International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2009, Vol. 5, Issue 3, pp. 72-84

Accelerating quality delivery of the mathematics curriculum by re-tooling mathematics classrooms with only one computer

Peter Wintz
University of Guyana, Guyana

ABSTRACT

Computer technology has become an integral part of most educational landscape. In Guyana, like many developing countries, educators are cognizant of the benefits of the integration of computer technology but due to economic constraints have been unable to equip their mathematics classrooms adequately. Based on this reality, educators were introduced to the one computer classroom that is known to offer a cost-effective way to accelerate high quality delivery of the mathematics curriculum especially to students with average and below average mathematical ability. The main objective of the study was to examine the impact of computer aided instruction on students' performance. Eight student-teachers from eight secondary schools and 190 secondary school students were involved in the study. The findings revealed that the computer aided instruction did not only improve students' performance but their level of retention of knowledge was higher. However, females made more significant progress than the males following the computer aided instructions. The most striking result was that the experimental group with students who were below mathematical ability recorded the highest 'true' difference mean for both the post-test and the re-test.

Keywords*: one-computer classroom; cost-effective technology*

INTRODUCTION

Guyanese candidates' poor performance at Caribbean Examination Council (CXC) mathematics triggers the demand for a catalyst in mathematics classrooms. The CXC mathematics results are relatively poor when compared with other Caribbean territories and even worse when compared with the other thirty three (33) subjects offered in Guyana. Mathematics was the only subject from 2000 to 2006 that recorded less than 50% passes. The mean number of students passing with Grades 1-4 was 42.2% whereas, 24.7% was the mean number of students passing with acceptable Grades 1-3 (NCERD, 2006). Policy makers and school administrators need interventions which must target the quality of instruction in mathematics classroom. They responded with a distance education approach using the Interactive Radio Instruction (IRI) Mathematics Programmes at the grades one and two levels (which is broadcasted during school hours). It is imperative to enhance and provide flexibility in the learning environment. Incorporating computer technology as an instructional tool to empower students to keep pace with the information age provides a viable option.

There are various modes of technology used in the teaching and learning of Mathematics. Computer technology can reshape and enrich the learning environment in our mathematics classrooms. Nevertheless, there is need for policy makers not only to make quality education accessible to all through technology but to discover a cost effective way to accelerate high quality delivery of the mathematics curriculum. Computer technology has become an integral part of most educational landscape (Graham, 2003). However, like many developing countries, in particular Guyana, educators are cognizant of the benefits of such integration but due to

economic constraints have been unable to equip their mathematics classrooms with computer technology abundantly (Mohan & Greer, 2003).

Some schools in countries, like Canada and the United States, operate with *one-computer* classrooms (Chaika, 2003). Basically, to adapt a *one-computer* classroom*,* the computer monitor is replaced with a television monitor to facilitate showing computer images to the entire class but some computers may need a card installed to facilitate the connection. The computer and the necessary peripherals are usually placed on a roll-around cart (computer desk) to make it portable, which is usually carted into a secured room. In many schools in Guyana, teachers have access to at least one computer and a television. Unfortunately, only one school in Guyana capitalizes on the potential of the *one-computer classroom.* One contributing factor might be the lack of information or support. In order to assist teachers to incorporate the *one-computer classroom* approach, a study was developed to encourage teachers' use of computer technology and realize the benefits and challenges to better prepare themselves for its integration. The following questions were addressed in the study:

1. Is there any significant difference in performance between students who were exposed to computer-supported instruction and those who were exposed to the conventional mode of instruction?
2. Is there any significant difference in performance of females and males who were exposed to computer-aided instruction?
3. How does the performance of the students who were exposed to the computer- supported instruction compare with those who were exposed to the conventional mode of instruction in terms of: (a) groups, (b) type of school and (c) gender?
4. What are the factors affecting the implementation of the *one-computer* classroom?

A case for computer technology in the classroom

The possibilities of using computer technology to provide for a variety of learning styles in our classroom are enormous. Studies have shown that computer related tools, when used regularly in class bring positive effects on students' cognitive and attitudinal outcomes (Cotton, 1997; Godfrey, 2001; King, 1997; Newhouse, 1998). Students are provided with opportunities for enhancing understanding via real life images, appropriate sound and attractive text to allow interaction among learners and help with the construction of new knowledge. Scaplen (1999) outlines attractive presentation, opportunities to change one's presentation style, and the saving of lessons for future reference as some of the benefits of using computer technology in the classroom

A growing number of studies support the claims of the potential of technology to provide new kinds of instructional opportunities and to enhance the knowledge and learning experiences of both teachers and students (O'Connor, (1992) & Polin, (1991), cited in Fleming-McCormick, Nyre, , Schwager, and Tushnet, (1995)). When effectively integrated into curriculum, t echnology tools can extend learning in powerful ways (Hawkins, 1997). Problem-solving and critical thinking skills can be developed when the computer is used as a cognitive tool (Cathcart, Pothier, Vance & Bezuk, 2003) The use of technology may also help to address the cognitive, social, and motivational needs of "at risk" students (Kozma & Croninger, 1992).

Computer-based tools allow students to learn in a deeper and more immediate way. Technology plays an integral part in teaching and learning mathematics; it does not only influence the mathematics that is taught but activates students learning (NCTM, 2000). The magnetic appeal of the television monitor accounts for its high motivational value. " Motivation in a general sense is that which influences the arousal, selection, direction, and maintenance of all human behavior . . . Motivation is what stimulates students to acquire, transform, and use knowledge" (Groccia, 1992, p. 62). Children do not become bored by the technology. According to a USA-based Department

of Education (1995), students do not only become re-energized and highly motivated but grades are likely to improve significantly.

Technology brings into the classroom more interesting and diverse materials than ever before possible. There is scope for multi-sensory stimulation and fashioning authentic real-world content . Students' learning experiences can be enhanced through computer technology which provides additional enrichment and stimulaton (Posamentier & Stepelman, 2002). Nevertheless, teachers must be cognizance that although the computer technology can bring the global environment into the classroom students must continue to do mathematics beyond the walls of the school (Cangelosi, 2003).

THEORETICAL FRAMEWORK

Integrating technology into classroom instruction has been viewed as a key idea in current educational reform in many countries (Demetriadis, Barbas, Molohides, Palaigeorgious, Psillos, Vlahavas et al., 2003; van Braak, 2001). The effective use of technology in the classroom can help to shift the current pedagogical paradigm in various productive ways. Research reveals positive effects on teaching and learning when technology is used to its fullest potential (Mistretta, 2005). Many educational organizations are promoting the constructivist philosophy of learning and have recommended changes in the way mathematics is taught (Inch, 2002). Nevertheless, effective use of computers is likely to improve not only students' mathematical achievement but may improve the overall learning environment (Wenglinsky, 1998).

METHODOLOGY

This research followed a pre-test – post-test equivalent group design. In this quasi- experiment the entire pre-existing classes were randomly assigned as treatment and control (comparison) groups. The experimental groups received computer-supported instruction after the pre-test while the control groups received the standard conventional instruction treatment. The same post-test (re-test) was re-administered six weeks after the first administration to determine students' level of retention.

Participants-students

Initially, there were 232 students but only 190 students who completed the pre-test, post-test and the re-test were considered for the analysis. The age range of Grade 7 students was 10 – 13years and Grade 8 students were 12 – 14years old. Of the 190 students who participated in the study there were 93 males and 97 females.

Table 1: *The Sample*

Groups	Type of Secondary School								Total
	Junior *Grade 8*		Junior *Grade 7*		Senior *Grade 7*		Private *Grade 7*		
	M	F	M	F	M	F	M	F	
Control	16	5	12	13	13	13	12	12	96
Experimental	3	17	13	15	8	15	16	7	94
Total	19	22	25	28	21	28	28	19	190
	94				49		47		

As outlined in Table 1, the four junior schools accounted for 94 students. There were 44 males and 50 females. The academic status of the students ranged from average to below average. The 49 senior school students whose academic standard was mainly above average comprised of 21 males and 28 females. Twenty-eight males and 19 females accounted for the 47 students from the two private schools. The academic ability of these students ranged from below to above average.

Participants-teachers

Eight of the thirteen student-teachers, who were pursuing the post-graduate Diploma in Education, and taught mathematics at grades 7 or 8, participated in the study at their respective schools. Four student-teachers worked with the experimental groups and the other four student-teachers taught the control groups. The teachers who worked with the experimental group s were purposefully selected because they had easy access to a computer at their schools and three of them had relevant computer skills. All the student-teachers completed a course in Mathematics Pedagogy and at least one semester of practicum.

Table 2: *Teaching experience at present school*

Groups	Gender		Teaching status		Teaching experience			
	M	F	Part-time	Full-time	$\leq$ 2 yrs		> 2 yrs	
Control	1	3	1	3	2	50%	2	50%
Experimental	1	3	1	3	3	75%	1	25%

Table 2 shows that 50% and 25% of the teachers from the control group and experimental group respectively had more than two years teaching experience. In addition, 3 or 75% of the student-teachers from both the experimental group and control groups were full-time teachers.

Participating Schools

As outlined in Table 3, four schools were used as the experimental group and another four parallel schools were used as the control group. Eight schools representing the three types of secondary schools were used in the study. These were; two pairs of junior, one pair of senior and

one pair of private secondary schools. Discussion with officials from the Ministry of Education confirmed the equivalence of the parallel schools selected.

Table 3: *Schools in the Pre-test Post-test Design*

Groups	Type of Secondary School and content taught			
	Junior Grade 7	Junior Grade 7	Senior Grade 7	Private Grade 7
Control	Algebra	Algebra	Geometry	Measurement
Experimental	Algebra	Algebra	Geometry	Measurement

The selection of the control and the experimental schools was limited to the schools at which the student-teachers had practicum and the willingness of their school to participate in the study. Six Grade 7 and two Grade 8 classes were used in the study. Algebra was taught at the 4 junior schools, Geometry was taught at the two senior schools and Measurement at the 2 private schools.

Instrumentation

Three instruments were used in this study: two cognitive tests, a classroom observation checklist, and an interview schedule. In keeping with the pre-test – post-test equivalent group design, four 20-item multiple choice tests were prepared by the student-teachers after consultation between teachers from parallel schools. One test was used as the pre-test and a parallel test was used as the post-test. The same structure and methodology were used to prepare the pre-test and the post-test. The test content reflected the schemes of work of the four parallel schools and the cognitive levels of questions were *recall* (5), *comprehension* (10) and *problem solving* (5). The research team reviewed the tests to ensure that they were unbiased, well written and related to the Mathematics curriculum.

The post-test served as both the post-test and re-test. The re-test was administered six weeks after the post-test to examine the students' level of retention. It was believed that administering the same multiple choice test three rather than two times might have led to the contamination of the results. The STATA (9.2) statistical software was used to process a regression analysis on the *true* difference of both the post-test and re-test scores applying the robust standard error. The post-test minus the pre-test and the re-test minus the pre-test was used as the *true* difference. Fixed effect was used on schools to wipe out the differences in the levels of schools.

To address the fourth research question, "What are the factors affecting the implementation of the *one-computer* classroom?" An 8-item Classroom Observation Instrument was employed. The items focused on: (a) Planning: preparation and presentation; (b) Interaction: managing learning activities, and (c) Knowledge of subject matter. The participants were assessed on each item, reserving the highest scores for unusually effective performances. The scores were: Excellent (5), Good (4), Satisfactory (3), Unsatisfactory (2), and Poor (1). The mean score of the three Observations for each item was computed and treated as the participant's regular practice in his or her classroom. The column on the Observation Form labeled Comments was used to record striking observations and highlights for the Feedback Conference with the student-teacher.

An interview schedule was prepared by the three researchers to address the fourth research question. It was administered at the end of the treatment to the four teachers who taught the experimental groups. The 10-item instrument was intended to capture those factors, within and outside the classroom, affecting the implementation of the *one- computer* classroom.

Procedure

The student-teachers of the four control and experimental groups coordinated their work plan which reflected their scheme of work for 10 to 12 lessons. The three researchers guided the student-teachers through the planning, presentation and evaluation stages of their classroom practice via classroom visit, telephone conversation and e-mail.

All lessons were conducted as time-tabled by the participating school. The pedagogy employed by the four teachers of the experimental group was aided by the use of a television as a computer monitor. These teachers provided clear attractive power-point presentations with appropriate pictures and diagrams. Solutions to homework and class work were also projected on the monitor to maximize class time. Both the monitor and chalkboard were used as instructional tools. However, the control groups did not have access to the computer technology and employed the standard conventional mode of instruction.

The eight student-teachers from the eight participating schools worked in pairs (one control and one experimental) to map out the mathematics content for the project. The four sets of content guided the construction of the pre-test which was administered to the four pairs of control and experimental groups before the teaching commenced. The six student-teacher researchers from the public schools taught twelve mathematics lessons while the two from the private schools had ten lessons. Four sets of content [Table 3] were taught to the four pairs of parallel classes but the experimental group received instruction using computer technology.

The post-tests were administered within one week after the teaching sessions and re-administered six weeks later. The students were unaware that the same post-test would have been re-administered and no revision of the content was done by the teachers. The researchers acted as moderators for the pre-test, post-test and the re-test.

There was an initial visit to each of the eight schools to formalize the school's participation with the project. Permission to conduct the research was granted by both the Ministry of Education and the Head teachers of participating schools. All the participants were willing to participate in the project. In addition, all the necessary hardware (video card), software and cables were supplied and installed at the four experimental schools. One of the schools used a laptop and the other three schools used desk top computers.

A supervisor was assigned to each student-teacher. The student-teachers were guided through the planning, presentation and evaluation stages by the three researchers. Each student-teacher had at least three school visits. During the classroom observations, factors affecting the implementation of *one-computer* technology in mathematics classroom were recorded.

In addition, after the teaching and testing period, a focus group interview on the factors influencing the implementation of one-computer technology in mathematics classroom was conducted with the four student-teachers who worked with the experimental groups.

FINDINGS AND ANALYSIS

Basically, the impact of computer aided instruction on students' performance and factors affecting the implementation of one-computer technology in mathematics classroom were examined in this study. The first two questions addressed Differentials in Performance with and without the One-Computer Technology. The third question dealt with Differential Performances among Groups, Schools, and Gender and the fourth question focused on Affects on the O *ne-Computer* Classroom.

Differentials in Performance with and without the One-Computer Technology

The results of the regression model, presented in Table 4, addressed the research questions: (1) Is there any significant difference in performance between students who were exposed to computer-supported instruction and those who were exposed to the conventional mode of instruction? and (2) Is there any significant difference in performance of females and males who were exposed to computer aided instruction?

Table 4: *Group and p-value*

Group	Experimental vs. control	Male (Experimental)	Female (Experimental)
p-value	0.011	0.082	0.040

There was a significant difference in the students' overall performance. In other words, the performance of the experimental group was significantly better than the control group with a p-value of 0.011 at the 5% conventional level. Instructional technology can enhance student performance. The high level of motivation generated by the computer via real-life images, attractive graphics and text resulted in effective learning.

However, the females recorded significant results at the conventional level of 5% but the result of their male counterparts was only significant at the 10% level. The visual simulation created by the computer probably had a greater impact on the females than males.

Differential Performances among Groups, Schools, and Gender

The third research question was "How does the performance of the students who were exposed to the computer technology compare with those who were exposed to the conventional mode of teaching in terms of: (a) groups, (b) type of schools and (c) gender?" The analysis that follows gives a description of students by whole group, schools, experimental and control groups and gender.

Table 5: *Overall performance by group*

Group	Size	Maximum Gain (%)		Mean True difference			Standard Deviation	
		Pre-test	Re-test	Pre-test	Re-test	%	Pre-test	Re-test
Both	190	55	60	10.27	8.18	79.64	16.33	16.01
Control	96	55	50	7.30	4.3	58.90	16.28	14.91
Experimental	94	55	60	13.30	12.13	91.20	15.92	16.25

Firstly, Table 5 shows the overall performance by group. The score in all categories recorded showed a relatively high degree of dispersion around the mean. The maximum gain over the pre-test ranged from 50% to 60% but the control group recorded the lowest range. Likewise, the control group recorded the lowest mean of the true difference at less than 60% retention rate when compared with a retention rate of more than 90% for the experimental group. The findings revealed that the computer-aided instruction did not only improve students' performance but their level of retention of knowledge was higher.

Table 6: *Overall performance by type of school*

Type of School	Size	Maximum Gain (%)		Mean True Difference			Standard Deviation	
		Pre-test	Re-test	Pre-test	Re-test	%	Pre-test	Re-test
All	190	55	60	10.27	8.18	79.64	16.33	16.01
Junior	94	40	45	12.66	9.15	72.27	16.03	15.15
Senior	49	55	50	10.30	12.04	116.89	14.19	13.77
Private	47	55	60	5.44	2.24	41.17	18.22	18.38

Secondly, Table 6 shows the overall performance by type of school. The senior schools showed a very high level of retention and a better spread of the scores. The junior schools recorded the lowest maximum gain at both the post-test and the re-test. Nevertheless, the junior schools recorded the highest mean of the true difference and the retention level of 72.2% was significantly better than the private schools, which was 41.17%. Students with relatively lower academic ability benefited the most in terms of gains in mathematics performance.

Table 7: *Experimental (E) versus Control (C) by Type of School*

Groups		Size	Maximum Gain (%)		Mean True Difference			Standard Deviation	
			Pre-test	Re-test	Pre-test	Re-test	%	Pre-test	Re-test
Junior	C	46	40	35	8.92	3.04	34.08	16.23	14.63
	E	48	40	45	16.25	15	92.30	15.1	13.33
Senior	C	26	55	50	11.73	13.46	114.74	16.55	14.95
	E	23	30	30	8.70	10.44	120	11.10	12.42
Private	C	24	25	15	-0.58	-3.125	-	13.68	10.09
	E	23	55	60	11.74	7.82	66.6	20.42	23.15

In addition, as presented in Table 7, the senior school's experimental group recorded the highest retention level and the best spread of scores but, unlike the junior and private schools, the control group performed better than the experimental group. The senior school control group probably did better than the experimental group because, unlike the experimental group, they were exposed to similar concepts in Geometry during their Technical Drawing classes during the conduct of the study. Reinforcement usually enhances learning.

The most striking result was that the junior school's experimental group recorded the highest true difference mean for both the post-test and the re-test. This strongly indicates that the computer-aided instruction had a positive impact on student performance. In contrast, when compared with the experimental group, the control group recorded a true difference mean of only half that of the post-test and one-fifth of the re-test.

The private schools had students with the broadest range of academic ability. The mean true difference of both the post-test and re-test of the control group indicated that many students performed the same or worse than the pre-test. This unusual situation was probably due to the fact that the teachers did not capitalize on students high pre-test scores. These teachers were apparently overwhelmed by the students' previous knowledge of area and perimeter and did little to encourage their students to think mathematically to extend their knowledge. Nonetheless, the experimental group had a higher true difference mean than the senior school but their level of retention was the lowest.

Table 8: *Experimental (E) versus Control (C) by Gender*

Groups		Size	Maximum Gain (%)		Mean True Difference			Standard Deviation	
			Pre-test	Re-test	Pre-test	Re-test	%	Pre-test	Re-test
Male	A	93	55	60	10.23	6.67	64.51	17.07	17.12
	C	53	55	50	8.32	4.25	51.08	16.45	15.43
	E	40	55	60	12.75	9.88	77.49	17.76	18.86
Female	A	97	45	45	10.30	9.64	93.59	15.69	14.81
	C	43	35	45	6.05	4.42	73.06	16.17	14.44
	E	54	45	45	13.71	13.80	100	14.58	13.87

Finally, Table 8 shows the overall performance by gender. The females recorded a lesser maximum gain in performance but the highest retention level and true difference for both the post-test and re-test. Also, their spread of scores was more homogenous than the males. Further examination of the females' experimental group revealed that the retention level of the female was 100% compared with 77.49% of the males. The impact of the one-computer classroom favoured the females much more than the males.

On the other hand, the poor performance of the females in the control group was similar to their male counterpart. The mean true difference for the female control group re-test was only about 30% of what experimented group recorded.

Affects on the O*ne-Computer* Classroom

Data to respond to the fourth research question "What are the factors affecting the implementation of the *one-computer* classroom?" was collected via classroom observations and teachers' interview.

Teachers' interview

The four student-teachers who conducted the *one-computer* classroom reflected on their general experience and highlighted some factors that affected their *one-computer* classroom.

Seventy-five percent of the teachers believed that the computer aided instruction helped the majority of weak students improve their performance. All the teachers reported that their students were eager to learn, highly motivated and were actively involved during the lessons. Consequently, the retention of the content learned lasted longer.

All the student-teachers reported strong support from their Head Teachers but experienced non-cooperation from some members of the senior staff. The student-teachers linked the non-cooperation to lack of vision by members of the school boards in terms of technological innovations. They lamented on the need to train teachers to adopt the *one-computer* classroom.

Some physical problems were also identified. Two student-teachers expressed the need to have better seating arrangements to ensure that every student gets the best vantage point to view the television monitor. There was also the problem transporting the computer and television to the classroom, especially in multi-storey buildings, without the aid of a trolley.

Classroom observation

Unlike the *one-computer* classroom which generated a high level of motivation, most of the lessons with the control groups lacked enthusiasm. Teachers were unable to generate and sustain students' enthusiasm in the classroom although they were engaged in task related activities.

The teachers who worked with the experimental group showed stronger evidence of planning and preparation. The teachers in the *one-computer* classroom were free from excessive writing on chalkboard which resulted in more time for essential teachers' activities such as monitoring students' work and marking books.

The conduct of the *one-computer* classroom was not without problems. Teachers were uncomfortable with the time spent preparing the power point presentations. The lack of this type of teaching experience resulted in some teachers loading too much information on one slide and showing some discomfort in effectively managing the level of classroom discourse created by the students' high level of motivation.

RECOMMENDATIONS

Computer technology is part of the educational landscape. The *one-computer* classroom offers a cost-effective way to accelerate high quality delivery of the mathematics curriculum especially to students with average and below average mathematical ability. The following recommendations should be considered in the implementation of the *one-computer* classroom.

1. Computers should be an important part of classroom instruction. Policy makers and educators should embrace the introduction of the *one-computer* classroom in mathematics classroom.
2. Mathematics teachers should work more as mentors and less as presenters of information.
3. The *one-computer* approach to teaching should be included in all methodology courses at the University of Guyana.
4. There should be an active role of the schools' administration in the implementation of the *one-computer* classroom. Teachers, mathematics teachers in particular, must have easy access to the television and computer.

5. In addition to initial training sessions using computer technology as a cognitive tool, teacher training in the use of computer technology and technical support should be easily accessible.
6. A wider cross-section of mathematics topics in a larger sample of schools should be explored with the use of the one-computer classroom.

CONCLUSION

Mathematics teachers need to find new ways of gaining students' enthusiasm and their effectiveness in mathematics classrooms if they are to enhance students' performance in mathematics. The results showed that computer supported instruction had a positive impact on student performance in mathematics. Using the *one-computer* technology in mathematics teaching helped teachers motivate most of their students to learn mathematics.

Mathematics should help children make sense of the world around them and find meaning in the physical world. Using computers have not only expanded the horizon of instruction in the classroom and helped students in becoming confident active real-world learners but it helped with the retention of concepts. We know that mathematics learning takes place in the mind. The longer the images stay in the mind the easier for the learner to process mathematical ideas.

Special attention should be given to the fact that females made more significant progress than the males following the computer-aided instructions and further research and investigation could look at why some students made extremely rapid progress while others did not.

Initially, some school administrators failed to see the need for their teachers to use technology in the classroom. Their confidence level towards the use of technology in the classroom increased with formal training. Nonetheless, teachers' beliefs and values must be shaped if they are to adjust their instructional practices to include the use of computers as a cognitive tool.

Reflection on the fact that all the participants were post graduate students, we share the view that higher education can serve as a catalyst towards effective use of instructional technology (Mistretta, 2005). Computer technology is not only the fashion but we live in a highly developed technological environment and teachers will be forced at some point to utilize technology in the classroom. However, the technology cannot substitute poor quality teaching and lack of content knowledge. It only supplements what takes place in the classroom.

REFERENCES

Becker, H.J. (2000). Proceedings from American Educational Research Association. *Secondary Teachers of Mixed Academic Subjects: "Out-of-Field" Problem or Constructivist Innovators.* Retrieved January 30, 2007, from http://www.crito.uci.edu/tlc/findings/aera/out-of-field

Cangelosi, J.S. (2003). *Teaching Mathematics in Secondary and Middle School* . (3rd Ed.). New Jersey: Pearson Education, Inc.

Cathcart, W. G., Pothier, Y. M. ,Vance, J.H., Bezuk, S. N. (2003). *Learning Mathematics in Elementary and Middle School*. (3rd Ed.) New Jersey: Pearson Education, Inc.

Chaika, G. (2003). How to thrive-not just survve in a one-computer classroom. Education World Retrieved, December 23, 2008, from http://www.educationworld.com/a_tech/tech/tech092.shtml

Cotton, K. (1997). Computer-Assisted Instruction. School Improvement Research Series (SIRS).

Demetriadis, S., Barbas, A., Molohides, A., Palaigeorgious, G., Psillos, D., Vlahavas, I., et al. (2003). "Culture in negotiation": Teachers' acceptance/resistance attitudes considering the infusion of technology into schools. *Computers and Education*, 41, 19–37

Department of Education (1995). Technology's Impact on Learning. Retrieved March 10, 2007, from http://www.nsba.org/sbot/toolkit/tiol.html

Fleming-McCormick, T., Nyre, G., Schwager, M. and Tushnet, N. (1995). *District Response to the Demonstration: The Practice of Technology.* San Francisco, CA: Far West Lab. For Educational Research and Development. (ERIC -NO- ED388311)

Fulton, K., & Torney-Purta, J. (2000). Proceedings from *How teachers beliefs about teaching and learning are reflected in their use of technology: Case studies from urban middle schools* . Paper presented at the International Conference on Learning with Technology, Temple University, Philadelphia, Pennsylvania. Retrieved December 20, 2006, from http://l2l.org/iclt/2000/papers/126a.pdf

Godfrey, C. (2001). Computers in school: Changing technologies. *Australian Educational Computing*, 16(2), 14-17.

Graham. R. J (2003). Online IT training for school administrator. *Academic Exchange Quartely* Retrieved, December 20, 2008, from http://findarticles.com/p/articles/mi_hb3325/is_/ai_n29051782

Groccia, J. E. (1992). *The college success book: A whole-student approach to academic excellence.* Lakewood, CO: Glenbridge Publishing Ltd

Hawkins, J. (1997). The World at Your Finger Tips. Retrieved February 28, 2006, from http://www.edutopia.org/node/307

Inch, S. (2002). The accidental constructivist: a mathematician's discovery. *College Teaching*, 50 (3), 111-113.

King, T. (1997) *Technology in the classroom: A collection of articles* . Australia: Hawker Bronlow Education.

Kozma, R. & Chroninger, R., (1992). Technology and the fate of at-risks students. *Education and Urban Society* 24(4), 440-453.

Mistretta R., (2005). Integrating technology into the mathematics classroom: The role of the teacher preparation programs. *The Mathematics Educator* ,(15)1, 18–24

Mohan, P. & Greer, J.(2003). Using learning object technology to tackle the education challenges of the Caribbean. *International Conference on Information Technology: Research and Education, 2003. Proceedings* . ITRE2003.Volume , Issue , 11-13 Aug. 2003, pp 484 – 488.

Retrieved, December23, 2008 from http://ieeexplore.ieee.org/Xplore/login.jsp?url=/iel5/8953/28360/01270665.pdf?arnumber=1270665

National Centre for Educational Resources and Development, (2006). *Analysis of Caribbean Examination Council Results 2000-200*6. Material Production Unit, NCERD

National Council of Teachers of Mathematics, Commission on Standards for School Mathematics. (2000) Curriculum and Evaluation for School Mathematics. Reston, VA: The Council.

National Council of Teachers of Mathematics. (2000).Principles and Standards for School Mathematics. Reston, VA: NCTM.

Newhouse, P. (1998). The impact of portable computers on classroom learning environments. *The Australian Journal of Educational Computing,* 13(1), 5-11.

O'Connor, B. (1992). Planning for the technology-rich learning environments of the future. In learning technologies essential for education change. Washington, DC: Council of Chief State School Officers.

Polin, L.G. (1991, April). Changing schools from the inside out: Observations of classrooms in transition. Paper presented at the annual meeting of American Educational Research Association, Boston.

Posamentier, A.S. & Stepelman, J. (2003). *Teaching Secondary Mathematics: Techniques and Enrichment Units*.(6th Ed.). New Jersey: Pearson Education, Inc.

Scaplen J. (1999). *Integrating technology in the classroom.* Retrieved, September 23, 2006, from http://www.stemnet.nf.ca/~/scaplen/integration/english//oceng.html

van Braak, J. (2001). Factors influencing the use of computer mediated communication by teachers in secondary schools. *Computers and Education*, 36,41Y57.

Wenglinsky, H. (1998). Does it compute? The relationship between educational technology and student achievement in mathematics. Princeton, NJ: Educational Testing Service. Retrieved, September 23, 2008, from http://www.ets.org/Media/Research/pdf/PICTECHNOLOG.pdf

Original article at: http://ijedict.dec.uwi.edu//viewarticle.php?id=678