OPPORTUNITIES FOR THE USE OF COMPUTER-ASSISTED INSTRUCTION IN ENHANCING THE QUALITY AND COVERAGE OF EDUCATION DELIVERY IN GUYANA AT THE GENERAL SECONDARY SCHOOL LEVEL

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Abstract: The main thesis of this paper is that Information and Communication Technologies (ICTs) hold tremendous opportunities for enhancing the quality and coverage of public goods in developing countries. Within this context, the paper examines, through a SWOT analysis, the opportunity for using Computer-Assisted Instruction (CAI) to enhance the quality and coverage of education delivery in Guyana at the General Secondary School (GSS) level. Its main conclusion in this regard, is that through the use of CAI, the negative effects which the shortages of trained teachers have on the quality of education delivery at the GSS level, can be reduced if not eliminated. Noteworthy, CAI can be used to support Conventional Teacher-Centered Instruction (CTCI). In addition, it can serve to reduce urban-rural inequality in terms of access to quality secondary education. The paper considers, however, that these opportunities must be predicated on an understanding of the characteristic weaknesses of the education system and the related possible threats to effective application of ICT to education delivery. Of import are the informal dynamics that inter-play in the use of certain ICT in schools, namely computers; the risk of erosion of local educational materials and tools for learning given current indigenous capacity weaknesses and the increased marketability of trained teachers for the foreign market where the application of ICT to learning occurs on a higher level. However, this paper suggests that with prudent policy approaches, the weaknesses can be overcome, the threats can be minimised and therefore the opportunities can be accomplished. In this regard, this paper concludes with policy recommendations.

Keywords: *Universal Primary Education; Universal Secondary Education; Information Communication Technologies (ICTs); General Secondary Schools; Computer-Assisted Instruction; conventional teacher-centered mode teacher-centered; student-centered.*

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INTRODUCTION

Having moved closer towards achieving Millennium Development Goal (MDG) 2 – Universal Primary Education (UPE), the Government of Guyana (GOG), in 2003, embarked on a policy of delivering Universal Secondary Education (USE) (MOE, 2008). This was, seemingly, in recognition that poor access to secondary education can serve to reverse the accomplishment of UPE. Lavy (1996) found that improving access to secondary education in Ghana, did not only improve enrollment at the secondary level but also incentivized the completion of primary school. Similarly, Clemens (2004, p.19) observes that "no country today has achieved over 90% primary net enrollment without having at least roughly 35% secondary net enrollment".

As reflected in the 2008–2013 Ministry of Education Strategic Plan (MOESP), USE for Guyana seems to be an issue more of quality than access. The strategy is therefore focused on amalgamating lower secondary schools, which followed a different programme, deemed to be lower in quality, into General Secondary Schools (GSSs)[1] (MOE op. cit.). As a result, all secondary students would be able to present themselves for the Caribbean Secondary Education Certificate (CSEC)[2] or an alternative competency-based certificate (ibid).

As reflected also in the 2008–2013 MOESP, good student performance – grades 1 to 3 proficiency – at the CSEC examination is indicative of the delivery of a good quality of secondary education. This is not an implausible measurement. It is within that context, however, that the delivery of USE seems daunting and unachievable.

Student performance at the CSEC examination in core subject areas – English A, Mathematics, Biology, Chemistry, and Physics – remains very poor by the MOESP's measurement (ibid.). This is attributed to, among other factors, the continuous shortages of trained teachers and the resorting to untrained teachers which results in poor quality of secondary education delivery (ibid.). The shortages of trained secondary teachers seem to be a permanent feature in Guyana. Every year, Guyana loses, to foreign education providers, a significant portion of its trained secondary teachers before the age of retirement (ibid.). In fact, for many developing countries, secondary trained teachers are the hardest segment for the teaching profession to attract and most difficult to retain (World Bank, 2005).

According to 'anecdotal evidence ... better salary options are a major reason' for the migration of trained secondary teachers from Guyana (MOE op. cit.). And sadly, 'Guyana in the near future' will not be able to 'compete with salaries offered outside of the country' (ibid.). Sad as the situation may be, however, retreating from the delivery of USE cannot be an option, for it has implications for the sustainable accomplishment of UPE. This makes imperative the need for finding ways by which the quality of secondary education delivery, insofar as it is negatively affected by the continuous shortages of trained teachers, can be enhanced.

One such way can be the use of Information and Communication Technologies (ICTs). Owing to the fact that information and communication are at the very center of education delivery (Blurton, 1999), then ICT can be used to support conventional teacher-centered mode of education delivery. ICT are a diverse set of technological tools and resources used to create, store, communicate, display, and manage information by electronic means (UNESCO, 2007). They include such technologies as radio, television, video, DVD, telephone (both fixed line and mobile phones), satellite systems, and computer and network hardware and software, as

well as the equipment and services associated with these technologies, such as videoconferencing, e-mail and blogs (ibid.). Having recognised the successes that are related to use of computer-assisted instruction (CAI) in support of conventional teacher-centered instruction (CTCI) at the secondary school level, this paper examines, through a SWOT[3] analysis, the opportunity for similar occurrences at the GSS level in Guyana.

Towards that end, the remainder of this paper is structured as follows: Section 2, offers an analysis on the continuous poor student performance in core subject areas at the CXC/CSEC examination; Section 3 provides an analysis on the continuous shortages of trained secondary teachers; Section 4 examines the successful uses of CAI in support of CTCI at the secondary school level; Section 5 focuses on the opportunity for CAI in support of CTCI at the GSS level in Guyana; Section 6 examines potential risks and challenges that can stultify effective use of CAI in support of CTCI at the GSS level in Guyana; and Section 5 concludes with recommendations.

CONTINUOUS POOR STUDENT PERFORMANCE IN CORE SUBJECT AREAS AT THE CXC/CSEC EXAMINATIONS

Poor student performance at the CXC/CSEC examination in core subject areas continues to haunt secondary education delivery in Guyana. Table 1 shows that for the period 2001–2007, the mean percentage of grades 1–3 passes was 39.1, 53.8, 47.1, 48.8, and 24.8, for English A, Biology, Chemistry, Physics, and Mathematics, respectively.

Moreover, of the aforementioned subject disciplines, only Biology recorded an average above 50% passes in grades 1–3 for the period 2001–2007, with Mathematics recording alarmingly below 25%. Finally, there was a disparity in the performances between students of urban and rural GSS, with the latter having much lower averages

Table 1 Percentage of Grades 1–3 for Core Subjects at the CXC/CSEC (General and Technical) Proficiency Levels (2001–2007)

Key subjects	2001	2002	2003	2004	2005	2006	2007	Avg.
ENGLISH A	36.1	34.5	37.4	33.2	53.2	39.5	40.1	39.1
BIOLOGY	41.2	43.2	52.3	52.3	61.5	63.4	62.9	53.8
CHEMISTRY	31.4	43.6	52.5	39.2	58.4	50	54.8	47.1
INFO. TECHNOLOGY	96.7	56.3	60.7	51.1	58.5	78.1	63.5	66.4
INFO. TECHNOLOGY*	NA	NA	NA	NA	64.8	57.5	72	64.8
AGRI. SCIENCE (DA)**	70	71.4	75.3	86.3	85.3	90.8	83.2	80.3
INTE. SCIENCE	83.3	72.7	70.6	78.7	79.9	79.3	81.4	78
PHYSICS	42.9	57	52.2	56	55.5	43.2	34.8	48.8
MATHEMATICS	19.6	23.1	24.9	25.7	31.5	25.2	23.9	24.8

Source: Authors' own calculation using data from the MOE's Digest of Education Statistics

*Technical Proficiency.

**Double Award.

in subject areas such as Mathematics and English A (MOE, op. cit.). Finally, as Table 4 has shown, for the subject disciplines mentioned above, only Biology recorded an average above 50% passes in grades 1–3 for the period 2001–2007, with Mathematics recording alarmingly below 25%.

CONTINUOUS SHORTAGES OF TRAINED SECONDARY TEACHERS

Notwithstanding, all the efforts by the Ministry of Education (MOE) to ensure that secondary education delivery have the required number of trained teachers (ibid.), significant shortages seems to be a permanent feature. Between academic years 2000/2001 to 2007/2008, the mean number of secondary trained teachers in urban GSS was 735 as compared to 580 for untrained (see Table 2). Thus, out of an average of 1,315 secondary teachers in urban GSS, 44% were untrained. A similar situation existed for rural GSS where the mean number of trained secondary teachers was 660 as compared to 454 for untrained (see Table 2). Therefore, out of an average of 1,114 secondary teachers in rural GSS, 41% were untrained.

As shown also in Table 2, the mean student/trained teacher ratio for urban GSS was 32:1 as compared to 34:1 for rural GSS. In the case of student/untrained teacher ratio, the mean was 41:1 for urban GSS and 49:1 for rural GSS. Noticeable, is an imbalance between the mean student/trained teacher ratios for urban and rural GSS, with rural GSS having more students per trained teacher. In addition, there is a stark difference between the mean student/trained teacher ratio obtained in GSS and the target of 27:1, which was set by the GOG since 2001 (GOG, 2001).

SUCCESSFUL USES OF CAI IN SUPPORT OF CTCI AT THE SECONDARY SCHOOL LEVEL

The dramatic increase in the capability and affordability of personal computers has influenced an increase in the development and use of various forms of computer-delivered instruction (Brown, 2001). CAI, which is among the various forms, is a method of instruction in which the computer is used to instruct the student and where the computer

Table 2 No. of Students and Teachers as per Academic Year (AY) and Urban-Rural Divide

AY	Urban					Rural				
	A	B	C	D	E	A	B	C	D	E
2000/2001	22,146	689	538	–	–	21,380	559	428	–	–
2001/2002	21,821	724	627	–	–	22,052	672	478	–	–
2002/2003	21,954	778	630	–	–	21,006	666	482	–	–
2003/2004	23,781	739	654	–	–	22,368	673	475	–	–
2004/2005	24,061	731	625	–	–	20,924	620	452	–	–
2005/2006	24,789	741	559	–	–	22,770	646	436	–	–
2006/2007	24,929	643	539	–	–	22,879	802	449	–	–
2007/2008	24,540	833	465	–	–	23,286	645	433	–	–
Average	23,503	735	580	32:1	41:1	22,083	660	454	34:1	49:1

Source: Authors' own calculation using data from MOE's Annual Digest of Education Statistics

Note: A = No. of Students; B = No. of Trained Teachers; C = Number of Untrained Teachers; D = Student/trained teacher ratio; and E = Student/untrained teacher ratio

contains the instruction which is designed to teach, guide, and test the student until a desired level of proficiency is attained (AECT, 1977). Studies have shown that secondary school students who were in receipt of CAI, showed improved performances in Mathematics (Kulik et al., 1983; Roberts and Madhere, 1990), Science (Brophy, 1999; Kulik et al., op. cit.; Tabassum, 2004), and Reading and Comprehension (Dunn, 2002; Hall et al., 2000; Lynch et al., 2000). Condie et al. (2007) also provide evidence regarding the positive effects of computer-delivered instruction on student performance in other subject areas.

Through its multimedia capabilities, computer-delivered instruction can enhance learners capacity to understand concepts that they previously could not grasp (ibid.). With a full range of media, it complements text and static images, by combining audio, video, and animation that provide learners with a richer learning environment that can provide greater support and develop deeper understanding (Selinger, 2008). Explaining concepts to students through text and static images in a book can cause difficulties particularly when the concepts are dynamic (Haddad and Jurich, 2002). Some computer simulations allow variables to be changed so that students can understand cause and effect relations and the need to sometimes control variables in experiments (Ibid.). Understanding can also be greatly enhanced with multimedia models of concepts that are too fast or too tiny to be observed with the naked eyes such as cell growth or a chemical reaction (Selinger op. cit.).

CAI can be accessed on site or from a distance, using the internet (Tabassum op. cit.), and therefore students are not bound by time and place, and certainly not by the school day. Therefore, with regards to secondary education delivery at the GSS level in Guyana, the use of CAI provides an opportunity not only for enhancing quality but also efficiency. It provides also an opportunity to reduce rural-urban inequality and exclusion in terms access to quality secondary education. With access to CAI, students in rural GSS, owing to the fact that trained teachers are less inclined to live and work in rural communities (MOE op. cit), will not be at any huge disadvantage, in terms of the quality of education delivery, relative to those in urban GSS. Moreover, students who cannot attend formal secondary schools due to financial, geographical, cultural or social reasons will not be excluded from the delivery of secondary education.

The intent in the use of CAI, however, is not to replace but to support CTCI. It is in this way that it is most effective (Kulik and Bangert-Drowns, 1983). The role of the teacher, however, changes from that of an instructor and sole possessor of knowledge of the subject area to that of a facilitator or guide of what is being delivered (Tabassum op. cit.). Therefore, as teaching becomes student-centered (Trucano, 2005; UNESCO, 2008), a single trained teacher is able to attend effectively to more students. Thereby, the negative effect which the shortages of trained teachers have on the quality of education delivery are reduced if not eliminated.

CAI IN CONTEXT: THE NATIONAL ICT4D STRATEGY AND THE MOESP (2008–2013)

The use of CAI in support of CTCI at the GSS level in Guyana is an idea that falls within the context of the GOG's policy decisions that are enshrined in the National ICT4D Strategy (GOG, 2006), and the 2008–2013 MOESP.

The National ICT4D Strategy

The National ICT4D Strategy is geared towards harnessing ICT to accelerate the socio-economic development of Guyana

(ICT4D 2006). Its specific objectives include but are not limited to:

1 improving the delivery of, and access by all citizens to educational services
2 ensuring access to reliable ICT at the lowest sustainable prices
3 developing and implementing the necessary policies, laws and regulations that support the sustainable development of the ICT sector
4 supporting initiatives to encourage innovation and creation in the ICT sector (ibid.).

Towards this end a new Telecommunication Act was passed to establish the legal framework for fostering the growth and development of the ICT sector (GINA, 2010). And the procurement process for the infrastructure to facilitate the landing of a fiber optic cable from Brazil has commenced (Coward, 2010). This will complement the recently landed Suriname-Guyana Submarine Cable System by the Guyana Telephone and Telegraph (GT&T) Company (ibid.).

The 2008–2013 MOESP

In the 2008–2013 MOESP, the GOG regarded the use of ICT as 'a major supportive tool in the teaching and learning process' (MOE op. cit.). And as a result several objectives were set to be achieved by 2013. They are: (1) The establishment of a computer laboratory with internet connectivity in all GSS, (2) The training of all secondary teachers in the use of computers for teaching and learning and (3) the training of teachers and staff of the MOE in the development of e-learning courses (ibid.).

Towards this end, the GOG, with assistance from the Organization of American States (OAS), implemented a 'Computers for Secondary Schools' pilot project (ibid.). The project resulted in the placement of around 500 refurbished computers into secondary schools and the setting up of a Computer Refurbishing Centre at the Government Technical Institute (GTI) (ibid.). A similar project, 'SchoolNet Guyana', was also implemented in partnership with Global Partnership for Literacy (GPL). The project, which has five major elements, is aimed at integrating ICT in approximately 120 GSS across Guyana (GPL, 2010). Its major elements are:

1 *System-wide ICT infrastructure:* a computer lab and internet access for each school with opportunities for collaboration and sharing of information.
2 *Professional development:* ICT training for teachers.
3 *Curriculum development:* technical assistance to the MOE for the incorporation of ICT into the curricula.
4 *Digital content:* aid with the development and access of online information on Guyana.
5 *ICT dissemination:* programs to enhance the use of ICT outside of the classroom, e.g., distance learning, after school programs, literacy programs, etc. (ibid.).

ISSUES AND CONSIDERATIONS FOR CAI

The path from opportunity to realisation will neither be easy nor automated, but rather challenging and risky. Several characterising weaknesses of the education sector have the potential to stultify effective adoption of CAI. Further, new methods always bring risks of making extinct old but valuable approaches. In essence, there is a

trade off with respect to new technologies for education delivery and old approaches that have governed the system for decades. Understanding this trade off is important to balancing the costs and anticipated benefits of the application of ICT to education delivery in Guyana. The first sub-section addresses challenges while the second addresses important risks that must be duly considered.

Challenges to the adoption of CAI

Challenges can be broadly characterised as:

Infrastructural

In the education sector, there is paucity in access to and use ICT resources-no functioning computer laboratories, poor internet connectivity, limited access to telephones, etc. (MOE, 2009). This is symptomatic of limited access to ICT services by the general populace, which is constrained by the nature of the ownership of the infrastructure[4] and is exacerbated by the divergence in access by type of technology. Generally, access to all types of ICT has been expanding in Guyana. However, access has been more dynamic with respect to modern telecommunication services as opposed to computer and internet services. For instance, in 2007, mobile subscriptions per 100 inhabitants increased by more than 600% above the 2000 level (see Table 3). In contrast, despite growth in internet subscriptions (70% between 2000 and 2007), internet connectivity[5] remains low for broadband internet access. In 2007, broadband penetration was a mere 2.62 users per 100 inhabitants (see Table 4). Further, notwithstanding growth in mobile telephony, fixed telephony remains low. In 2007, tele-density with respect to landline access stood at 14.9 lines per 100 people which was below the Latin American & Caribbean (LAC) average

Table 3 Basic access to ICT in Guyana

Per 100 people	2000	2007
Telephone lines	9.3	14.9
Mobile cellular subscriptions	5.4	38.0
Internet subscribers	1.8	6.5
Personal computers	3.0	3.9
Households with a television set	41	59

Source: World Bank (2009)

of 18.1 (UNCTAD, 2006). The slow growth in fixed tele-density and broadband internet access can barricade effective adoption of CAI as these offer greater scope for service provision. Added to this is the persistent inequality in access between relatively well-developed urban, sub-urban areas and the rural interior regions such that the window of access to modern technologies remains small in these areas.

GSS also have precarious infrastructure that can impose additional challenges to the adoption of CAI. Many GSS, particularly those in rural areas, are constrained by poor physical infrastructure; poor quality of buildings and access to utilities such as electricity. As argued by Hepp et al. (2004), the poor state of physical infrastructure can support praedial larceny and 'menace hardware's lifespan'.

Also, in the interior regions, which are sparsely populated, many of the village schools are small or single room schools with nursery, primary and secondary departments housed in one building. This can affect effective separation and targeting of ICT use for secondary-level students. Hepp et al. (2004) also raises the important argument of political and government financial commitment for CAI in rural areas given the higher per-student investment rate associated with small schools. Concerns in the political sphere

Table 4 Internet users (Mns)

	2003	2007	Compound average annual growth rate 2003–2007/2008
Internet Users (millions)	0.03	0.15	49.53
–Fixed Broadband Subscribers (Mns)	0.00	0.02	
Penetration (users per 100 inhabitants)	3.38	19.66	16.28
–Fixed Broadband	0.00	2.62	

Source: UNCTAD (2009)

may arise as to the economics of investing in computers and other equipment for small rural schools given also the need for maintenance. The issue of hardware maintenance becomes even more crucial given the geographical isolation of many interior schools, which also puts a strain on teacher training.

Human capacity

An important challenge to effective use of CAI is the deficit in IT trained teachers. This problem has multiple sources, ranging from the small number of students studying information technology at the secondary level (just over 1,000), compared to other subject areas (MOE op. cit.), to minimal specialist training at the college and university level (ibid.). From this standpoint therefore, the ICT training needs of secondary teachers is enormous. This deficit may be exacerbated by the looming risk of exacerbation by brain drain, a perennial phenomenon in public service in Guyana (Jennings–Craig, 2009).

Financial capacity

Education as a percentage of GDP has remained fixated around an annual average of 7% between 2003 and 2007. Further, the sector relies significantly on external financial support. In 2007, the sector received approximately US$11 Mn from such donor agencies as the Canadian International Development Agency (CIDA) and UNESCO under the Education for All/Fast Track Initiative (EFA-FTI). But even with increased investment, low performance and poor physical infrastructure pervade. It therefore goes without saying that the sector currently lacks the financial capacity for the radical transformation that it requires to support CAI. Of course, the flipside is that over the long term, investment in CAI can save resources that can subsidize development in other areas of the educational system, such that the country can achieve its goal of USE.

Potential risks of adopting CAI in Guyana

Risks can be broadly characterised as:

Erosion of student-teacher relationship

Whilst CAI brings with it benefits for improved coverage and access to quality education, it also poses several risks for education delivery. Some ICT resources, such as computers reduce the student-teacher interface in the learning process. As such they can contribute to the erosion of the teacher-student relationship that is normally evident in a classroom setting. The teacher-student relationship enhances the learning process through a number of fronts including addressing non-academic student-related matters that may affect the process of learning. Further, increased computer use, despite having a positive impact

on learning, introduces informal dynamics into the classroom that can diminish teacher capacity to control the classroom.

Culture intrusion in education delivery

The lack of human and technical capacity for education programme development using ICT increases the likelihood of the erosion of domestic indigenous educational materials and tools and culture intrusion in education delivery. This is primarily because there is likely to be reliance on foreign-devised training materials. Further, even where some technical capacity exists for the development of indigenous educational materials utilising ICT, limited capacity to keep up-to-date with changing hard and software can still contribute to the intrusion of other cultures in education delivery. This is similar to what obtains in many academic textbooks used at the University level. Because of limited capacity to devise illustrations and examples that takes developing countries' context into consideration, many universities in developing countries utilise textbooks that provide examples pertaining to developed countries.

POLICY RECOMMENDATIONS

1 Follow through on the policy decisions as enshrined in the National ICT4D Strategy the MOESP 2008–2013.

2 Study the successes of other countries with a view of adopting a similar approach regarding the use of CAI to support CTCI.

3 Further the liberalisation of communication services in Guyana to expand the window of access to modern ICT technologies in the sub-urban and rural interior regions.

4 Consider offering majors in ICT at CPCE and UG.

5 Pursue more and consolidate existing public–private partnerships in the delivery of secondary education using ICTs.

REFERENCES

AECT (1977) *Educational Technology: Definition and Glossary of Terms,* Association for Educational Communications and Technology, Vol. 1, Washington, DC.

Blurton, C. (1999) 'New directions of ICT-Use in education', in Tawfik, M., Bartagnon, G. and Courrier, Y. (Eds.): *World Communication and Information Report,* United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris, France, pp.46–61.

Brophy, K.A. (1999) 'Is computer-assisted instruction effective in the science classroom?' *Masters Abstracts International,* Vol. 37, No. 5 (UMI No. 1393859).

Brown, K.G. (2001) 'Using computers to deliver training: Which employees learn and why?' *Personnel Psychology,* Vol. 54, pp.271–296.

Clemens, M. (2004) *The Long Walk to School: International Education Goals in Historical Perspective,* Working Paper, No. 37, Center for Global Development, Washington, DC.

Condie, R., Munro, B., Seagraves, L. and Kenesson, S. (2007) *The Impact of ICT in Schools: A Landscape Review,* Becta Research Publication, Strathclyde.

Dunn, C.A. (2002) *An Investigation of the Effects of Computer Assisted Reading Instruction Versus Traditional Reading Instruction on Selected High School Freshmen,* Unpublished Dissertation, Loyola University, Chicago.

GINA (2010) *Government of Guyana Passes New Telecommunication Law,* Government Information Agency, Georgetown, Guyana.

GOG (2001) *The Guyana Poverty Reduction Strategy Paper,* Government of Guyana, Georgetown.

GOG (2006) *National ICT4D Strategy,* Online: http:// www.ict4d.gov.gy, Accessed 10/04/10.

GPL (2010) *SchoolNet Guyana: A Literacy Project Aimed at Computerizing all Secondary Schools in Guyana,* Online: http://www.globalpartnershipforliteracy.org/.

Haddad, W. and Jurich, S. (2002) 'ICT for education: potential and potency', in Haddad, W. and Drexler, A. (Eds.): *Technologies for Education: Potentials, Parameters, and Prospects,* Academy for Educational Development, Washington, DC, pp.28–40.

Hall, T. et al. (2000) 'Computer assisted instruction in reading for students with learning disabilities: a research synthesis', *Education and Treatment of Children,* Vol. 23, No. 2, pp.173–193.

Hepp, P.K., Hinostroza, E.S., Lava, E.M. and Rehbein, L.F. (2004) *Technology in Schools: Education, ICT and the Knowledge Society,* Online: http://www. siteresources. worldbank.org/EDUCATION/ Resources/278200, Accessed 10/04/10.

Jennings-Craig, Z. (2009) *Hard Road to Travel: The Challenges of Initial Teacher Training in Guyana,* Unpublished.

Kulik, J.A. and Bangert-Drowns, R.L. (1983) 'Effectiveness of technology in precollege mathematics and science teaching', *Journal of Educational Technology Research,* Vol. 12, No. 2, pp.137–158.

Kulik, J.A., Bangert, R.L. and Williams, G.W. (1983) 'Effects of computer-based teaching on secondary school students', *Journal of Educational Psychology,* Vol. 75, No. 1, pp.19–26.

Lavy, V. (1996) 'School supply constraints and children's educational outcomes in rural Ghana', *Journal of Development Economics,* Vol. 51, No. 2, pp.291–314.

Lynch, L. et al. (2000) 'Computer-assisted reading intervention in a secondary school: an evaluation study', *British Journal of Educational Technology,* Vol. 4, No. 31, pp.333–348.

MOE (2009) *Reforming Teacher Education and Training in Guyana,* Ministry of Education, Georgetown, Guyana.

MOE (2008) *Strategic Plan 2008-2013,* Ministry of Education, Georgetown, Guyana.

Roberts, V.A. and Madhere, S. (1990) *Resource Laboratory Program for Computer Assisted Instruction (CAI) 1989-1990,* Evaluation report, Washington, DC.

Selinger, M. (2008) 'ICT in education: catalyst for development', in Unwin, T. (Ed.): *ICT4D: Information and Communication Technology for Development,* Cambridge University, Press Cambridge.

Coward, S. (2010) *Guyana: President Discloses Plan for Second Fibre Optic Cable from Brazil, Stabroek News,* Georgetown, Guyana.

Tabassum, R. (2004) 'Effect of Computer Assisted Instruction (CAI) on the secondary schools students' achievement in science', *Doctoral Thesis,* University of Arid Agriculture, Unpublished.

Trucano, M. (2005) *Knowledge Maps: ICT in Education,* infoDev/World Bank, Washington, DC.

UNCTAD (2006) *Information Economy Report: The Development Perspective,* United Nations Conference on Trade and Development, United Nations, New York.

UNESCO (2007) *The UNESCO ICT in Education Programme,* United Nations Educational, Scientific and Cultural Organization, Bangkok, Thailand.

UNESCO (2008) *ICT Competency Standards for Teachers: Competency Standards Modules,* United Nations Educational, Scientific and Cultural Organization, Paris, France.

World Bank (2005) *Expanding Opportunities and Building Competencies for Young People: A New Agenda for Secondary Education,* World Bank, Washington, DC.

NOTES

[1] Notwithatnding, that there are several private GSS, the focus of this paper will be only on public GSS.

[2] CSEC is the successor of the Caribbean Examination Certificate (CXC).

[3] Strengths, Weaknesses, Opportunities, and Threats.

[4] The ICT infrastructure for fixed telephony in Guyana is monopolised by the Guyana Telephone and Telegraph Company (GT&T), which has control over national and international voice and data transmission.

[5] The GT&T provides connectivity to the internet to end-users via a combination of Dial-up, Digital Subscriber Line (DSL) and wireless technologies, directly and indirectly through; privately-operated internet services providers and country-wide public internet access points (internet cafes) (ICT4D 2006).