

Ergonomics: Possible Roles in Helping Literacy Acquisition in Developing Countries

Remo Job, Tania Cerni
Department of Cognitive Science and Education
University of Trento, Italy

Résumé

Ergonomics, and the implementation of psychologically-tailored technologies, may prove helpful in the process of literacy acquisition. In this paper we discuss the possible role of ergonomics in allowing a greater number of children to get access to formal education, focusing on literacy acquisition through the use of ICT. In this perspective, ergonomics not only allows for better design of educational settings, and enhancing the physical learning environment, but may promote the use of communication technologies as important learning tools. We briefly review some ICT based programs aimed at enhancing the acquisition of reading and writing skills launched in several countries.

1. Ergonomics and Acquisition of Literacy

1.1. Why is Ergonomics Important

Ergonomics, and the implementation of psychologically-tailored technologies, may prove helpful in tackling areas of criticality in modern societies. It may also play an important role in helping the acquisition of literacy by both children and adults. It may do so in several ways, either directly or indirectly, and it may be a driving force for other developments as well.

In our opinion, taking into account an ergonomic prospective on the use of ICT resources requires balancing constraints and possibilities of available technologies and constraints and possibilities of the contexts of use broadly defined. Among the latter, aspects of economic and social development directly affect education (Williams & Cooke, 2002), and thus it might be argued that an ergonomically tailored ICT-related intervention may in principle be particularly productive in developing countries since technologies can overcome problems related to distance, availability of teachers, and typologies of available tools. In this regard, however, we must be aware of two different but connected gaps: the "literacy divide", i.e. the disparity in the access to literacy, and the so-called "digital divide", i.e. the disparity in the availability of, and in the access to, ICT. These two gaps seems to decrease and to increase together because the lack of education is often linked to the absence of technological diffusion and use, as measured by years of schooling (Chinn & Fairlie, 2010). Despite the rapid and worldwide diffusion of technologies, the difference between the developed and developing part of the world is still large and it will increase without a rational introduction of educational program and economic measures linked to ICT diffusion (Kim, Miranda & Olaciregui, 2008).

While adult illiteracy is an important issue that requires a research impetus to find solutions that would be beneficial to both individuals and societies, in this paper we will focus on the possible role of ergonomics in

allowing a greater number of children to get access to formal education, thus improving literacy acquisition through the use of ICT.

Ergonomics may play a pivotal role in improving educational environments at both the physical and psychological level. Recently, Andrée Woodcock (2011) has proposed a four-fold categorization of such benefits:

1. Good ergonomic design can protect the health and well being of the children and teachers
2. Good ergonomics design can enhance learning and teaching
3. Behaviors learned in schools during early years can have a cross over into family and later life
4. Ergonomics can provide a way of linking diverse initiatives undertaken to enhance the learning environment- such as curriculum innovation, use of ICT.

Thus, ergonomics can be effective at several level, from the design of the furniture of the school, that should enhance correct seating and limit the possibility of wrong postures during lessons, to the structuring of the class context, favoring different types of interaction (for some activities a face-to-face setting is better than the traditional row-behind-row setting of most classes); from the long-lasting effects of ergonomically congruent behaviors that would be beneficial for both the individual as well as the society to the role of ergonomics as a source of change in the learning environment by providing new tools and, as a consequence, tuning the pedagogical approach to instruction. This latter is the perspective we are interested in in this paper. Specifically, we discuss how ergonomic principles may enhance the use of ICT in setting up programs of literacy acquisition in developing countries.

1.2. A role of ICT?

In the acquisition of literacy ICT can play a crucial role thanks to the main, shared features of the different devices available on the market and to the new possibilities of adapting such devices to users who presents with varied and idiosyncratic personal as well as contextual characteristics. Indeed, technologies are very flexible in reaching users regardless of the distance, of the information shared, and the modality, or multimodality, in which this information becomes available. Thanks to the multisensoriality and the interactivity of ICT, curiosity and motivation of children (and older users) can be increased by using technologies and this, in turn, can create new opportunities of learning. However, the effects of technologies in the educational context are not clear cut, and further studies are needed to understand whether, and how, ICT may be beneficial for education.

In fact, investigations of technology and internet investments in schools in developed countries seem to show mixed results, leading to uncertainty about the simple idea that diffusion of ICT in educational context *per se* can promote the learning progression (Cummins, Brown & Sayers, 2006). Here, we briefly review some examples in order to discuss the use of technologies in developed countries formal educational institutions and to investigate their possible role in the multifaceted educational contexts of the developing countries.

In a study examining the impact of the federal e-rate program in California's public schools between 1996-2000, Goolsbee and Guryan (2006) concluded that although the program had increased access to Internet (more

in urban schools than in rural ones), there was no evidence that such program had any measurable effect on students' achievement. Also Fuchs and Woessman (2004) found a negative relationship between home computer availability and student achievement, but they did find a positive relationship between home computer use of Internet communication and education software. Similarly, they found a positive relationship between Internet use in schools and students' educational performance. On the other hand, a study by Angrist and Lavy (2002) on the influence of the introduction of new computers on Israeli school teachers and students shows an increased in the use of computer-aided instruction but, surprisingly, a decrease in the test scores of the students. Finally, Machin, McNally and Silva (2006) evaluated the effects of ICT investments in England and found a positive impact on students' performance, particularly in English and Science, though not for Mathematics.

In developing countries the educational investments in ICT can lead to a different scenario. In this respect, He, Linden and MacLeod (2007) and Linden (2008) propose that technology can have a better impact in poor educational contexts while leading to an impoverishment of the educational results in scholastic system that work well, as in developed areas. These Authors develop this idea analyzing pedagogical methods that take advantage of technological tools inside and, especially, outside the classroom as an integration of the formal teaching. The findings suggest that the integration of formal programs with ICT outside the classroom leads to positive results in learning.

The complementary proposal we advance is that ICT, as learning instruments, can be interpreted as an *integrative tool*, that is a helpful tool for both the teacher – to complement other tools in the school setting - and the learner - to integrate formal teaching. On the other hand, ICT can be a *substitutive tool* that can be used when and where formal institutions are not present, when the student learns autonomously or, as in the specific case of developing countries, when relevant aspects of the school system, e.g. buildings and teachers are suboptimal, e.g. ill-structured or unskilled.

In conclusion, considering that literacy acquisition is a basic right and that it is essential for social development in developing areas both at the individual and the group level, ICT, as a substitutive tool, can be viewed as a useful tool to increase both the diffusion and the quality of education. To illustrate how this can be done, we review two cases of the development of ICT resources for educational purposes in developing zones.

2. A review of two cases

2.1. The case of Interactive Radio Instruction (IRI) in Zambia

The Directorate of Open and Distance Education of Zambia's Ministry of Education has developed alternative basic education programs at lower basic (Grades 1-4), middle basic (Grades 5-7), and upper basic (Grade 8) levels. Such programs for lower and middle basic education are delivered to learners countrywide using Interactive Radio Instruction in community-supported learning centers of two types: center that are dependent entirely on radio lessons and mentors, and community schools that use IRI methodology wherein children learn by following a radio lesson under the supervision of a mentor (Zambia Ministry of Education, 2006).

As reported by Siaciwena & Lubinda (2008) the program is a partnership between the Ministry of Education and different organizations – among which there are local community-based organizations, international non-governmental organizations, and churches and aims to reach out-of-school children who have no basic education, nor the ability to access the formal school system due to inadequate provision or insufficient facilities, poverty, distance to the nearest formal/government school, increasing parental disinterest in school education, and the impact of HIV/AIDS.

The Interactive Radio Instruction (IRI) program was launched in July 2000 as a pilot project catering for Grade 1 learners at 22 IRI learning centers. The program has been expanding rapidly as shown by the increase in both the number of schools using IRI radio broadcasts, up to 1,058 in 2006, the number of community schools adopting IRI methodology, up to 497 in 2006, and the number of learners, up to 81,324 in 2006, reflecting a 44 percent increase (Zambia Ministry of Education, 2006).

Data about the achievement of educational goals for the individuals involved are not available (to the best of our knowledge), but Siaciwena & Lubinda (2008) list three main achievements that can be considered indexes of success of the program. First, the IRI accounts for a significant portion of the schools offering basic education – i.e., 893 IRI centres out of a total 7,256 schools offering. Second, IRI have helped to improve the quality of education in community schools, as shown by the fact that teachers uses IRI to supplement teaching materials and that IRI assists untrained teachers to manage their lessons adequately. Third, “the IRI programme is promoting equity and equality in educational provision” Siaciwena & Lubinda (2008) by (a) increasing the number of school in rural areas, (b) providing educational opportunities to girls as well as to boys; (c) increasing access to education for orphans.

2.2. One Laptop Per Child (OLPC)

OLPC is a nonprofit organization whose aim is to design, produce and distribute low-cost computers so that every child in developing countries have access to knowledge and computer literacy with the hope of reducing the digital divide in the planet. As suggested by Kraemer, Dedrick and Sharma (2009), the case of OLPC can be seen as a study in general diffusion of technology in developing countries.

The laptop is designed to be shock and water resistant and it adapts to the exposure to sunlight, being equipped with a display that can be used either in black and white or color, allowing good outdoor visibility. It is designed with particular attention to energy saving, and it is particularly suitable for conditions where electricity is not readily available (Buchele & Owusu-Aning, 2007). Furthermore, OLPC has been designed in such a way as to enable a connection even when there are no close access points. This is made possible by a mesh network that allows to automatically connect a laptop that has access to the network in a sharing signal system (Buchele, 2009).

The educational framework of the project relies on the constructionist view of learning, developed by Papert (Papert & Harel, 1991). Within the OLPC project, the laptop is viewed as an useful tool in the construction of both individual and shared knowledge (Buchele & Owusu-Aning, 2007; Apiola, Pakarinen & Tadre, 2011). Therefore, the development of educational programs following this system should ensure a child's

learning through direct interaction with the instrument in a situation of peer-to-peer learning.

Since 2007 OLPC has spread in many developing countries. Half-dozen countries have reported positive changes, but also critical issues, in their pilot studies. As reported by Kramer, Dedrick & Sharma (2009), enrollment in schools grow, absenteeism decreases, discipline and participation in class increases. A study conducted in Uruguay on the usability and functionality of the OLPC laptop has reported that connectivity is still a challenge, especially when children are not in school. Then, there are problems with input devices, in particular with touchpad and keyboards. The interaction with the interface is not always intuitive - for example, because of the bad language translation or the difficulty in concept understanding and content localization (Hourcade, Beitler, Cormenzana & Flores, 2008). Unfortunately, evaluation studies on the use of OLPC are rare, given the novelty of the project. In addition, they often tend to have a formal imprint since they are funded by ministries, who are the direct intermediaries between OLPC and schools (Nugroho & Lonsdale, 2010).

In an ergonomic perspective, the lack of usability measures about the device is unfortunate, and it is not clear how well the laptop fits into the specific contexts in which it is used (Martinazzo, Patrício, Biazon, Ficheman & Lopes, 2008; Leaning, 2010). Cuts of production and a sale curve less dynamic than predicted are sometimes interpreted as cues of difficulties of the project (Kraemer, Dedrick & Sharma, 2009; Leaning, 2010).

At a more theoretical level, Leaning (2010) is concerned with the fact that OLPC provides both a hardware and a software but not a proper educational program, despite the stated goal. Indeed, the educational program and the actual method of use in the classroom are left to the specific country and the specific school in which the laptop is placed. On this issue, Apiola, Pakarinen & Tedre (2011) see two opposing forces: omitting specific educational guidelines is useful for inserting laptops in the context of use, but lack of teachers' skills in the educational framework within which OLPC has been developed is detrimental. Also lack of teacher training on the specifics of the laptop may also affect the program (Kraemer, Dedrick & Sharma, 2009).

The two cases reviewed are at the opposite ends of an ideal continuum that range from "collective" to "individual" technologies. The radio is a unidirectional, one-to-many technology, while the laptop is, to some extent, interactive, and a one-to-one tool. Both have strengths and weaknesses that are related to their context of use, availability of resources, and the educational support they can rely on. The two cases were instrumental in showing that there is no "optimal" technology, that each tool can support learning and teaching in some conditions better than in others, and that in order for ICT to play a role it must take into account a set of variables and intervening factors at different levels of complexity.

3. Conclusions

An ergonomic approach to ICT in education requires to consider jointly the pedagogical and the technological aspects, in order to foster productive learning environments and to provide effective teaching tools. In addition, it requires to take into account the user knowledge and the context wherein the technology is used in order to reach the appropriate pedagogical goal.

In this regard, the kind of technology that can be used is another decision we have to make. A mass media tool, like the radio, or a new ICT, like a laptop, can have different roles in collective/individual or interactive/unidirectional education, be it in the classroom or out of the classroom.

Given the specific situation of developing countries, ICT can play a role as an integrative or a substitutive tool depending on the human, social and economic resources available in the educational system, such as the presence or absence of skilled teachers, of apt building, and school material.

In conclusion, an ergonomics prospective is able to consider at the same time several of the aspects cited above and to give a contribution to the reduction of the literacy and digital divides that exist between and within countries by identifying the technologies more suitable to the relevant aspects of the specific environment considered.

4. References

1. Alam Md.S. (2002). Technology based literacy education through distance mode in Bangladesh: Problem and prospects. Commonwealth of Learning. Pan-Commonwealth forum on open learning: Open learning: transforming education for development, 29 July - 2 August 2002, Durban, South Africa, p.8
2. Angrist J., Lavy V. (2002). [The Effect of High School Matriculation Awards: Evidence from Randomized Trials](#). [CEPR Discussion Papers](#) 3827, C.E.P.R. Discussion Papers.
3. Apiola M., Pakarinen S., Tedre M. (2011). Pedagogical Outlines for OLPC Initiatives: A Case of Ukombozi School in Tanzania. Proceedings of IEEE Africon 2011 Conference, September 13-15, 2011, Livingstone, Zambia.
4. Buchele S.F., Owusu-Aning R. (2007). The One Laptop per Child (OLPC) Project and Its Applicability to Ghana. Proceedings of the 2007 International Conference on Adaptive Science and Technology, December 2007, 113-118.
5. Buchele S.F. (2009). Using OLPC Laptop Technology as a Computer Science Case Study Learning Tool. The Journal of Computing Science in Colleges, 24/4, 130-136.
6. Chinn M.D., Fairlie R.W. (2010). ICT Use in the Developing World: An Analysis of Differences in Computer and Internet Penetration. Review of International Economics, 18, 1, 153-167.
7. Cummins J., Brown K., Sayers D. (2006). Literacy, Technology, and Diversity: Teaching for Success in Changing Times, Allyn & Bacon.
8. Fuchs T., Wößmann L. (2007). [What accounts for international differences in student performance? A re-examination using PISA data](#). [Empirical Economics](#), Springer, 32, 2, 433-464.
9. Goolsbee A., Guryan J. (2006). [The Impact of Internet Subsidies in Public Schools](#). [The Review of Economics and Statistics](#), MIT Press, 88, 2, 336-347, 06.
10. He, F., Linden, L.L., MacLeod, M. (2007). Teaching what teachers don't know: an assessment of the Pratham English language program. Columbia University Department of Economics. Available: http://www.columbia.edu/~l2240/PicTalk_Working_Paper_2007-03-26.pdf
11. Hourcade J.P., Beitler D., Cormenzana F., Flores P. (2008). Early OLPC Experiences in Rural Uruguayan School. In Mobile Technology for Children: Designing for Interaction and Learning (under the direction of Druin A.). Boston: Morgan Kaufmann.
12. Kim P., Miranda T., Olaciregui C. (2008). Pocket school: Exploring mobile technology as a sustainable literacy education option for underserved indigenous children in Latin America. International Journal of Educational Development, 28, 435-445.
13. Kraemer K.L., Dedrick J., Sharma P. (2009). One Laptop per Child: Vision vs. Reality, Communication of the ACM, 52, 6, 66-73.
14. Leaning M. (2010). The One Laptop per Child Project and the problems of technology-led educational development. In High-Tech Tots: Childhood in digital

world (under the direction of Berson I.R., Berson M.J.), Information Age Publishing: Charlotte, NC.

15. Linden L.L. (2008). Complement or substitute? The effect of technology on student Achievement in India. Infodev Working Paper No. 17
<http://www.infodev.org/en/Publication.505.html>
16. Machin S., McNally S., Silva O. (2007). [New Technology in Schools: Is There a Payoff?](#). [Economic Journal](#), Royal Economic Society, 117, 522, 1145-1167, 07.
17. Martinazzo A., Patrício N.S., Biazon L.C., Ficheman I.K., Lopes R. (2008). Testing the OLPC Drawing Activity: an usability report. Proceeding in Advanced Learning Technologies. ICALT'08. Eighth IEE International Conference, July, Santander, Cantabria, 844-846.
18. Nugroho D., Lonsdale M. (2010). Evaluation of OLPC programs globally: a literature review. Proceeding of the Australian Council For Educational Research, August, Version 4.
19. Papert S., Harel I. (1991). Situating constructionism. In Constructionism (under the direction of Papert S., Harel I.). Ablex Publishing Corporation, 36, 2, 1-11.
20. Shrestha S., Moore J.P.T., Adelnour-Nocera (2010). Offline Mobile Learning: Open Platforms for ICT4D. Proceedings 10th IEEE International Conference on Advanced Learning Technologies, Jult 2010, 703-704.
21. Williams E., Cooke J. (2002). Pathways and Labyrinths: Language and education in development. TESOL Quarterly, 36, 3, 297-322.
22. Woodcock A. (2011) *Precis of ergonomics and educational environments*. Education Business. Available :
<http://educationbusinessuk.net/features/34/53-ergonomics-and-environment>