	DTI	20.088*	1.683	.000	16.770	23.407
DTI	MII	-9.994*	1.957	.000	-13.852	-6.135
	CAI	-20.088*	1.683	.000	-23.407	-16.770

Based on estimated marginal means
*. The mean difference is significant at the .05 level.

Table 6 reveals that a significant difference exists between the mean attitude scores of students taught Mathematics using MII and CAI in favour of CAI. Table 6 also reveals that a significant difference exists between the mean attitude scores of students taught Mathematics using MII and DTI in favour of MII. Table 6 further shows that there is significant difference between the mean attitude scores of students taught using CAI and DTI in favour of CAI. The most effective method is therefore CAI followed by MII.

Hypothesis 2: There is no significant difference between the mean attitude scores of male and female students taught Mathematics using MII, CAI and those taught using DTI.
Data relating to hypothesis 2 is contained in Table 4. Table 4 shows that there was a significant influence of gender on students' attitude to Mathematics, $F(1, 202) = 6.847$, $P = 0.010 < 0.05$. Therefore, the null hypothesis was rejected meaning that there is a significant difference between the mean attitude scores of male and female students taught Mathematics using MII, CAI and those taught using DTI.
Hypothesis 3: There is no interaction effect of instructional approaches (MII, CAI, DTI) and gender on students' attitude towards Mathematics.
Data relating to hypothesis 3 is contained in Table 5. Table 5 shows that there is no significant interaction effect of instructional approaches and gender on students' attitude, $F(2, 202) = 0.492$, $P = 0.612 > 0.05$. Therefore, the null hypothesis was not rejected meaning that there is no interaction effect of instructional approaches (MII, CAI, DTI) and gender on students' attitude towards Mathematics.

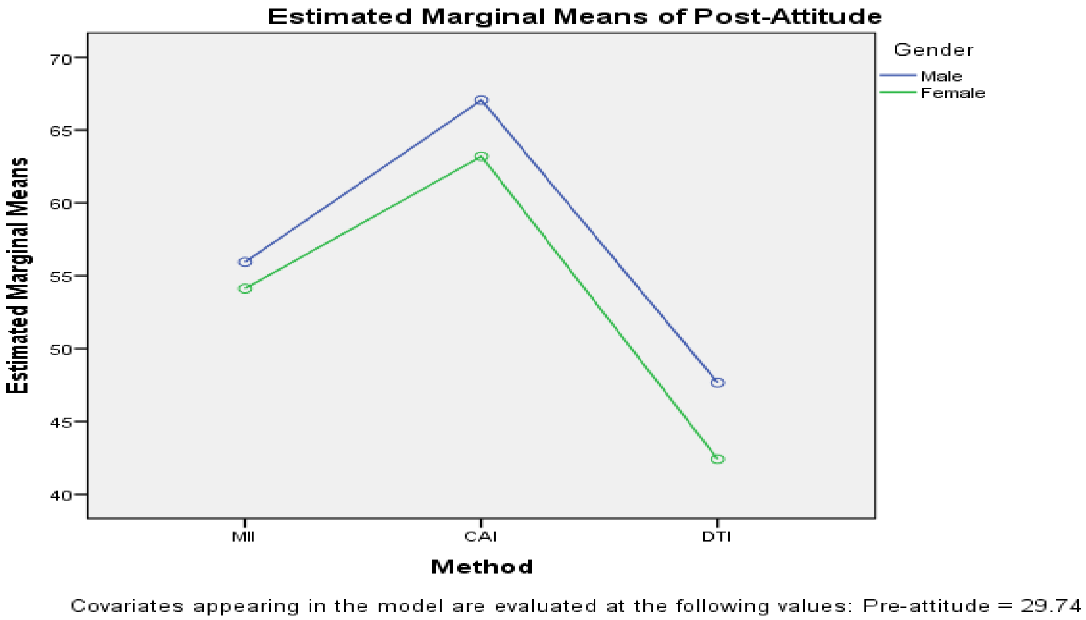

Figure 1: Plot of interaction between instructional methods and gender on students' attitude towards Mathematics

Figure 1 shows that the plot of interaction between instructional methods and gender on attitude towards Mathematics. The plot shows that there is an ordinal interaction between teaching methods and gender on attitude towards Mathematics meaning the instructional methods are gender biased as they improved only the attitude of male students more than female students towards mathematics.

Discussion

The study revealed that there was a significant difference in the mean attitude score of students taught mathematics using MII, CAI and DTI in favour of CAI. The observed finding of the study is attributed to the fact that the use of CAI enabled students to learn easily and faster through the multiple learning experience provided via video tutorials, animated text and simulated images. It thus, reduced the abstraction common with mathematical concepts leading to a consequent boost in students' attitude toward mathematics. Although, the teaching and learning of mathematics requires higher cognitive processes and materials, using CAI for teaching and with all its embedded features, students' perception of the subject was altered resulting in a higher change in attitude towards the subject than was observed among students in MII and DTI groups.

CAI takes on different forms and engages the learning meaningfully. These forms which are not common to the students compel the students to respond to these exciting ways of gaining knowledge and absorbing contents with better and positive attitude. Unlike MII which tasks the different intelligence of the learner and DTI which has higher level of boredom as the learning is centred around the teacher, students' boredom in CAI class was drastically reduced. This made learning very interesting. Again, given that they develop greater critical thinking abilities via the knowledge gained from the computer resources and application as well as the problem-solving skills, students' knowledge of the idea that they can extend the acquired skills in solution to other problems clearly improved their attitude giving them a more positive and favourable disposition towards mathematics as a subject.

The finding of the study supports the finding of Haluk (2008) that there was a significant difference in the posttest achievement scores of students taught chemistry in favour of CAI. The finding of the study lends credence to the finding of Gambari, Shittu, Falode and Adegunna (2016) that students taught algebra had significantly higher positive attitude than students in other groups. The finding of the study is in line with the findings of Tella and Faith (2017) that there was a significant main effect of treatment using two different forms of CAI on students' attitude to quadratic equations. Again, the findings of the study do not contradict the findings of Caleb (2017) that there was statistically significant difference in the post-test attitudinal mean scores of the experimental and the control groups in favour of the experimental group taught using CAI.

The study also revealed that there was a significant difference between the mean attitudinal scores of students taught mathematics using MII and DTI in favour of MII. Using the multiple-based instruction benefited the students more as lessons were customized as well as classroom layouts and assignment, all to the different intelligences of the learners. This approach allowed the teacher to provide the framework and tools that allowed students in the group to better have their needs met right in the classroom. When teachers meet the academic mathematical needs of the students, they perceived mathematics concepts not as difficult as they earlier held and this resulted in a more positive change in attitude than in DTI group. Students have varying levels of intelligence that can change over time and a range of skills and strengths and weaknesses. Tailoring instruction in their arrays of skills and strengths and abilities showed the students that they have something important to offer in every class situation and that the differences in abilities strengthens us as a whole. It thus, fostered better interaction among students in their different abilities leading not only to a better understanding of the concepts but correspondent improvement in positive attitude towards mathematics.

The use of MII gave students opportunity to learn holistically while developing different capacities and intelligences which instructions can further draw out and nurture in each student. Giving the students task in their levels of intelligence and more difficult tasks in their intelligences of strength gave them a sense of ability to solve mathematics problem. It also gave them the chance to discover and develop their different intelligences which benefited them also in fostering new abilities and becoming more active and involved learners. It enabled them to develop their capacity to recognize and most importantly value their individual strengths, guiding them into becoming confident, successful and accomplished students. The resultant effect was a higher and better attitude towards mathematics.

The finding of the study supports the finding of Gokhan (2010) that the multiple intelligences instruction strategy activities were more effective in the positive development of the students' attitudes. The finding of Habib, Ahmad, Zohreh and Saeed (2012) lends credence to the findings of the study that students taught based on MI theory exceeded the traditionally instructed students both in general and in each sub-skill of learning English (vocabulary, reading comprehension, and structure). The finding of the study contradicts the findings of Deniz and Hatice (2017) had no significant effect on students' attitudes towards force and motion topics.

Conclusion

The study concludes that CAI is effective for helping students develop a more positively high attitude towards mathematics and to reduce their fear for mathematics. The study also establishes that MII is a better instructional approach for enhancing students' attitude towards mathematics than direct teacher instruction.

Recommendations

1. Mathematics teacher should adopt the use of CAI in teaching and learning mathematics in order to reduce the abstraction associated with mathematics concepts and develop a more positive attitude in students towards the subject
2. Efforts should be made by mathematics teachers to present instructional contents at varied lines of intelligence possessed by students as a way of ensuring that lesson are cut across the dominant intelligences possessed by each students in the class.
3. Since the instructional methods are gender biased, as they improved the attitude of male students far more than female students towards mathematics, teachers of mathematics should tune more towards methods that are equally fair to both male and female students. This will help to improve attitude of both categories of students towards mathematics.

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