

## 4. Gender and Psycho-pedagogical Implications for Cognitive Growth through Access to Information and Communication Technologies

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### ABSTRACT

This paper focuses on gender differentials in the use of information and communication technologies (ICT) in the education process with a view to identify the implications for cognitive growth, degree of motivation, enduring learning capacity and psycho-pedagogic practices. Drawing from the Cognitive Load theory and the Social Cognitive theory, the paper explains what mindsets and learning communities are created by ICT. This permits an insight into the role and use of ICT in learning that encourages individual work, collaborative learning, active engagement, intrinsic motivation, and the search for meaning and diverse viewpoints. Such practices can serve as resources to address gender differentials in learning. Bottom-up learning with ICT lends support to inductive, experiential, constructivist and discovery approaches. These conceptual views are substantiated with empirical data from a transnational study in five African countries on the integration of ICT in the school system, with Cameroon being one country studied. The findings of the study demonstrate that when ICT is integrated into the curriculum process, it does make a difference in students' cognitive growth with some gender differences in levels of self-efficacy, attention, and motivation. In the end, we affirm the positive impact of ICT on students' learning and cognitive growth with potentials to promote gender driven strategies. On this account, teacher training should emphasize not only the teaching of ICT skills but also the development of gender sensitive pedagogical skills to meet gender differential needs in the use of ICT for teaching and learning.

*Keywords:* information and communication technologies (ICT) – cognitive skills – cognitive load theory – intrinsic and extraneous cognitive load – social cognitive theory – gender – psycho-pedagogical development

### RESUME

Ce chapitre porte sur les différences observées entre garçons et filles dans l'utilisation des technologies de l'information et de la communication (TIC) dans l'éducation, dans l'optique d'identifier les implications concernant le développement cognitif, le degré de motivation, la durabilité des capacités à apprendre, et les pratiques psychopédagogiques. En s'appuyant sur la théorie de la charge cognitive, ce papier explique quelles mentalités et communautés d'apprentissage sont créés par l'utilisation des TIC. Ceci permet d'explorer le rôle des TIC dans l'enseignement et l'apprentissage, surtout pour encourager le travail individuel, le travail collaboratif, un engagement actif, des apprentissages qui ont du sens, la motivation intrinsèque, et la quête de points de vue divers. De telles pratiques peuvent servir de ressources pour aborder les différences filles/garçons dans l'éducation. L'apprentissage avec les TIC permet des approches inductive, expérimentale, constructiviste et de découverte. Ces positions conceptuelles s'appuient sur des données empiriques provenant d'une étude transnationale concernant cinq pays africains, dont le Cameroun, qui explore l'intégration des TIC dans le système éducatif. Les résultats de l'étude

démontrent que lorsque les TIC sont intégrées au programme, une différence apparaît dans le développement cognitif des élèves avec quelques écarts filles/garçons en termes d'autonomie, d'attention et de motivation. Enfin nous affirmons que les TIC ont un impact positif sur l'éducation des élèves et leur développement cognitif et qu'elles pourraient permettre de promouvoir des stratégies sexuées. Pour cette raison, la formation des enseignants devrait non seulement renforcer l'enseignement des TIC mais aussi le développement de compétences pédagogiques conscientes des différences filles/garçons pour répondre aux besoins différenciés des filles et des garçons dans l'utilisation des TIC sur le plan de l'enseignement et le plan de l'apprentissage.

*Mots clés* : technologies de l'information et de la communication (TIC) – compétences cognitives – théorie de la charge cognitive – charge cognitive intrinsèque et extrinsèque – théorie cognitive sociale – différentiels genre – filles/garçons – développement psychopédagogique

## **Introduction**

Educating girls is increasingly recognised as an essential component of strategies to develop a people's human resources. Hafkin and Taggart (2001) argued that the "single most important factor in improving ability of girls and women in developing countries to take full advantage of the opportunities offered by information technology is more education, at all levels from literacy through scientific and technology education." Huyer (2003) went on to argue that women and girls are poorly placed to benefit from the knowledge economy because they have less access to scientific and technical education specifically and to education in general. Research conducted in Cameroon (Tchombe, 2006) and elsewhere indicates that educational returns are higher in a woman than a man. Female education stimulates changes in knowledge, power and attitudes in areas such as fertility, health and children's education. Despite these benefits, however, girls in Cameroon rarely attain the levels of education reached by boys. In Cameroon, fewer girls enrol in school and few persist as far as boys (Amin, 1990). As a result, fewer girls acquire the knowledge and qualifications necessary for active roles in the economic and civic lives of their country. Many studies (Amin, 1990; Amin & Fonkeng, 2000; Tchombe, 1993, 1995) show that girls of certain provinces or regions in Cameroon attend school less frequently than boys. This is due mainly to discriminatory attitudes towards girls in the socialisation process, attitudes linked to economic, social, educational and pedagogical factors.

The implications of the integration of information and communication technologies (ICT) for teaching and learning with a gender perspective are presented in this paper in relation to cognitive growth and the development of learning capacity within an active gender sensitive pedagogical framework. The computer is viewed as enhancing technological capabilities and empowering the learner, making him/her responsible for his/her learning. This view leads to the revolutionisation of education because of the focus on learners as constructors of knowledge thus making them not only responsible for their learning but also accountable for the quality and use of that learning. The computer should in this case not be referred to only as a tool. It is strongly held that ICT can help improve, even revolutionize how students learn and teachers teach but this should depend also on the pedagogic sequence specially designed to help and encourage female learners. With ICT playing an increasing role in schools through students' communication via e-mail and use of web-based resources, there is growing interest in how it might best be used to eradicate the faulty belief about female inability to manage the computer or technologically oriented learning.

To raise concerns about the implications of the integration of ICT in schools, we begin by identifying the technology-based resources available to students and discriminate between which are best suited to different kinds of learning goals and what key cognitive skills and strategies students should possess. Taking full advantage of technology's potential requires that students have a repertoire of knowledge and cognitive strategies. The rest of the paper examines students' uses of technology and cognitive skills needed, cognitive load theory, gender differentials in terms of access, and research findings on gender differences on cognitive skills and psycho-pedagogical implications. It concludes with recommendations.

### **Conceptual framework and theoretical issues**

Information and communication technologies (ICT) are becoming increasingly accepted and heavily relied upon in Cameroon and the whole of Africa, as a crucial means towards social and economic development. The project measuring the digital gender gap in francophone Africa reported by Mottin-Sylla (2005) echoed that women are marginalised within the Information Society in many ways. According to her, women are far less likely than men to play a role in decision making about ICT, to shape ICT content, to acquire ICT training, and to have access to ICT-based services. We need thus to understand how women are prevented from benefiting from the African Information Society and what steps can be taken to empower them. ICT has the potential to eliminate barriers and disparities and can improve the lives of women because it offers new economic and social opportunities. In Mozambique the integration of ICT in secondary schools has produced favourable results (Cossa & Cronje, 2004). Accentuating female access to ICT by putting in place computer facilities in the school system is one way to address poverty in all its dimensions.

ICT comprises a complex set of goods, applications, and services used to produce, process, distribute, and transform information (Munyua, 2005; United Nations, 2005). The information and communication technology sector consists of segments as diverse as telecommunications, television and radio broadcasting, computer hardware, software and services, and print media and electronic media including the internet and electronic mail. The term ICT has been used to encompass technological innovation and convergence in information and communication leading to the development of so-called information and knowledge societies, with resulting changes in social interaction, economic and business practices, political engagement, education, health, leisure and entertainment (United Nations, 2005). However, the concept of information technology as an important development mechanism is still a fairly recent phenomenon in many developing countries (Liverpool, 2002), Cameroon not left out. Many if not all development, education and business projects in both developed and developing countries today are initiated, carried out and evaluated by means of ICT. There is almost every reason for all individuals (boys and girls and men and women) to get linked up to the information society. Commitment to the information society especially ICT is exemplified in the UN's involvement in issues concerning it in the last few years. For instance, the Millennium Declaration adopted in 2000 underscored the urgency of ensuring that the benefits of new technologies, especially ICT, are made available to all (United Nations, 2000).

Introducing ICT in schools may be a major stride in ensuring a turn out of women and men who are literate enough to fit into and shape the information and communication society. ICT are a source of curricular content as well as a pedagogical mechanism for the construction of knowledge. As far as sustainable management and durability in integrating ICT within schools, a number of challenges have been identified (ROCARE Cameroun, 2005).

### **Student uses of technology**

Bruning, Schraw, Norby and Ronning (2004) indicated domains where students' use of ICT could be a driving force behind learning. When we look at the computer and internet-related technologies, we can see many ways they can be used in education and equally sense their growing educational potentials. Students use ICT to receive information and search for and find information. They use it to organize and present information and also explore simulated environments. Furthermore, they use it to participate in authentic learning environments, communicate and collaborate with other students and practice skills and receive feedback on progress. With cooperative learning, there is group accountability that encourages group products. In the same manner, there is individual accountability as a function of timed performance task. Through these uses, students' educational experiences are enhanced because ICT provides cognitive support and extends abilities both to students with learning disabilities and normal students. It also leads to cognitive development needed in making simple summaries to highly complex productions involving gathering information, refining, and presenting it. The best of the skills can include virtually all students' self-regulatory and motivational resources. Students who require assistive technology are those with mental or physical impairments that interfere with learning or other life functions. The technology helps these students to overcome or compensate for the impairment and makes him/her more independent in participating in school. Gender sensitive assistive technology still needs to be examined, in the light of giving girls more facilitating learning opportunities.

Using ICT for learning does improve learning capacity and makes the learner focused on the process for acquiring knowledge and at the same time the content of knowledge. Huyer (2003) also argues that access to ICT offers many opportunities for women and girls to gain the education and technical skills required for them to participate equally in the knowledge economy. However, active use of ICT requires many competencies. Two concerns come up: the capacity requirement of the task and the mental effort that needs to be exerted. The degree of attention and resources demanded for ICT use needs to become a focal point of research. With the integration of ICT, it is important to understand and think more specifically about productive uses by students through reflection on theories and research on technology, cognition and education.

### **Theoretical framework**

The cognitive premise for this discussion is that learning is a constructive, not a receptive process. Making this statement is to insist on the fact that learning is not so much knowledge and skill acquisition but the construction of meaning by the learner (Prawat, 1996). Knowledge is not simply acquired. It is created and recreated on the basis of previous learning. Knowledge is co-constructed. What motivates learning is the "search for meaning." Adopting a passive approach by relying heavily on rote memorization indicates both superficial and transitory learning. In contrast, learning that aims at deeper understanding relates new information to what learners already know and regularly checks back for comprehension. We see here the role of students' meta-cognitive skills that support the knowledge management process. Potent cognitive concepts are mental frameworks or structures used to organize knowledge. They direct perception to attention and affect perception, learning and memory. Attention in the context of ICT focuses the mind and enhances concentration on cognitive processes and consciousness on what is being learnt. Selective attention is very crucial for concentration. Extended practice is needed to develop

cognitive skills just as developing self-awareness and self-regulation are critical to cognitive growth. The domain of cognitive psychology is expanding by shifting from pure cognitive variables of memory and thought to include the learners' motivational and belief systems and attitudes. These may also have cultural implications, however.

#### ***a/ Cognitive Load Theory***

The cognitive load theory proposed by John Sweller and his associates (Sweller, 1999) focuses on the role of working memory in instructional design such as computer-based instructional programmes and multimedia (Clark, 2003). From a cognitive load perspective, meaningful learning depends on active cognitive processing in learners' working memory even though it has a limited capacity. Therefore, there are two types of cognitive load, the first being intrinsic which is the content being learnt. It creates the cognitive load in working memory based on its difficulty and complexity. The other is extraneous cognitive load, which relates to the instructional design. The learning process can collapse with excessive load thus decreasing processing efficiency. On the other hand, instructional media needs to make an effective use of the working memory if students are to achieve a deeper understanding of scientific principles and increase ability in problem solving. Learners need to actively process, organize, and link multimedia content in working memory. But care has to be taken to ensure that the multimedia learning activities do not overload the working memory. Control for such problems can be accounted for by reliance on long-term memory. Chances of success are also increased when extraneous cognitive load is reduced. Is there a gender differential in cognitive loading as per this theory?

#### ***b/ Social Cognitive Theory***

The cognitive load theory discussed above examines technology-related factors affecting individual learning and cognitive growth to enable an insight into the role of technology in classroom interaction and knowledge construction. It is increasingly being argued that social interactions, discourse and cultural processes are fundamental to cognitive development (Bruner, Goodnow, & Austin, 1956; Gauvain, 2001; Vygotsky, 1962). This implies that social cognitive activities, such as well managed cooperative learning and classroom discussions, stimulate learners to elaborate, clarify, recognize and re-conceptualize information (Cowie & van de Aalsvoort, 2000). Collaborative efforts such as peer interaction have potential for cognitive growth in integrating different forms of discourse, focus on common problems, and building on each other's work as a community. This community approach lends support to the new focus on participatory pedagogy and the focus on higher order learning through the bottom-up multi-modal approach. Bruner (1964) suggests that to learn at the symbolic level, it is necessary to retrace through the sensory-motor (enactive) and iconic levels. So, the social cognitive theory emphasises collaboration and mutual understanding between male and female students. In this way learning assumes deep rather than surface quality (Biggs, 1994). Two issues emerge: the constructive perspective and the social nature of learning in which the external mediation releases the responsibility of learning to the learner. Proponents of constructivism argue that "meaningfulness comes from working with others on authentic tasks" (Blumenfeld, 1992: 278). Understanding is enhanced when students and teachers work together on tasks or projects in a Vygotskian manner, with the teacher and other skilled peers gradually withdrawing support as the student gains in competence and confidence.

*c/ Some biological theoretical* explanations of gender differences in the use of ICT may draw on the structural differences of the right and left hemispheres. Literature is replete with gender differences on this account (Maccoby & Jacklin, 1974). But there exist some functional differences that perhaps can explain enduring female behaviour. Two areas of greater functioning in the female are memory and sensory intake. The female brain is very active as it uses its resources and does so quickly. The female brain, which is never at rest, has a true learning advantage (Gauvain, 2001).

Take the issues of gender differences in spatial abilities that focus on the influence of gender-role orientation on cognitive performance. Gender-schema theories, for example, try to explain gender differences through individual differences in gender-schematic processing of information (Bem, 1981). In these theories individuals build up a gender schema in which knowledge of activities and interests, personality and social attributes, and scripts about gender-linked activities are successfully included. Males and females on this account behave consistently with gender schema that reflects the cultural gender roles. The socio-cognitive theory of gender, however, assumes that gender-linked roles and conduct are acquired through enactive experiences – or perception-action and interaction in the environment – and shaped by evaluative social reactions to gender-linked behaviours (Bussey & Bandura, 1999).

#### **Gender considerations in access and effective use of ICT**

Unfortunately, ICT especially in developing African countries is an area quite sensitive to gender. It is an area where women and girls are at particular risk of exclusion from potential opportunities for diverse reasons. Confirmation of this can be found in the statement of the speech of the Secretary General of the United Nations at the World Summit on the Information Society in Geneva in December 2003 in which he said there is “a gender divide, with women and girls enjoying less access to information technology than men and boys” (in Awe, nd). If gender dimensions of ICT in terms of access and use, capacity building and employment opportunities, and potential for empowerment are explicitly identified and addressed, ICT can be a powerful catalyst for political and social empowerment of women and the promotion of gender capacity. There is therefore the need to develop gender specific indicators on ICT and mainstream and monitor gender perspectives in all ICT initiatives.

The journey towards female inclusion in the general field of science and technology has been a long and difficult one. For the most part, women and girls are particularly vulnerable to constraints especially as more than two thirds of the world's illiterates are women, and they comprise 60 percent of rural populations where infrastructure is weakest. However, women's access to ICT and their effective use of it are constrained by factors that go beyond issues of technological infrastructure and socioeconomic environment. Socially and culturally constructed gender roles and relationships play a crucial role in shaping and limiting the capacity of women and girls to participate on equal terms in the information society (Munyua, 2005). Other typical gender related issues have to do with women's poverty, insufficient access to education and training, and insufficient time as a result of their multiple roles in families and communities.

The role of education and training is evident in alleviating gender related hindrances to access and effective use of ICT in Cameroon and Africa at large. Women generally have lower levels of education than men, less access to training, and fewer opportunities to learn the skills necessary for ICT participation, including basic technical skills development. But

there is evidence to indicate that computers in classrooms and learning environments can increase and enhance the value and quality of learning especially for girls. Results from ERNWACA's transnational study (ROCARE Cameroun, 2005), indicate that girls become more focused and concentrated than boys once they are effectively introduced to the use of ICT. Therefore, when we consider gender issues in ICT, the actual problem would rather be traced more to access than to effective use by women.

It is yet worth noting that women need ICT for much the same reasons as do men and training and access to it can enable women and men to gain stronger voices in their communities, their governments and at the global level (United Nations, 2005). Achieving gender equality in ICT requires more than mainstreaming gender concerns into the ICT arena. It requires serious commitment and political will. Given the potential of ICT in development and social transformation, women have felt that it is essential that the existing gender divide be addressed. The aim is both to ensure women's access to the benefits of ICT and to make ICT a central tool in women's empowerment and the promotion of gender equality (Munyua, 2005).

### **The effects of gender socialisation in a cultural context**

It is important to examine what characterises child development and shapes gender roles in early life until people become mature men and women. If we consider socialisation processes and gender role development in African context, we realise that boy children become more instrumental whereas the girls become more expressive. As early as childhood, some girl children can already deal accurately with issues of quantity and measurement. Since they are socialised into carrying out home chores such as cooking, they acquire the skills of measurement, which are extremely scientific, and can accurately determine how much water, salt and other ingredients produce the desired food taste. Many discriminatory decisions are made and with little difficulty. So how can we say that they are not very scientific? There is a great change of mindset needed in thinking about gender and competency. Attitude is a deterring factor here and must be addressed with urgency.

Meanwhile, very early in life, boys are given the opportunity to become more exploratory and instrumental than girls. They are more involved in play activities. These differences that emerge already in childhood from cultural milieus determine the degree of men's and women's participation in scientific and technological activities such as ICT. This offers the basis for supposing why girls tend to concentrate and remain more focused than boys, who like to use ICT to play games.

While the potential of ICT for stimulating economic growth, socioeconomic development, effective education and training, and good governance is well recognised, the benefits of ICT have been unevenly distributed within and between countries, regions, sectors, and socioeconomic groups (United Nations, 2005). This uneven distribution is fondly referred to as the "digital divide" to describe the gap existing as a result. It is common knowledge that basic literacy and numeracy are needed to read and compose simple messages, navigate the internet, and execute commands in software applications, but women make up nearly two thirds of the world's illiterates, and one out of every two women in developing countries is illiterate. Moreover, women often have complex relationships with technology and machines as a result of being socialised over time to believe that machines and technology are a man's domain and not for women and girls, thus generating a gender bias in attitudes towards studying or using information technology. The

social factors that produce these gender differences operate in both institutional and informal settings. In some societies like parts of Cameroon, cultural norms and practices discourage interaction between women and men outside the family, and women may be uncomfortable in situations where men are present either as trainers or as peers (Fraser-Abder & Mehta, 1995; Liverpool, 2002; Mottin-Sylla, 2005; Munyua, 2005; United Nations, 2005). Consequently, women are more likely than the men to lack the basic literacy and computer skills that would enable them to take advantage of new global communication opportunities on this account.

### ***Advocacy***

Gender issues in the information society cover a wide spectrum: integrating gender perspectives into national policies; raising awareness among gender advocates about collective ICT plans and training for gender equality; and promoting gender-responsive governance and democratic media, effective use of ICT by women, and relevant content. Gender advocates have consistently called for the realisation of gender equality within the ICT sector and for ICT diffusion that contributes to positive change in gender relations. If these conversions happen we may begin to hope for development in its surest form for our African countries.

### **Empirical evidence from transnational study on gender differences in the use of ICT, cognitive skills and implications for teaching**

#### ***Justification for case study approach***

Creswell (1994: 12) cited Merriam (1988) and Yin (1989) as saying that a case study is an approach where the researcher explores a single entity or phenomenon ("the case") bounded by time and activity and collects detailed information by using a variety of data collection procedures during a sustained period of time. Shaughnessy and Zechmeister (1990) also state that a case study is an intensive description and analysis of a single individual and the data may be obtained from sources such as naturalistic observation, interview, personal documents, and archival records. Many aspects of case study method make it valuable for this study, given its exploratory nature and aspiration to understand those pioneering the use of ICT in schools in West and Central Africa. Information was collected about attitudes, gender differences in performance, degree of motivation, study styles and even difficulties. Much can be learned from studying one individual, one classroom, and one school, for example in relation to patterns or regularities in students' behaviours, teaching strategies with the use of ICT, administrative style, and parental involvement. The advantage of the case study approach for this research is in its ability to open ways for discoveries and even as a prelude to the basis for stating hypotheses that may be pursued in subsequent studies. A very important value is that it provides qualitative explanations that are consistent with the inductive model of thinking. Here, the concept of "pattern theories" emerges and Neumann (1991: 38) says pattern theories use metaphors or analogies so that relationship "makes sense." While the advantages stated above are evident, the case study poses difficulty when conclusions on cause-effect are to be drawn. Data obtained from this study addressed the concept of the integration process of ICT in the school system.

#### ***Process of selection of case***

What influenced the selection of the cases for this study, conducted within the context of a five-country study conducted by the Educational Research Network for West and Central Africa (ERNWACA), were factors such as gender, level of education, enrolment figure of the school (500 pupils for primary and 1500 students for secondary), and geographic diversity. Clearly, selection was not necessarily based on a statistical model but on the significance of the case in relation to the objectives of the study. Internet connectivity and the use of computers for teaching and learning, among others, were significant considerations for inclusion of the eight schools studied.

For the study in Cameroon, two sets of data were collected from eight cases or schools. For qualitative data there was a sample of 235 persons (75 teachers, 80 students, 80 parents). For quantitative data, of a sample of 18 662 students, 11 552 (5 862 boys, 5 690 girls) or 62% responded to the questionnaire. Among a sample of 831 teachers, 216 (138 males, 78 females) or 26% completed the questionnaire. Three visits were made to the schools, each the duration of about a week. Data collection activities included interviews, classroom observations, focus group discussions (FGD) and the passing of a questionnaire. Gender was a determining variable.

### ***Findings***

It is worthy to recall that access to ICT in schools and communities and effective use of ICT by learners and community members have enormous implications for education. There is evidence to indicate that computers in classrooms can increase and enhance the value and quality of learning. However, access to ICT facilities is usually a function of socio-economics and logistics; suitability and availability of curriculum; and national ICT strategy and commitment. Access provides pedagogical material that can be used by students as well as teachers and also helps make it possible to initiate students to the computer not only as curriculum content but also as a medium for learning and for constructing knowledge (ROCARE-Cameroun, 2005).

### ***Student motivation***

Rapid technological change can produce sudden increase in expectations, which in turn can dramatically affect motivation. The integration of ICT has had a motivating effect on students as evident in comments from each principal of the eight schools studied. For instance, the Head teacher at a primary school said the children are very happy during ICT lessons. A high school principal stressed the effect especially for science students, since arts students have their books to use. This is because science textbooks are very expensive and consequently few students can afford them, thus they may depend largely on the internet for material. The influx in ICT centres during the hours of ICT use and other hours made another principal note that ICT has a motivating effect on students. A principal explained that "les technologies favorisent énormément l'intérêt des élèves pour l'école. Les exemples portent sur l'attitude des enfants qui ne veulent pas laisser les machines respirer. Ils sont très attentifs." Another principal stated: "De manière affirmative, les TIC favorisent l'intérêt des élèves pour l'école. Les élèves vont au centre multimédia enrichir les connaissances, préparer leur exposés, télécharger des exercices avec les autres élèves ou de certaines écoles sur des projets." On the whole, the principals observed that ICT excites the students and generates more interest in school among them. This high motivation, collaboration, attention and participation is much evident among 5th and 6th year students, for whom computer studies is an examination discipline. Additional evidence of motivation is the

reduced rate of absenteeism and increased school participation. In this way the effects could be far reaching in also reducing dropout rate to ensure progression and completion.

### ***Students' attitudes***

On the whole, students' attitudes regarding the use of ICT were positive, as evident in the statements from students of the bilingual high school Lycée Bilingue Essos in Yaoundé: "It enriches me with information as a student. / It is interactive. / It helps me understand my lessons. / It helps me know many things as my teacher."

This positive attitude is addressed more by boys than girls. However, some girls also have very positive views, for instance, at Lycée Joss (high school) in Douala, a girl remarked: "Il est très important d'utiliser l'outil informatique à la base de la mondialisation. Il nous aide à tous les projets éducatifs."

In Collège Lauréats (junior high), also in Douala, both boys and girls demonstrated the same positive reaction, as evidenced in statements such as the following: "Bien sur l'ordinateur est un moyen de communication, deux, l'ordinateur sera l'une des grandes technologies de ce monde, trios, l'utilisation de l'ordinateur est indispensable de nos jours dans les bureaux, les banques et les écoles."

### ***Students' perceptions of competencies***

Peer support was evident in the extent to which peers helped solve problems of their classmates who ran into technical difficulties. Whilst in most schools boys emerged as experts, in others, girls, besides scoring high evaluation marks, were also identified as experts who teach others how to connect to the computer and operate it.

Still on gender, some schools such as the Bilingual High School in Yaoundé reported 66.7% comparability between boys and girls and their use of computers, yet 16.7 % stated that boys get too distracted while girls concentrate more. Other schools such as Lycée Leclerc (high school) in Yaoundé demonstrated gender differentials as follows: 50% of students questioned said boys are better than girls while 33.3% felt that they are the same, but another 16.7% said boys are more distracted than girls. In Longla Comprehensive College in Bamenda, 66.7% said boys and girls are comparable in performance, yet 33.3% stressed that girls are interested and show better understanding of ICT. In Oiselets primary school, in Bafoussam, 30% said both boys and girls are the same and 23% feel boys are better than girls, while another 23% said girls are much better than boys.

### ***ICT effect and gender differences***

There was slight variation in opinion as to the issue of differences between boys and girls on the effect of ICT. While the teachers (50%) of Lycée Bilingue, Yaoundé and those of Lycée Leclerc Yaoundé (50%) contend that there is no gender difference, the principal of Longla Comprehensive College Bamenda was very categorical as he stated that girls had more interest in ICT than boys. The example given is the rate of female registration in the computer laboratory and the cyber café. It is interesting to note here that in the schools the teachers highlighted that girls are more focused once they have gained mastery in manipulating the computer. They are more assiduous and stay longer in school.

### ***Students' increasing communication skills***

Without any gender discrimination, parents mentioned improvement in their children's language competency, computational skills and how critical they have become. They narrate

stories or teach other siblings songs and poems, explained one parent. Out of 11 552 students who responded to the questionnaire 5 690 were girls and 5 862 boys. It was observed from the data collected that both boys (42%) and girls (41%) had email addresses. But the frequency of ICT use in school was as a function of the discipline. A high proportion of students do not always use ICT in the learning of language (54% girls and 60% boys), natural and physical sciences (61% girls and 59% boys), or history and geography (64% girls and 65% boys). It is curious that they always use ICT for other unspecified activities. Some activities students specified for ICT use show significant gender disparity: computer literacy (55% girls, 48% boys) and the realization of school related activities such as research and typing of texts (34% girls, 41% boys). While many more girls (61%) focus on computer literacy, the boys (54%) on their part use ICT for typing of texts. Students' overall perception of the effects of ICT demonstrate many more boys (38%) than girls (33%) affirming that ICT greatly facilitates the production of schoolwork. The students, most especially the girls (34%) said the computer is something "very important."

### ***New ways of teaching and learning***

The findings highlight how ICT helps teachers move learners to produce their own knowledge as mentioned by the literature. In particular, teachers of Lycée Bilingue Essos said, "Students are very attentive and anxious to participate." "They participate by carrying out research for homework and prepare exposés." The teachers as a whole in focus group discussions said the ICT centre has websites rich in all types of information and on various disciplines. The Principal of Lycée Joss made the following statement: "L'objectif général est de faire en sorte que tous les élèves soient capables d'utiliser l'outil informatique pour accéder régulièrement aux ressources pédagogiques sur internet afin d'améliorer leurs connaissances et ainsi rivaliser avec les autres élèves du monde et même des pays développés. Ceci passe par la maîtrise de l'outil informatique par les enseignants. Cette maîtrise nécessite trois étapes à savoir : l'initiation, l'appropriation et l'intégration dans leur curriculum." Strengthening this view, the Principal of Collège Lauréats, in Douala, Cameroon stipulated that they use ICT to "intégrer les élèves dans l'évolution du monde d'aujourd'hui pour leur meilleur insertion tout en étant vigilant."

### **Discussion**

The findings reported above reveal a critical situation for social policy and education. Research by Liverpool (2004) on women and the development of ICT in Nigerian universities makes reference to a consistent record of low female representation and participation in science and technology, especially in the area of information and communication technology. Because ICT plays a major role in development, and women constitute about half of the world's total population, she feels that if women do not actively participate in ICT development, nations will be limiting the scope of the impact that ICT could have on their economies. Richards (2005) also reports on a number of studies that highlight the fact that computers are widening the gender gap in schools, as boys spend their spare time playing games on the computer while girls use them for homework. He cites the report, by the Department of Education and Skills by academics at Leeds and Sheffield universities, which calls on schools to try to "redirect" boys' use of computers towards schoolwork. It also found that pupils who used computers for their schoolwork scored higher grades on tests and examinations than those without access to computers at home. But children, mainly boys, who played computer games, achieved significantly lower grades. Thus, as we ensure

increased access and parity in access, so too must we ensure effective time management and useful and valuable learning activities.

### ***Psycho-pedagogical implications***

Computer sciences applied to education have been causing a real revolution in the teaching and learning process. One modality is to computerize traditional teaching methods. Another is to apprehend the computer as an educational tool with which the learner solves problems related to several areas of knowledge. Considering this constructivist approach, no distinction exists between subject matter knowledge and pedagogical knowledge because all knowledge is pedagogical in varying ways. Constructivism implies that "knowing" is created rather than transferred.

Two ideas emerge from this conception of learning. Learners are active in constructing their own knowledge and social interactions are important to knowledge construction. In dialectical constructivism, in reflective classroom situations, students interact with other students and with teachers in ways that stimulate both knowledge construction and cognitive growth. The main aim of teaching, from a constructivist perspective, is not so much to transmit information but to encourage knowledge formation and metacognitive processes for judging, organizing, and acquiring new information (Bruning et al., 2004). What becomes important for teachers is to understand how students construct and use their understandings. These constructive processes of knowledge growth occur in a social context as a result of interpersonal interactions. Based on these views ICT can provide learning opportunities. But there is the need to understand ICT and the way it can pedagogically constrain or enable particular activities. For teachers, reflection and action is required on the ways they incorporate technology, with gender alertness, into their pedagogy.

Notions of differences in male-female brain structure, learning styles and development of intelligence must be clear in the teacher's mind. The issue of brain-based gender differences has created a gender advantage/disadvantage hypothesis, in which girls in particular are seen to be disadvantaged in acquiring technological skills. From the transnational study reported above, gender parity in internet access seems less serious a problem than the inherent sexism in patriarchal school culture that intimidates the girl. What emerged is the fact that boys are more aggressive users of ICT than girls. Teachers need to be aware and vigilant with the girls in this respect as some girls do not gravitate toward the spatial stimulant of the computer screen as boys do. Considering these male-female or gender psychosocial dynamics, it is increasingly clear that some girls who could learn with computer technologies will not do so. These girls could be left behind. Girls need to be encouraged to address their knowledge and skills in ICT.

Self beliefs can affect self-determination in the classroom. Bandura's learning theory (1993) emphasizes the reciprocal relationship among self-belief, performance, environment and feedback. Changing pedagogical approaches that incorporate participation – through small group work and collaborative and peer tutoring –demonstrate the enabling effect, as observed in the transnational study, of these approaches in instituting gender parity in ICT classes. It was observed that girls with more autonomy and intrinsic motivation were able to control activities in the same way as the boys and were seen to offer support to peers requesting such support, as in the case of Longla Comprehensive College in Bamenda.

Wentz (1997) referred to an agenda converging to transform students' learning and accomplishment. The agenda consists of 1/ new cognitive theories in teaching, 2/ learning

and integrating new technological advancements, and 3/ restructuring of school. These are emerging to bring about possibilities for the redesign of education and educational resources. Research (Wentz, 1997) supports the theory that technology and use of computers can add value to learning when thoughtfully integrated into the curriculum. Teachers using technologies report that they are more comfortable with students working independently and are able to present more complex materials. They adopt the role of a "guide on the side" rather than the "sage on the stage," spend more time on student-centred instruction than lecturing, tailor their instruction more to meet individual needs of students, and actually expect more from the student (Poole, 1997: 10). Furthermore, students with learning disabilities are at an advantage when using the computer.

Levels of inquiry-based learning have increased (ROCARE-Cameroun, 2005). Students using the computer in the area of problem solving and maths experience significant gains (Fletcher, Hawley & Piele, 1990). Effective use of ICT pushes students to the centre of the classroom. New trends in psycho-pedagogy point to the games and experiments in which students engage and the cooperative learning styles these encourage. Being able to benefit from such learning styles depends on students' basic skill sets and their learning needs. Computer proficiency must therefore start with the expectation of raising student performance through deeper learning and application of problem solving techniques. A learner's cognitive, affective, and behavioural performance should be enhanced during computer usage (Ahmed & Al-Naamany, 1997). Using ICT has great implications for the development of critical thinking, for example when students have to make decisions about which material to select from the internet.

It was clear in the findings from the qualitative data that the integration of ICT is not just a matter of furnishing schools with computers without training teachers. It is not just substituting or allocating a few hours on the timetable for computer literacy and skills development. ICT integration is using the computers effectively and efficiently in the general content areas to allow students, both girls and boys, to learn how to apply computer skills in meaningful ways (Dockstader, 1999). Integration of ICT within a curriculum-driven approach should help develop a scientific mind characterised by critical thinking and should be inquiry driven. Bruner (1966) even made reference to the fact that using technology extends the power of the mind. However the culture of inquiry in schools has been a pedagogical ideal as evident in the writings of Dewey (1938) and Bruner (1966), rather than an enduring reality. Textbooks and limited libraries could not sustain inquiry-oriented pedagogy, but now ICT provides the opportunity.

Our research findings supported the fact that ICT serves two functions to students and teachers: a source for curricular content material as well as a pedagogical tool for researching information and constructing knowledge. "Students obtain information from the internet where they lack textbooks." "Now our students can no longer avoid doing homework with the excuse that they do not have the required textbooks. There is easy access by students and teachers to relevant information." In focus group discussions with students in Lycée Bilingue, a 17-year-old boy in lower sixth stated that "when a teacher talks, he does not tell students all, so we have to complement with textbooks which for most of the time we do not have, but we can now carry out research using the internet to get more material."

More teachers (66.7%) posited that their pupils are at ease with the computer and 33.3% held an opposite view. Teachers did not mention any significant gender differences but reiterated the ease with which all students work with the computer. However teachers

highlighted gender differences in the sense that girls are more focused once they have gained mastery in manipulating the computer. On the other hand about 80% of the teachers contended that the students focus more on learning the task when working with the computer, while 20% postulated that they do not always concentrate on the learning task.

The availability of ICT enables teachers to do research, calculate marks, and prepare lessons. It provides teachers with access to a variety of examples of teaching practices, and the opportunity to engage in reflection and analysis, both individually and in groups. It allows teachers to access instructional products such as student work, lesson plans and assessment instruments; provides access to a broad array of teaching and learning resources; provides sustained, ongoing opportunities for teacher development and involves a range of individuals and groups with different types of expertise who can contribute to teacher development including experts, researchers, and curriculum specialists. Pedagogically, it also ensures that lessons are didactic, punctuated with questions, explanations, reactions and problem solving. Such an approach addresses the social constructivist theory in learning that focuses on peer tutoring, collaborative learning and cooperation.

Teachers need better ICT training so that students will be helped to learn to navigate through great amounts of information, to analyse and make decisions. There is need for curriculum and teacher education reforms. ICT can be well integrated to avoid an old curriculum being used to strengthen poor pedagogical processes that will not respond favourably to provide quality education.

### **Conclusions and recommendations**

From this paper emerge three areas of particular significance in understanding gender perspectives in access and use of ICT in education. These are 1/ attitudes about gender in relation to ICT, 2/ learning goals and motivational issues, and 3/ skills for using ICT as a means of knowledge construction. The case studies related illustrate students' skills in learning and use of ICT. They self rated their proficiency, even the way they perceived the role of ICT in learning and teaching in schools and their learning styles. Perceived gender divides were identified among teachers and also among students. The predictable outcome of ICT in relation to student development seems linked to self assessment on the question. As observed, gender differences were related to some extent to anxiety about using ICT. Compared to boys, girls seemed to exhibit a greater level of anxiety in using ICT at the beginning state, though this situation improves with increased use. Girls also seemed to have less interest in using computers for playing games. To an extent, girls emphasized improvement in access to education and retention whereas boys stressed improvement in quality of education. All students feel that access to ICT makes learning easier and accessible.

Practice requires a theoretical base. We have demonstrated in the discussion above that cognitive theories provide a sound basis from which we can generally judge the effects of ICT in education. Thus, we may use cognitive principles as criteria for evaluating technology-based instruction. Cognitive perspectives of technology's best uses are those producing meaningful learning. In teaching therefore, we should support authentic, challenging tasks with technology. Such tasks lend themselves to developing habits of self assessment and reflective processes that lead to cognitive growth. It is also evident that we need to create and support collaborative learning communities in our classrooms as these also create a context for cognitive growth. From a gender perspective, assistive technologies

need to be explored for support to students with disabilities and those in disadvantaged positions in classroom or other learning communities.

Both boys and girls acknowledged that using ICT has increased their productivity as students. However, both boys and girls tend to be equally disadvantaged in using these tools. Although awareness of the importance of information and communication technology and computer skills is growing in schools that have these facilities, educational systems in Africa will have to change at all levels to ensure the infrastructure and needed skill base for broader use. Achieving gender equality in the use of ICT would require more than mainstreaming gender and gender sensitive pedagogical concerns into educational arenas. Teacher education for example must add programmes in the pedagogical use of ICT. Pedagogical approaches on the continent must be redressed and reformed to address cognitive processes.

Continued research is required on 1/ gender differentials in the effect of ICT and their causes, 2/ role of ICT for cognitive growth with pedagogical implications, and 3/ use of ICT to strengthen pedagogical approaches for working with disabled persons.

As Mathonsi (2003), in reporting on the Women's Electronic Network Training (WENT) workshop Africa 2003, explains, knowledge production remains "fuelled by unequal power dynamics." Girls and women need access to ICT and, more importantly, need to be creating and sharing their own knowledge with it. However, cyber cafés are not "particularly welcoming" places for women and can be even "daunting" (Gordano, 2007; Nyarko 2007). And, as is the case in schools in Cameroon (ERNWACA-Cameroun, 2005) and in others countries as found in a World Bank study (see Nyarko 2007), due to inadequate facilities, lack of policy on gender access, first-come-first serve use basis, we see that boys often run to secure their places at computers while girls must wait. When women do access the power of the computer for breaking silences, speaking and telling, it can be an empowering experience as evidenced by participants in WENT 2007 (APC-Africa-Women, 2007). However, empowerment should not have to wait for international workshops and conferences. It can happen in families, schools and communities. To make it happen we need to inform ourselves about the underlying dynamics at work to promote or inhibit digital inclusion within Africa and we need to understand, in African contexts, theories that underpin constructive learning.

The Declaration of Agreement in Support of Girls and Women in Information and Communication Technology (WSIS, 2005), introduced at the United Nations World Summit on the Information Society in Tunis, Tunisia reiterates among other issues that "failing to recognise and remedy women's severe under-representation in the development of ICT and related policies, regarding both access and leadership, limits our ability to advance our global society. ICT allows women increased participation in political, social and economic arenas and supports empowerment for themselves, their families, and their communities" (p. 2). This suggests that the situation can only be enhanced through education, where teachers' pedagogy is guided by constructivist theoretical tools to guide the use of ICT in classrooms. Consideration should be given therefore to teachers' knowledge of psychological process which becomes aligned with the perceived needs of the learning situation and the use of ICT in teaching and learning. Such support should empower the teacher to maximize his/her pedagogical skills to be flexible to move from constructivist to didactic strategies in responding to differentials in his/her pupils' agency.

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