Study of the attitude of students towards new technological contexts and neuroscience progress

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Abstract

Technology and Neuroscience have formed a strong collaboration to improve education. The effective use of information and communication technologies (ITC) in education practice requires that both students and teachers maintain a positive attitude towards these technologies, and develop their use in educational contexts to update teaching methodologies based on educational neuroscience and neuropsychology. Thus, the use of ITC requires a positive attitude when using these tools during the teaching-learning process, as a starting point to improve the quality of the process. The aim of this study is to analyse the student´s attitudes towards the use of new technologies in the primary school classroom. We designed a questionnaire and gave it to 1.770 students aged between 1—12 years from 50 CEIP (Infant and Primary schools). In general, the results show that whilst students between 11-12 years do not show a rejection of the use of ITC, a low percentage of these demonstrate that they would prefer to use them in a group. We conclude that an adequate use the use of ITC in the classroom would depend on the predisposition of the students, and the knowledge of the technologies and their use by the teachers and students. Therefore, it is recommended that ITC is implemented in the classroom in order to improve the teaching-learning process and to incorporate new methodologies from neuroscience research.

Keywords: Technologies, Information, Communication, Student, Teacher, Innovation, Learning, Neuropsychology

1 Introduction

Cognitive neuroscience and technology have, in recent years, been developing in parallel and collaborating closely (Enríquez, Martín-Plasencia, Maestú, Ríos, Periañez & Calvo, 2006). The use of neuronal imaging techniques, along with other types of electrophysiological techniques makes it possible to obtain new scientific knowledge for a better understanding of brain processes. It also allows us to know in which part of the brain (along with when and how) these processes are integrated in order to better perform learning processes (Llinás, 2002). As an example, we can find several studies concerned with global functional connectivity (Stam, C. J. & de Bruin, E. A., 2004), the neural correlates of the action denomination and spatial relationship (Damasio, Grabowski, Tranel, Ponto, Hichwa & Damasio, 2001), or the relationship between the neural substrate related to the sense of touch and object recognition (Reed, Shoham & Halgren, 2004). As research has progressed, some techniques have been used to run a cross validation of several techniques such as electroencephalogram (EEG) and RNMF (magnetocephalography) that allow a better understanding of brain functioning (Martínez-Montes, Valdés-Sosa, Miwakeichi, Goldman & Yamaguchi, 2004). These technological advances favour not only the development of knowledge about brain function, but also an understanding of the complexity of the information processing involved in attention, memory, thinking skills and learning that require the synchronisation of a multiple neuronal network. Access to this information by the teacher opens up the possibility of applying neuropsychological progress to the educational context, including programs to develop multiple intelligence (García & Llamas, 2016), neuropsychology and technology programs to improve language difficulties (Pradas & De la Peña, 2016), or programs applying neuropsychology to schools at

different ages (Martín-Lobo, 2016). Some studies have shown an improvement in processes such as attention, motivation, and memory in university students when technology is used based on neuroscience strategies (Valerio, Caraza, Martínez & Jaramillo (2014).
When referring to attitudes, decision-making and emotions, there are also a number of studies based on the use of technologies. An example of this can be found in the study by Greene, Sommerville, Nystrom,Darley y Cohen (2001), which examined the role of emotion on moral judgement using magnetoencephalography (RNMF).

Neuropsychology and technology in students aged between 11 and 12 years

The neurofunctional basis of cognitive and emotional learning allows us to have a perspective of the brain as a functional support for learning, and it particularly allows us to apply technological methodologies in the classroom (Pradas, 2016). It is therefore relevant to know the neurodevelopmental characteristics of the students included in this work in order to use technology from the neuropsychological perspective. The development of their brain functionality shows that during this period (11-12 years) they are capable of processing information in different areas of the brain at the same time, in order to integrate and coordinate the information. This complex information processing requires a certain degree of brain development and myelination of neurons, along with an increase of neurotransmitters in the synaptic processes (Bressler, 2002). When observing children of this age using technology, we can appreciate the high degree of interest that this generates, along with the implications of the tasks and multitasking actions that they are required to perform. Further, this is a period involving better comprehension, memorising and organising, for which it is necessary that they develop the frontal lobe areas and integrate information through the hard body that links both hemispheres (Ferré & Ferré, 2013). When technological methodologies are applied considering these facts, this helps the teacher when making decisions regarding the use of technology as an efficient tool for neurodevelopmental progress rather than as mere entertainment. At this age the reading and comprehension speed increases due to binocular reading using both eyes, which allows for higher precision and higher visual, visuo-spatial and visuo-motor skills that are developed between 6 and 11 years of age, and that continue to develop thereafter (Bova, Fazzi, Gionvenzana et al, 2007). A further important aspect worth consideration is attention. Between the ages of 9 and 12 years, children develop attentional control processes that improve selective attention (Goldberg, Maurer, Lewis, 2001), and attentional difficulties are due to a lack of development of the frontostriatal circuit that is responsible for inhibitory control (and that continues to develop during adolescence), rather than due to selective immaturity (Booth, Burman, Meyer, et al. 2003). Technology can facilitate the development of selective attention and focusing when doing homework as well as working memory, given that during this age grey matter increases in parietal and frontal areas that are involved in this type of memory process (Campo, Maestú, Ortiz et al, 2005).

Neurotechnology

Over the last few years, technology has been incorporated into the classroom, and is now believed to be present in every school. As early as the 1970s, some authors suggested that adaptation to the environment in the digital era entails training and using new technologies in all the subjects in schools (Donaldson, 1970). However, in order to use them correctly we need to know the effects that they can have on the generation of knowledge, and therefore know the relevance of training teachers and understanding the development of knowledge when interacting with technologies. Based on these suggestions, our study aims to incorporate educational neurotechnology into our educational and neuropsychological research. We therefore find a bridge between two relevant areas of study for the educational context: neuropsychology and technology. These areas offer the opportunity to promote a more successful learning experience. Educational neurotechnology focuses on the use of technology in the educational context by also analysing neural processing. It can therefore be regarded as a new science of learning based on the knowledge of the brain and the methodology used when including technology in the classroom context (Pradas, 2016). This methodology focuses more on "how" learning occurs rather than "what" is being learned. In the current context we can find a high diversity of sources of information, news, data and an overabundance of information, and we require a learning approach focused on inquiry, coordination and dynamic articulation processes of knowledge to solve problems rather than simply acquiring fixed knowledge. The key is to know the advantages of using technology for our brain, as well as to discover its drawbacks, in order to develop new strategies. For instance, Small (2009) suggested that whilst the use of the Internet has a positive impact on brain functioning, it is problematic when overused. Individuals that spend around 10 hours per day using the computer can show a reduced aptitude for interpersonal contact, such as keeping a conversation face to face. Small (2009) also suggested that the Internet has changed not only the way people produce and create content, but also the way they communicate and experience enjoyment. The Internet also alters brain functioning (Small, 2009). We should take into account that when using technology, the effect of stimulus-response takes place at a speed that does not occur in the analogic context. The success achieved when playing videogames, for instance, is due to the decisions we make. Thus, Linehan, Lawson and Doughty (2009) developed a serious game designed to improve behaviour when making collaborative decisions. The game MetaVals aims to develop collective decision-making processes in pairs (Romero, Usart & Almirall, 2011; Usart, Romero & Almirall, 2011). It is critical to understand that with the use of technology we can maximise the sensory information that we receive through multimedia sources. This allows the stimulation and potentiation of the capacities of both hemispheres, stimulating both ways of thinking in order for them to complement each other. This in turn would help to fulfil the great potential of the human brain in a holistic way.

Application and development of technology

In order to use this progress and apply innovative programs, education that uses ITC should offer the conditions required to optimise the teaching-learning process, promote knowledge transfer, and incorporate new skills. Attitude is one important issue that should be taken into account in studies about learning contexts (Collins, 1996). Learning contexts should reflect the anticipated use of new knowledge in order to avoid the acquired knowledge being lost (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Duffy & Knuth, 1990). When implementing ITC, the educational context should also be adequate, providing and preserving the links with the context outside the classroom. Moreover, the teachers should promote the student´s participation with a positive attitude when using the ITC, and also favour active construction of knowledge. This requires an open learning space instead of a mere transference of facts (Collins, 1996; Hannafin, Hall, Land, & Hill, 1994; Jonassen, Peck & Wilson, 1999). Cooperation and interaction in the classroom are also important to promote the acquisition of learning skills, problem solving skills, and social relations (Bennett & Dunne, 1994; Slavin, 1995; Susman, 1998). Finally, given that we can find differences in skills and perception in the classroom towards the use of ITC, these differences should be considered as key criteria for an effective teaching-learning process in the classroom (Bearne, 1996; Kerry & Kerry, 1997; Wang, 1990). Thus, the responsible authorities should adapt the educational context to the needs and capacities of the individual students.

ITC can contribute towards the creation of powerful learning contexts in various ways. In particular, ITC offers opportunities to access a vast quantity of information through multiple resources, along with various ways to visualise this information from different perspectives. ITC can also make complex problems easier to understand through simulations that promote the creation of an optimum learning context (Llamas-Salguero, 2013). Moreover, ITC can also be an instrument for curricular differentiation, offering opportunities to adapt learning content and tasks to the specific needs and skills of each student, and offering tailored information (Mooij, 1999; Smeets & Mooij, 2001).

However, some studies show that the approach in schools is focused on the use of ITC based on traditional knowledge (Chalkley & Nicholas, 1997; Richardson, 1997; Smeets & Mooij, 2001; Williams, Coles, Wilson, Richardson, & Tuson, 2000). Further, a recent study about the impact of ITC on student performance (including 60 schools) shows that the percentage of lessons that include ITC was generally low. And whilst some links were found between the amount of use of ITC and the student´s performance, this relationship was not consistent across all of the different levels.

Programs of educational neuropsychology using technology

Educational neuropsychology programs train visual, auditory and perceptive skills, and sensory integration and lateral development in order for the brain hemisphere to provide good integration and comprehension of incoming information. These programs also improve linguistic, memory, higher thinking skills and creativity that favour neurodevelopment and learning (Martín-Lobo, 2016). All of these processes can be trained with technology using educational neurotechnology programs (Pradas, 2016). Further, the students show an attentional affinity towards technology that facilitates the creation of strategies for accessing information and new neural circuits for learning, which is possible due to the plasticity of the young brain (Small, 2009), and they also display a profile that has both the necessary skills and interest for using technology (Roca, 2008). This allows the use of neurotechnology to improve school performance from a neuropsychological perspective. Increasing the number of studies in this area will open up new lines of educational and methodological research. A first step in this analysis is to study the attitudes of students towards technology.

2 Methodology. Experimental design

The present study aims to analyse the attitude of students towards the use of new technologies in a Primary school classroom. The study made use of a questionnaire methodology, and this questionnaire was given to a sample of 1.770 students (Table 1) between 11-12 years old from 50 different CEIP (Infant and Primary schools). We employed a questionnaire with closed questions and two possible outcomes, “Positive” and “Negative”, along several open questions that allowed the participant to provide more detailed information and opinions related to educational contexts and technologies applied to education.

The closed question in the questionnaire was: What do you think of Information and Communication Technologies? This question was also related to other guided open questions to corroborate the perception of the students towards ITC, with the following study indicators: Comprehension of the tools and applications, possibilities to use it as a future working tool; Accessibility for students and teachers, interaction in the classroom, active communication, speed and easiness of use, and educational support.

The questionnaires were given to the students in order to know their attitude, given that, with this information, we could change, modify, or develop different teaching methodologies using ITC as a support to generate new knowledge for the students. The sample analysed in this study was composed of students from the 6th grade of Primary School, recruited from various Infant and Primary Schools in Spain.

Table 1. Sample distribution

	Frequency	Percentage
Male	921	52,0
Female	818	46,2
Total	1.739	98,2
Lost data	31	1,8
Total	1.770	100,0

Statistical analysis

We made use of SPSS 13 (Windows version) package for the statistical analysis. As a preliminary step, we analysed the normality and homogeneity of the variances. In addition, we ran a descriptive analysis of the sample. For each of the analyses, we considered the number of valid cases, excluding cases with lost data. The Frequency tables display the absolute frequency of the valid cases for each of the variables (Frequency), percentage frequency (percentage), percentage frequency of the valid cases, that is, eliminating cases with lost data (valid percentage) and the accumulated percentage frequency (accumulated percentage).
As a measure of the relationship between the variables evaluated in the frequency tables, we used the Chi-square statistical analysis. A $p < 0.05$ value indicated that the variables were related (for some results we also provide the Likelihood ratio). For each relationship of interest, the statistical analysis is provided, with a significance level predetermined at $p<0.05$. Once the relationship between two nominal variables was obtained, we evaluated the strength of this relationship using the Contingency Coefficient. When appropriate, we compared the mean values - for instance the male and female student´s age, using a T Students for independent samples. For all of the cases we adopted a significance level of confidence of 95%, and all cases with lost data were excluded. We applied the Levene (F) test as well as the T (t) statistics, degrees of freedom (df), the bilateral significance, the means differences for each group, and also applied the typical error of the mean difference.

3 Results

After analysing the student´s responses to the open questions, they were asked to respond to the closed question: “What do you think about the Information and Communication Technologies? It was found that 86.3% (1.527 of 1.770 students) of the sample answered with a generally positive opinion of ITC. Their answers to the open questions included the following comments: “They are important because we learn easily and they are fun”, “They allow us to do many things”, “They are fun”, “They are easy to use”, “They provide a higher diversity of activities, and they are useful to gather information easily”, “They are quicker”, “They are important to communicate with others”; “They support the study process”. Apart from the most common answers as seen above, some students pointed out that there are insufficient technological tools in their school or that they are not in use.

The students with negative attitudes to ITC accounted for 5.4% of the total sample (96 of 1.770 students). On the basis of these results, we can conclude that the majority of the students take a positive stance towards ITC. Amongst the negative answers given by the students, some examples included: “We don´t know much about them, They can be addictive”, “They are OK, but I prefer the text book for some things”, “They are a waste of time”. These answers are of interest because they show that some students do not have enough knowledge about ITC, given that in some schools ITC tools are not implemented, or if they are implemented, they are not in use or are only used to project video. Under these circumstances, the students would not be expected to be aware of their functionality or potential educational value. One of the answers that is of special interest is “They can be addictive”. The students are familiar with the use of ITC in their homes without much control other than that of the family. The teachers, however, can offer some guidance in the classroom about the function and use of the tools by using, for instance, programs for learning how to interact with ITC, guides for internet surfing, social networks, and various types of games. There is a percentage of the sample, 8.2 % (146 of the total 1.770) that did not answer this question.

The attitude of the students obtained from the data in this study is somewhat puzzling, given that not all of the students indicated that they like ITC, whilst some did not understand the use of ITC in the classroom as being something positive. Only 60% of the sample stated that they like to use ITC in the teaching-learning process, are motivated by its use, have a better understanding of concepts, and like to write essays with these tools. These data are surprisingly low, given that ITC technologies appear to be generally welcomed by the schools (Table 2).

Table 2: Student´s attitudes towards ICT.

Items	DA%	N%	A%	CA%
I like using ICT as a tool in teaching and learning.	40			60
I don´t like to use ICT as a toll in teaching and learning	40	40	10	10
I am very motivated with the use of ICT in teaching and learning	10		20	60
I like to participate in classes when using ICT	30		20	50
I like to present work with ICT in the classroom as they are very easy to use.	30		10	60
With ICT I can understand the concepts more efficiently	20		20	60
When I use ICT increases my attention in class	20	10	20	50

Scale: DA- Disagree N-Neutral A-Agree CA-Completely Agree.

We also analysed gender differences, in an attempt to examine whether they reflect some of the stereotypical views held in society regarding the use of ITC by male and female children - for example that male children like more ITC than female children. A total of 52 % (921 of the total 1770) were male, whereas 46.2% (812 of the total 1770) we female. Table 3 displays the responses according to gender. Subsequent analysis of these differences revealed that there were no significant differences in the general perception of the use of ITC, but there were significant differences regarding the positive or negative value of these technologies (Table 3).

Table 3. Chi-Square Tests.

	VALUE	DF	ASYMP. SIG. (2-SIDED)
Pearson Chi-square	1,685[a]	2	,431
Likelihood Ratio	1,701	2	,427
Linear-by-Linear Association	1,676	1	,195
N of Valid Cases	1739		

* 0 cells (,0%) have expected count less than 5. The minimum expected count is 6,92.

4 Discussion

The importance that we assign to the use of ITC is of considerable significance (Harrison et al., 2002). Our results show that even in schools that have an equivalent ITC system in place, students perceive these technologies differently in terms of both availability and use of the related tools. In particular, the students can be categorised into two groups according to the type of answer given. Those that say that “The tools in the school are not enough and not used”, and those that perceive that the infrastructure available is adequate and that “The ITC tools are important because we learn easily and have fun”, “They allow us to do many different things”, “We understand them”, “They are easy to use”, “They provide a wider range of activities”, “They support our study”.

The attitude that the students have towards the use of ITC has a significant impact on the learning context, and this attitude is defined by different factors. The skills of teachers in terms of the use of ITC play an important role (Smeets et al., 1999; Veen, 1995). Another aspect that could influence this attitude is the ease with which the students are able to access ITC (Kennewell, Parkinson, & Tanner, 2000; OTA, 1995). This refers not only to the number of computers per student, but also to the positioning of the computer station, for example, the computer room or the classroom. Kennewell et al. (2000) considered that it critical that the computers are placed in the classroom to maximize the opportunities for ITC to be part of the curricular activities. These authors suggested that the number of computers, however, is less important.

Further, the pedagogical perspectives of the teachers and their point of view about how ITC can contribute to the learning context play an important role in the real use of ITC in the classroom (Drenoyanni y Selwood, 1998; Higgins y Moseley, 2001; Hokanson y Hooper, 2000; Niederhauser y Stoddart, 2001). Switching towards a learning context focused on the students, and where teachers create the intellectual learning context is of particular interest. This particularly applies to open learning contexts (Hannafin & Savenye, 1993; Keeler, 1996).

Another factor to take into account is the possibility of a gender difference with regard to the use of ITC. It has been suggested that female children have a less positive attitude towards ITC than male children (e.g., Huber & Schofield, 1998; Makrakis & Sawada, 1996; Volman, 1997). However, we found no significant differences related to gender when analysing the closed question about attitude towards ITC. This could be due to the small differences obtained with young adults (Comber et al, 1997; Durndell, Glissov, & Siann, 1995). The students in our study displayed, in general, positive responses regarding the use of ITC. The students that showed a negative attitude towards the use of ITC accounted for only a low percentage of our sample, particularly with regard to attention, motivation, and a deeper understanding of concepts. We did, however, find a high percentage of respondents with a positive attitude towards the tools and applications, the speed and ease of use of ITC, the confidence of its use at work, the ease of understanding and learning, the interaction in the classroom, or active communication and educational support. This results is surprising if we consider the preference that young students show towards technology Roca (2008). This results could be explained in terms of a higher need of training of the teachers and updating of their knowledge of technological progress and methodological changes that come from neuropsychology and technological research studies. This new knowledge could be implemented in the classroom context to innovate and improve the educational experience in the classroom.

5 Conclusions

We can draw several conclusions from our data with regard to the attitude of students and their perception of the use and influence of ITC in the classroom. All the schools that participated in this study had the same technological facilities, and the pattern of responses was, in general, similar across the schools, regardless of the use of the ITC in the different centres. The opinion of the students towards ITC is, in general, positive, and we found no gender differences in the responses of our participants.

Whilst the attitude of the students towards the technological tools is generally positive in, their evaluation of the use of ITC in the classroom is particularly low. The participants in this study do not regard the use of ITC in the classroom to be adequate, and do not believe that ITC tools could function as a support for improving the understanding of concepts, attention, or the acquisition of knowledge. On the basis of these findings, both educational authorities and teachers should tailor the use of ITC to the individual needs of each technological-educational context when incorporating ITC into the teaching-learning process. The unique requirements of each context would be provided by individualised assessments.

A future perspective could start and focus on developing educational neurotechnology programs for neuropsychological skills training along with programs based on the findings from neurosciences and neuropsychology in order to develop the student´s potential. In addition, these should be adapted to the needs of each educational context to improve the quality of the teaching-learning process.

References

[1] Bearne, E. (Ed.). (1996). *Differentiation and diversity in the primary school*. London: Routledge.

[2] Bennett, N., & Dunne, E. (1994). *The nature and quality of talk in co-operative classroom groups.* Learning and Instruction, 1, 103–118.

[3] Booth, JR., Burman, DD., Meyer, JR., et al. (2003). Neural development of selective attention and response inhibition. Neuroimage 2003; 20: 737-51).

[4] Bova SM, Fazzi E, Gionvenzana A, et al. (2007). The development of visual Object recognition in school age Children. Dev Neuropsychol 2007:31, 79-102.

[5] Bransford, J. D., Sherwood, R. D., Hasselbring, T. S., Kinzer, C. K., & Williams, S. M. (1990). Anchored instruction: why we need it and how technology can help. In D. Nix & R. Spiro (Eds.), *Cognition, education, multimedia. Exploring ideas in high technology* (pp. 115–141). Hillsdale, NJ: Lawrence Erlbaum Associates.

[6] Bressler, A. (2002). In Understanding cognition through large-scale cortical networks. Curr Dir Psychol Sci 2002; 11: 58-61.

[7] Campo, P., Maestú, F., Ortiz, T., et al. (2005).Time modulated prefrontal and parietal activity during the maintenance of intagrated information as revealed by magnestoencephalografy. Cerebr cortex 2005; 15: 123-30.

[8] Carlson, N. R. (1996). *Fundamentos de psicología fisiológica* México: Pearson Pretince Hall.

[9] Chalkley, T. W., & Nicholas, D. (1997). *Teachers' use of information technology: observations of primary school classroom practice.* Aslib Proceedings, 49(4), 97–107.

[10] Chomsky, N. (1968). *Language and mind*. New York: Harcourt, Brace, World

[11] Collins, A. (1996). Design issues for learning environments. In S. Vosniadou (Ed.), *International perspectives on the design of technology-supported learning environments* (pp. 347–361). Mahwah, NJ: Lawrence Erlbaum.

[12] Comber, Ch., Colley, A., Hargreaves, D. J., & Dorn, L. (1997). *The effects of age, gender and computer experience upon computer attitudes.* Educational Research, 9(2), 123–134.

[13] Damasio, H., Grabowski, T. J., Tranel, D., Ponto, L. L. B., Hichwa, R. D. & Damasio, R. A. (2001). Neural correlates of naming actions and of naming spatial relations. NeuroImage, 13, 1053-1064.

[14] Donaldson. M. (1979). *La mente de los niños.* Madrid: Morata.

[15] Drenoyanni, H., & Selwood, D. (1998). *Conceptions or misconceptions? Primary teachers' perceptions and use of computers in the classroom.* Education and Information Technologies, 3, 87–99.

[16] Duffy, T. M., & Knuth, R. A. (1990). Hypermedia and Instruction: Where is the match?. In D. Jonassen & H. Mandl (Eds.), *Designing hypermedia for learning* (pp. 199–225). Berlin: Springer-Verlag.

[17] Durndell, A., Glissov, P., & Siann, G. (1995). *Gender and computing: Persisting differences.* Educational Research, 37(3).
[18] Enríquez, P., Martín-Plasencia, P., Maestú, F., Ríos, M., Periañez, J. A. & Calvo, B. (2006). Neurociencia Cognitiva: Una Introducción. Madrid: UNED.
[19] Ferré, J. y Ferré, M. (2013). Neuro-psico-pedagogía infantil. Bases neurofuncionales del aprendizaje cognitivo y emocional. Barcelona: Lebón.

[20] García, M.L. y Llamas-Salguero, F. (2016). Procesos y programas de Inteligencias Múltiples. En P. Martín-Lobo (Coordinadora) (2015). Procesos y programas de Neuropsicología Educativa. Madrid: Ministerio de Educación Nacional. Centro Nacional de Investigación e Innovación Educativa.
[21] Goldberg M., Maurer D., Lewis T. (2001). Development changes in attention the effects of endogenous cueing and of distracters. Dev Sci 2001; 4:209-19.

[22] González Jiménez, F.E. Et al. (2010). Selección formación y práctica de los docentes investigadores. La carrera docente. Madrid: Universitas.
[23] Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J.M. & Cohen, J. D. (2001). An fMRI investigation of emotional engagement in moral judgment. Science , 293, 2105-2108.
[24] Hannafin, M. J., Hall, C., Land, S., & Hill, J. (1994). *Learning in open-ended environments: assumptions, methods and implications.* Educational Technology, 34(8), 48–55.
[25] Hannafin, R. D., & Savenye, W. C. (1993). *Technology in the classroom: the teacher's new role and resistance to it.* Educational Technology, 33(6), 26–31.
[26] Harrison, C., Comber, C., Fisher, T., Haw, K., Lewin, C., Lunzer, E., McFarlane, A., Mavers, D., Scrimshaw, P., Somekh, B., & Watling, R. (2002). *ImpaCT2. The Impact of Information and Communication Technologies on Pupil Learning and Attainment.* ICT in Schools Research and Evaluation Series – No. 7. Coventry: British Educational Communications and Technology Agency.
[27] Higgins, S., & Moseley, D. (2001). *Teachers' thinking about Information and Communications Technology and Learning: beliefs and outcomes.* Teacher Development, 5(2), 191–210.
[28] Hokanson, B., & Hooper, S. (2000). *Computers as cognitive media: examining the potential of computers in education.* Computers in Human Behavior, 16, 537–552.
[29] Huber, B., & Schofield, J. W. (1998). I like computers, but many girls don't. Gender and the sociocultural context of computing. In H. Bromley & M. W. Apple (Eds.), Education/technology/Power. Educational computing as a social practice (pp. 103–132). Albany: State University of New York Press.
[30] Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). *Learning with technology: A constructivist perspective.* Uper Saddle River, NJ: Merrill.
[31] Keeler, C. M. (1996). *Networked instructional computers in the elementary classroom and their effect on the learning environment: a qualitative evaluation.* Journal of Research on Computing in Education, 28(3), 329–345.
[32] Kennewell, S., Parkinson, J., & Tanner, H. (2000). *Developing the ICT capable school.* London: Routledge Falmer.
[33] Kerry, T., & Kerry, A. (1997). *Differentiation: teachers' views of the usefulness of recommended strategies in helping the more able pupils in primary and secondary classrooms.* Educational Studies, 23(3), 439–457.
[34] Llamas-Salguero, F. (2013) *Repercusiones del uso de las Tecnologías de la Información y la Comunicación en la adquisición de conocimientos en los alumnos de Educación Primaria. Prospectiva para la formación de maestros.* Madrid:UCM
[35] Llinás, R. (2002). El cerebro y el mito del yo. Bogotá: Norma.
[36] Linehan, C.; Lawson, S. y Doughty, M. (2009) *Tabletop Prototyping of Serious Games for 'Soft' Skills Training*. (182-185). Proceedings of 1st International Conference in Games and Virtual Worlds for Serious Applications 2009.
[37] Makrakis, V., & Sawada, T. (1996). *Gender, computers and other school subjects among Japanese and Swedish pupils.* Computers and Education, 26(4), 225–231.
[38] Martín-Lobo, P. (2016). La intervención desde la base neuropsicológica y metodologías que favorecen el rendimiento escolar. En P. Martín-Lobo (Coordinadora) (2015). Procesos programas de Neuropsicología Educativa. Madrid: Ministerio de Educación Nacional. Centro Nacional de Investigación e Innovación Educativa.
[39] Martínez, F. (1994) Investigación y nuevas tecnologías de la comunicación en la enseñanza: el futuro inmediato. Pixel- Bit. *Revista de medios y educación,* 2, 3-17.
[40] Martínez-Montes, E., Valdés-Sosa, P. A., Miwakeichi, F., Goldman, R. I. & Yamaguchi, Y. (2004). Concurrent EEG/fMRI analysis by multiway partial least squares. NeuroImage,22, 1023-1034.
[41] Mooij, T. (1999). *Guidelines to Pedagogical Use of ICT in Education. Paper presented at the 8th Conference of the 'European Association for Research on Learning and Instruction' (EARLI).* Göteborg, Sweden, August 1999.
[42] Niederhauser, D. S., & Stoddart, T. (2001). *Teachers' instructional perspectives and use of educational software.* Teaching and Teacher Education, 17(1), 15–31.
[43] Ortega, (1982). La modernización social como mito. Claves de la razón práctica. Nº 41. Abril.
[44] OTA (1995). *Teachers and Technology: making the connection. Washington DC: Office of Technology Assessment, Congress of the United States/U.S.* Government Printing Office.

[45] Pradas, S. y De la Peña, C. (2015). Programas para superar las dificultades de lenguaje. En P. Martín-Lobo (Coordinadora) (2015). Procesos y programas de Neuropsicología Educativa. Madrid: Ministerio de Educación Nacional. Centro Nacional de Investigación e Innovación Educativa.
[46] Pradas, S. (2016). Neurotecnología Educativa. Madrid: Ministerio de Educación Nacional. Centro Nacional de Investigación e Innovación Educativa.
[47] Piaget, J. (1969). *El nacimiento de la inteligencia en el niño*. Madrid: Aguilar.
[48] Reed, C. L., Shoham, S. & Halgren, E. (2004). Neural substrates of tactile object recognition: An fMRI study. Human brain mapping,21 , 236-246.
[49] Richardson, J. (1997). *Information Technology – a new path to creativity in education.* Paris: Editions ESKA.
[50] Romero, M., Usart, M. y Almirall, E. (2011). *Serious games in a finance course promoting the knowledge group awareness.* (3490-3492). EDULEARN11 Proceedings.
[51] Slavin, R. E. (1995). *Cooperative learning: Theory, research and practice* (2nd ed.). Boston: Allyn and Bacon.
[52] Small, G. (2009). El cerebro digital. Cómo las nuevas tecnologías están cambiando nuestra mente. Barcelona: Urano.
[53] Smeets, E., & Mooij, T. (2001). *Pupil-centred learning, ICT, and teacher behaviour: observations in educational practice.* British Journal of Educational Technology, 32(4), 403–418.
[54] Smeets, E., Mooij, T., Bamps, H., Bartolom_e, A., Lowyck, J., Redmond, D., & Steffens, K. (1999). *The Impact of Information and Communication Technology on the Teacher.* Nijmegen, the Netherlands: University of Nijmegen, ITS. http://webdoc.ubn.kun.nl/anon/i/impaofina.pdf [February 15, 2004].
[55] Stam, C. J. & de Bruin, E. A. (2004). Scale-free dynamics of global functional connectivity in the human brain. Human Brain Mapping, 22, 97-109.
[56] Susman, E. B. (1998). *Co-operative learning: a review of factors that increase the effectiveness of computer-based instruction.* Journal of Educational Computing Research, 18(4), 303–322.
[57] Tejedor, F.J y García Valcarcel, A. (Eds.) (1996). *Perspectivas de las nuevas tecnologías en la educación.* Madrid: Narcea.
[58] Valerio, Caraza, Martínez y Jaramillo (2014). Neurociencia y gestión de tecnologías de información para la educación. México, Monterrey: Instituto Tecnológico de Monterrey. Identificador: http://repositorio.educacionsuperior.gob.ec/handle/28000/1339Rescatado el 29/01/2016
[59] Veen, W. (1995). Factors affecting the use of computers in the classroom: four case studies. In D. Watson & D. Tinsley (Eds.), *Integrating information technology into education* (pp. 169–184). London: Chapman & Hall.
[60] Roca, G. (2008). Soluciones para nuevas realidades. Modelos de negocio en las redes sociales. Madrid: Telos.
[61] Vigotsky, L. (1995). *Pensamiento y Lenguaje.* Barcelona: Paidós Iberica.
[62] Vigotsky, L. (1978). *Mind in society; The development of higher psychological process*. Cambrige: MA; Harverd University Press
[63] Volman, M. (1997). *Gender-related effects of Information and Computer Literacy Education.* Journal of Curriculum Studies, 29(3), 315–328.
[64] Wang, M. C. (1990). *Learning characteristics of pupils with special needs and the provision of effective schooling.* In M. C. Wang, M. C. Reynolds, & H. J. Walberg (Eds.), Special education: Research practice: synthesis of findings (pp.1–34). New York: Pergamon Press.
[65] Williams, D., Coles, L., Wilson, K., Richardson, A., & Tuson, J. (2000). *Teachers and ICT: current use and future needs.* British Journal of Educational Technology, 31(4), 307–320.