Digital communication technologies for teachers of science and mathematics in Mexico

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ABSTRACT

In the current context of the "information society" where knowledge is changing continuously, teachers and schools face difficulty in providing students with the knowledge of significant conditions that make up the scientific, technological and social milieu. Today practicing teachers require technical competence (Oduwa, 2009; UNESCO, 2008; Peralta and Albuquerque, 2007; Lavonen, Jutti, Aksela and Meisalo, 2006) in order to offer students learning opportunities supported by the educational use of Digital Communication Technologies (DCT). This paper investigated competences in the use of DCT by science and mathematics teachers from Mexican public high schools, and whether gender, education level, and seniority are factors that affect the use of DCT. The results of this study are discussed in the context of the National Development Plan (2013-2018) of the government of Mexico.

Keywords: Computer Competency, Computer Skills, Digital Communication Technologies, DCT, Science teacher, Mathematics teacher

INTRODUCTION

In the last few years, comparative scores achieved by junior high Mexican students on the international tests have not been the most encouraging. Scores have not met the expected results, especially on the science and mathematics fields (SEP, 2013; OCDE, 2009; INEE, 2009; UNESCO, 2008, Wang, 2003, INEE 2003). Results demonstrated that students have not been able to obtain the expected minimum knowledge for their respective course levels. Such results have repeatedly put in question the quality of the national education system. The adoption and integration of Digital Communication Technologies (DCT) within the classroom constitutes a new strategy to improve the quality of the teaching methods in the science and the math fields (Supata, 2010; Kalle, Jari, Maija and Veijo, 2009; Park, Khan and Petrina; 2009; Heck, Houwing and Beurs, 2009).

In today's educational setting, it is readily accepted that in order to live, learn and work successfully in an increasingly complex society rich in information-based knowledge (Barnett, 1999 and Wagner, 2010), students and faculty must have a good level of competence and effective use of DCTs. Evidence in this regard is found in the international work done by: Supata (2010) in India, Park, Khan and Petrina (2009) in Korea; Heck, Houwing and Beurs (2009) in Holland, Dawson (2008) in Australia; Driscoll (2007) in the United States and Zounek (2005) in the Czech Republic. All of the above studies have called for projects to encourage and strengthen the teaching of science and mathematics in basic education, but integrating the use of DCT.

From the perspective of developed countries that are considered world leaders in the field of DCT in education, the introduction of technology in the classroom goes beyond the strengthening of infrastructure on to the expansion the provision of computer equipment and compliance indicators to ensure connectivity in educational institutions. Beyond this, these countries see DCT as an essential cultural element: if the teachers and administrators conceive technology as a tool that should be conceived, designed, developed and distributed to support the acquisition and improvement of learning. These educational leaders promote environments involving such significant variables as the needs of the institution, academic performance, satisfaction and skills for the use of DCT between students and teachers (Severin and Capota, 2012; Claro, 2010; BECTA, 2009).

The *E -Learning Nordic* project (Gertsen, Malmberg, Christensen, Pedersen, Nipper, Duelund & Norrgard , 2006), by the *British Educational Communications and Technology Agency* known as The BECTA (BECTA , 2006); and the policy paper *The Horizon Report* (Johnson, Smith, Willis, Levine, & Haywood, 2011), are clear evidence of the concern of countries like Finland, Denmark, the United States, Norway and the UK, to document the uses they are giving to the DCT to enhance student learning, as well as to provide better practices for using these technologies so as to impact educational programs and promote their integration. Similarly, international entities such as the *Organization for Economic Co-operation and Development* (OECD), the *United Nations Educational Scientific and Cultural Organization* (UNESCO) , the *World Bank* (WB) and the *Inter-American Development Bank* (IDB) primarily focus their efforts in the search for empirical evidence (through the creation of conceptual frameworks, building performance standards in the use of DCT, and project financing) to facilitate the decision making processes to boost the promotion of professional development of teachers and students, in order to promote country development.

In this context, various institutions concerned with technological innovation have developed and disseminated proposals of performance standards related to the DCT. Pursuant to this, they have delineated the knowledge, skills and attitudes that teachers and students should be able to master in the use of DCT in the knowledge society, working jointly with educational agencies and administrators both nationally and internationally.

A review of relevant literature finds the extant DCT standards primarily in the United States, the United Kingdom, the European Community, Australia, and Chile. Table I summarizes the relevant characteristics and standards by different institutions among different countries as indicated in Table 1 (Appendix).

Proficiency standards in DCT for teachers acknowledge that teachers play the most important role in the task of helping students gain important skills in the use of DCT, being responsible for both the design of learning opportunities and the creation of an environment in the classroom to facilitate the use of DCT for pedagogy and communication (UNESCO, 2008). For this reason, it is essential that teachers are prepared to offer these opportunities to their students. However, contrary to the unequivocal international guidelines for designing a usage model for the DCT gathering standards, connectivity and definition of competencies to achieve, Mexico lacks a manual of standards of competence that includes the documentation of these processes, unlike countries such as the UK (*ICT Competency Standards for Teachers*) (UNESCO, 2008); Australia (*Teacher ICT Skills*) (Department of Education and Training, 2006); China (*China Educational Technology Standards*) (UNESCO, 2007); Camerún, Congo, Burkina Faso, Senegal, Angola, Namibia, Mali, Madagascar, Ghana, Guinea (*ICT- enhanced Teacher Standards for Africa -ICTeTSA-*) (UNESCO-IICBA, 2012); and Chile (*Estándares TIC para la formación inicial docente*) (OREALC/UNESCO, 2008).

The challenge for this study is to address the need for the development of competency standards for the use of DCT in teaching science and mathematics in basic education. In light of this, it is necessary to consider that in the southeast region of Mexico, specifically to the state of Yucatan, it is still unknown what should be the necessary skills that a teacher of these areas and educational level should possess, for the proper use of the DCT.

The problem is exacerbated when the results obtained by Mexican students in the last PISA test for Mexico, conducted in 2009, are examined. This test evaluated the areas of reading, math and science, and its main purpose was to determine the extent that 15year-old students, who are close to completing their middle school education, have acquired the relevant skills to participate actively and fully in modern society. The information derived from this assessment identifies the proficiency level of students in the evaluated areas and can be compared with other countries participating in the study. The results in the area of science provide evidence that within the 65 countries who participated in the study, 14 have a lower mean than Mexico, 49 a higher mean and only Jordan scored an average statistically similar (INEE, 2010).

Analyzing the situation of Mexico in the Latin American context (LA), it has shown a higher mean in science compared to the regional average of LA. Within the Latin American countries who participated on the PISA assessment in 2009, Peru, Panama, Argentina, Colombia, Brazil and Trinidad and Tobago obtained statistically below average scores than Mexico, surpassed only by Uruguay and Chile.

Analyzing the last three national education programs (2001-2006, 2007-2012, 2013-2018) empirical evidence reveals that since 2001 the teaching of science as well as the DCT are considered essential elements and are given priority among pedagogical initiatives that seek to improve the quality of education in the country (as indicated in Table II).

As shown in Table II, the analysis of the extracted paragraphs of official documents, show a clear concern for the improvement of science education and the incorporation of DCT in the process of teaching and learning, emphasizing that both strategies have been referred to as priority elements help Mexico to become a successful participant in the knowledge society.

More specifically, when analyzing the context of the study population, the results relating to the state of Yucatán show that average performance on an overall scale by state, science performed poorly. In was also detected that the "national average." Students from Yucatan had scores below the national average, which highlights the urgent need to reinforce the learning competence in this area and educational level. Thus, it is crucial that for both science and mathematics, the DCT of teachers of public schools in Yucatan should be studied in order to improve and enhance its effectiveness in science and mathematics education.

METHOD

Participants

Seventy (70) teachers who teach science at the secondary level (1st, 2nd and 3rd) from 18 federal and state secondary schools in the city of Merida, Yucatan participated in this study. Table III summarizes the characteristics of the participating schools in the sample. The selection of these was totally random and performed keeping the proportions between state and federal schools. As it can be indicated in Table III, all federal schools operate with two shifts, but not for the case of state schools, most operate with different shifts and only two share the characteristics of federal schools.

Of the 70 teachers who provided data, 32 belonged to the federal schools and 38 to the regional state schools. The teachers in the study taught any of the following subjects: biology, physics, chemistry and mathematics.

The ages of these teachers were between 22 and 62 years, and the average age of teaching was 22 years. It is important to highlight that most of them have a college degree, followed by those with postgraduate degrees.

Instrument and Technical Indicators

Three sections were considered to build the instrument: two of them gather general data relevant to the study (individual and institution) and one section dedicated to the skills for the use of DTC. The latter integrated a Likert scale, involving a section of domain importance and interest. The reliability indicator was obtained by calculating the Cronbach alpha coefficients corresponding to these sections, the results are indicated in Table IV.

The conceptual basis of some researches performed by Suarez Almerich, Gargallo, Aliaga, (2010), Kemp, L.; Engan-Barker, D., Lewis, J.; Coursol, D.; Descy, D., Nelson, A., Krohn, S., Moore, S. (2000) and Cano (2005) were taken as reference to build the instrument of study.

The *skills for the use of DTC* section was integrated for questions that were answered with a Likert type rating scale to collect primary data to determinate the extent of competence (as indicated Figure 1). The response was issued using an ascending numerical scale 1-5, that would locate the answers to a precise range, so that the responses of the participants could be transformed at intervals for analysis. Consistent with the use of a dichotomous scale, the participant was directed to answer, how important was the competency within the context of their profession, and if he would be interested in learning it.

Procedures

To determine the degree of normality of the 13 distributions and see if they fit or not an expected distribution, goodness of fit test Kolmogorov-Smirnov (KS) was used. Table V shows the indicators of central tendency and levels of significance for each of the observed variables. The test results indicate that only the variables: 10, 11 and 13 do not meet the criteria of normality to be $p <.05$.

Once the behavior of the distributions is known, and the criteria of normality, the three most significant variables for this study were analyzed: gender, level of education and seniority.

For purposes of statistical analysis of the distributions of the first two variables and taking into account their characteristics of normality and grouping a U test Mann Whitney was made for two groups.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - \Sigma R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \Sigma R_2$$

Where:
n1 = sample size of group 1
n2 = sample size of group 2
R1 = sum of the ranks of group 1
R2 = sum of the ranks of group 2

For purposes of analysis, the variables were reorganized as follows: the *gender* variable joined categories: man and woman; the *highest earned degree* variable was regrouped into two categories: degree (which included teachers with undergraduate and graduate) and graduate (which included teachers with specialization, masters and doctoral) in order to facilitate the analysis according to statistical criteria.

Then to analyze the *seniority* variable and considering the characteristics of normality and grouping an extension of the U Mann Whitney test, the Kruskal-Wallis test was performed, because the variable was regrouped as an ordinal level variable into 4 separate groups that encompassed the seniority of teachers (Up to 10 years; 11 to 20 years; 21 to 30 years, and 31-40 years).

RESULTS

Table VI includes the analysis of the competencies of the instrument. The results showed that global averages with the highest scores were found in the variables: MadVar11 (General attitudes towards the DCT) MadVar5 (Word Processing) and in MadVar1 (Basic knowledge of computer systems). Means with the lowest scores were found in: MadVar13 (use of web 2.0 tools), MadVar8 (the use and construction of database) and MadVar12 (Use technology platforms). The table below allows the reader to grasp the ranking of perceived levels of computer competence for math and science teachers. It will provide us with ideas about perceived DCT of math and science teachers in Mexico. These results help us to identify their training needs, and to ascertain critical areas on which they should focus their technological empowerment programs at the institutional level.

Gender, Highest Earned Degree and Seniority.

In this section, we would like to examine potential impacts of gender, highest degree, and seniority of teachers of mathematics and science in public high schools in the southeast of Mexico and their DCT. First, we examine characteristics of teachers who participate in the study are presented in Table VII. It is found that we have more males (62%) than females (38%). It is also found that 70% of teachers received college degree and some additional training. Only 30% of these teachers have advanced degree. Most teachers (44%) have taught 21 to 30 years. The second largest group is those teachers who have taught 11 to 20 years (30%). About 16% of teachers have taught 31 to 40 years and 10% of them taught 10 years or less.

The results of the bivariate relationships were presented in Table VIII where *p* values are presented for the tests applied to each of the studied variables. Specifically for the *gender* variable, tests showed that MadVar1 (Knowledge of computer systems); MadVar7 (Use of spreadsheets) and MadVar13 (web 2.0 tools) are statistical significant. The relationships between gender and other competencies are found to be independent. It implies that when we plan to conduct training, gender differences for knowledge of computer systems, use of spreadsheets, and web 2.0 tools should be addressed.

Educational backgrounds found to be associated with six different type of DCT in six different areas, i.e. 1) knowledge of computer systems, 2) use of spreadsheets, 3) use of database, 4) online procedures, 5) general attitudes toward CDT, and 6) web 2.0 tools. Seniority was found to associate with all six areas but general attitudes towards DCT. In other words, government or school administrators should pay attentions to educational background and seniority that have impacts on their computer knowledge and general attitudes as well as specific technologies in spreadsheets, database, online procedures, and web 2.0 tools. This study provide a valuable insight regarding to some demographic differences and educational backgrounds.

DISCUSSION

The literature on the use of technologies recommends the measurement of the impact of TCD in student learning, innovation and technological development of countries (UNESCO, 2013, *The Horizon Report*, 2011, *World Bank*, 2010; BECTA, 2006, *E-Learning Nordic* 2006). Some strategies documenting these measurements in developed countries are: *The Little Data Book on Information and Communication Technology*, *Information and Communication Technology for Education in India and South Asia* both the World Bank (2011 , 2010), and *Are the New Millennium Learners Making the Grade: Technology Use and Educational Performance in PISA* by the OECD (2010). The first traces the progress of the technological revolution for 213 countries worldwide. The second focuses on the enrichment of the pedagogical training of teachers in primary and secondary education in the development of specific tasks and providing opportunities to supplement their training in the specific area of expertise in a more convenient and flexible way across India , Pakistan and Sri Lanka. Finally, the third analyzes to what extent investments in technology enhance educational outcomes for the countries belonging to the OECD.

Yet despite recommendations made by some international organizations (UNESCO, ISTE, OECD, IDB) and a multiplicity of authors (Severin and Capota, 2012, 2011, Claro, 2010; Underwood, Baguley, Banyard, Coyne, Farrington, Selwood and Selwood, 2007; Butt and Cebulla, 2006; Harrison, Comber, Fisher, Hawe, Lewin, Lunzer, McFarland, Mavers, Scrimshaw, Somekh, and Watling, 2002; Pittard, Bannister and Dunn, 2003) who have conducted scientific studies to analyze the impact of DCT in the education of students, in Mexico, there is little scientific research existent in this area. Therefore, progress towards shaping the definition of competency standards for the use of DCT in basic education teachers is slow. So too is the delineation of action frameworks for curriculum integration of DCT, as well as the development of methodologies that include the implementation of a systematic monitoring to allow the measurement of the impact of DCT, as is being done in the developed countries.

Improving student learning through the use of DCT, is more than: merely providing technology infrastructure to educational institutions; creating community centers with Internet access for children and young people in rural areas; and training teachers in intensive courses of 3-5 days, with the with the mandate to apply that knowledge in their classrooms.

In this paper, we have ranked skill levels of the secondary science teachers when it comes to the utilization of DCT as a factor in improving educational quality, aligning our study with the recommendations of the World Bank (2010), Claro (2010) and UNESCO (2008). Besides the perceived levels of computer competence for high school science teachers, we included gender, highest level of education and seniority as potential factors that associate with different DCTs.

The implications of the results of this study shall be discussed in the context of the proposed National Development Plan (PND: 2013-2018) for Mexico and the State Development Plan (PED: 2012-2018) for Yucatan, taking into consideration that both documents recognize that the completion rate of primary education is low (from 100 children entering primary, only 76 complete secondary in a timely manner), more action is needed to keep young people in the classroom, while the quality of basic education remains a major challenge. According to these official documents, a way to achieve quality improvement at this level is to have teachers, principals and trained supervisors creating true learning environments that can unlock continuous innovation processes through the accessibility and usability of DCT. It will help government and school administrators to be more focused on different DCTs when they deal with different teachers.

In this regard, one of the main goals being considered in both official documents, on both the nation and state level, is: "*to promote the incorporation of new technologies of information and communication in the teaching-learning process*" (Strategy 3.1.4). However, despite the recommendations found in official documents, the work towards developing a national educational computer policy to ensure connectivity in educational institutions, the development of performance standards in the use of DCT for students and faculty, and intensification in the use of technological innovation tools at all levels of the education system remains inadequate.

Based on our results, we infer that teachers need better training for the effective use of DCT, considering differentially the role of such variables as education level and seniority. More specifically, it is necessary that institutions working in the development of competency standards extend the results of this study, pursuing similar research that considers more contextual analysis, changes in teaching practices, and experience in the digital milieu. If, according to Severin and Capota (2012), the technology is simply incorporated as a new tool to perform the same functions as before, positive educational impacts will be few if any.

This study provides the basis for considering other variables that should be included when measuring the impact of DCT on the students learning process. Subsequent research should: 1) identify the various applications of DCT that improve student learning ascertain best practices in the use of DCT that are related to the program objectives; 2) deepen the theoretical and practical knowledge of visual, sound and audiovisual languages; and 3) support the development of appropriate digital learning resources, in order to better differentiate and organize collaborative work, endowing them with clear objectives. Finally it is recommended that academics and practitioners design systems to monitor the use of DCT, as well as to develop methodologies that allow them to fully exploit the use of DCT in targeted subject areas (e.g. reading, writing, arithmetic). The rationale for integrated and extensive use of DCT in the classroom is already established. This study revealed some of the current gaps in DCT use and competence, and furthermore illumined a number of factors to be considered in future attempts to address these gaps.

REFERENCES

Barnett, R. (1999). Realizing the University in an Age of Supercomplexity. Buckingham, SRH & OU.

BECTA (2006). The Becta Review 2006. Evidence on the progress of ICT in education. BECTA ICT Research. www.becta.org.uk

BECTA (2009). The impact of digital Technology. A review of the evidence of the impact of digital technologies on formal education. www.becta.org.uk

Butt, S., and Cebulla, A. (2006). E-maturity and school performance –A secondary analysis of COL evaluation data. London: National Centre for Social Research. Becta.

Cano, E. (2005). Como mejorar las competencias de los docentes. Guía para la autoevaluación y el desarrollo de las competencias del profesorado. Grao, Barcelona.

Claro, M. (2010). La incorporación de tecnologías digitales en educación. Modelos de identificación de buenas prácticas. Naciones Unidas. Recuperado de: http://www.eclac.org/publicaciones/xml/8/40278/tics-educacion-buenas-practicas.pdf.

Dawson, V. (2008). Use of Information Communication Technology by Early Career Science Teachers in Western Australia. International Journal of Science Education. Vol. 30, No. 2, 5 February 2008, pp. 203–219. Recuperado el 12 de marzo de 2011, de la base de datos EBSCOHOST. [SE27601556].

Driscoll, D. (2007). Technology In Massachusetts Schools. Massachusetts Departament of Education.350 Main Street, Malden, M.A 02148-5023. Recuperado el 03 de agosto de 2011, de la base de datos EBSCOHOST. [ED508403].

Gertsen, S., Malmberg, P., Christensen, A.; Pedersen, M., Nipper, S., Duelund, C. & Norrgard, J., (2006). E-learning Nordic 2006. Impact of ICT on education. Ramboll Management. Denmark.

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. DfES/Becta.

Heck, A, Houwing, H, y de Beurs, C. (2009). “An e-Class in Action: Experiences with ICT-intensive Teaching and Learning of Discrete Dynamical Models at Secondary School.” Electronic Journal of e-Learning Volume 7 Issue 1 2009, (pp41 - 52), available online at www.ejel.org.Recuperado el 03 de agosto de 2011, de la base de datos EBSCOHOST. [EJ867101].

INEE (2003). Tercer Estudio Internacional de Internacional de Matemáticas y Ciencias Naturales (TIMSS): Resultados de México en 1995 y 2000. Informe Técnico.

INEE (2009). México en PISA 2009. México, D.F

INEE (2010). México en PISA 2009. México, D.F

Johnson, L., Smith, R., Willis, H., Levine, A., and Haywood, K., (2011). The 2011 Horizon Report. Austin, Texas: The New Media Consortium.

Kalle J., Jari L., Maija A. &Veijo M. (2009). Adoption of ICT in Science Education: a Case Study of Communication Channels in A Teachers’ Professional Development Project. University of Helsinki, Helsinki, FINLAND.

Kemp, L.; Engan-Barker, D.; Lewis, J.; Coursol, D.; Descy, D.; Nelson, A.; Krohn, S.; Moore, S. (2000). Technology Competencies in Teacher Education. Minnesota State Colleges & University, Mankato.

Lavonen, J.; Juuti, K.; Aksela, M.; y Meisalo, V. (2006). A professional development project for improving the use of information and communication technologies in science teaching.Technology, Pedagogy and Education. Vol 15, No 2, July. pp. 159-174. Recuperado el 04 de agosto de 2011, de la base de datos EBSCOHOST. [21142329].

OCDE (2009). PISA 2009 Results: What Students Know and Can Do. Student Performance in Reading, Mathematics and Science, Volumen 1, 2009. www.pisa.oecd.org

OCDE (2010). Are the New Millennium Learners Making the Grade?: Technology Use and Educational Performance in PISA 2006. París. OCDE.

Oduwa, S. (2009). Nigerian Inservice Teachers´ Self-Assessment in Core Technology Competences and Their Professional Development Needs in ICT. Journal of Computing in Teacher Education. Volume 26/ Number 1 Fall 2009. www.iste.org

Park, H.; Khan S. Y Petrina S. (2009). ICT in Science Education: A quasi-experimental study of achievement, attitudes toward science, and career aspirations of Korean middle school students. International Journal of Science Education. Vol. 31, No 8, 15 May 2009, pp. 993-1012. Recuperado el 04 de agosto de 2011, de la base de datos EBSCOHOST. [39566798].

Peralta, M. & J. Albuquerque (2007). “Teachers’ Competence and Confidence Regarding the Use of ICTs”. En: Sisifo. Educational Sciences Journal, 03, pp. 75-84, disponible en; http://sisifo.fpce.ul.pt/pdfs/sisifo03ENGa06.pdf

Pittard, V, Bannister, P & Dunn, J 2003, The Big pICTure: The Impact of ICT on Attainment, Motivation and Learning, DfES Publications, UK. http://www.dfes.gov.uk/research/data/uploadfiles/ThebigpICTure.pdf

Secretaria de Educación Pública (2013). Plan Nacional de Desarrollo 2013-2018. México: Autor

Secretaria de Educación Pública (2012). Plan Estatal de Desarrollo Yucatán. 2012-2018. México: Autor

Secretaria de Educación Pública (2007). Programa Sectorial de Educación 2007-2012. México: Autor

Secretaria de Educación Pública (2001). Programa Nacional de Educación Superior 2001-2006. México: Autor

Severín, E. y Capota, C. (2011). Modelos Uno a Uno en América Latina y el Caribe. Panorama y perspectivas. Banco Interamericano del Desarrollo. http://www.iadb.org

Severín, E. y Capota, C. (2012). Enseñar con tecnologia. En Cabrol y Székely (Ed.) Educacion para la transformación (pp.245-278). Banco Interamericano de Desarrollo.

Suárez, J.M. Almerich, G. Gargallo, B. y Aliaga, F. (2010). “Las competencias en TIC del profesorado y su relación con el uso de los recursos tecnológicos” Archivos Analíticos de Políticas Educativas, 18 (10). Recuperado 15 de Febrero de la base de datos EBSCOHOST. [51203557].

Sutapa B. (2010). Enabling Secondary Level Teachers to integrate Technology through ICT integrated Instructional System. India. Recuperado el 11 de Junio de 2011, de la base de datos EBSCOHOST. [ED511722].

Teacher ICT Skills (2006). Evaluation of the Information and Communication Technology (ICT) Knowledge and Skill Levels of Western Australian Government School Teachers Department of Education and Training. Department of Education And training.

Underwood, J., Baguley, T., Banyard, P., Coyne, E., Farrington, L., Selwood, F., & Selwood, I. (2007). Impact 2007: Personalising learning with technology. UK: British Education and Communications Technology Agency (BECTA). Accessed November 28, 2009, from http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/impact_July2007.pdf

UNESCO (2013). Enfoques estratégicos sobre las TICS en Educación en América Latina y el Caribe. OREALC/UNESCO. Santiago.

UNESCO (2012). ICT-enhanced Teacher Standards for Africa (ICTeTSA).UNESCO-IICBA. Ethiopia

UNESCO (2008). Estándares TIC para la formación inicial docente: Una propuesta en el contexto chileno. Centro de Educación y Tecnología del Ministerio de Educación de Chile (ENLACES). Santiago de Chile. www.unesco.cl

UNESCO (2007). ICT in Teacher Education. Case Studies from the Asia-Pacific Region. Bangkok, Thailand. www.unescobkk.org/education/ict

Wagmer, T. (2010). The Global Achievement Gap. Nueva York: Basic Books.

Wang, J.(2003). An Analysis of Item Score Difference between 3rd and 4th Grades Using the TIMSS Database. Paper presented at the Annual Metting of the American Educational Research Association, Chicago, IL

World Bank (2010). Información and Communication Technology for Education in India and South Asia. Essay II. ICT in School Education (Primary and Secondary). InfoDev. PriceWaterhouseCoopers.

World Bank (2011). The Little Data Book on Information and Communication Technology. Washington, D.C. USA.

Zounek, J. (2005). ICT and learning-and teaching-friendly environment in contemporary Czech school. Conference paper presented at the European Conference on Educational Research, University College Dublin, 7-10 September. Recuperado el 12 de marzo de 2011, de la base de datos EBSCOHOST. [ED490735].

APPENDIX

Table I. Characteristics and Standards of DCT in Different Institutions and Different Countries

Country	Institution	Characteristics and Standards
United States	International Society Technology Education	Integrate categories to strengthen DCT, giving the teacher references for creating more interactive learning environments.
United Kingdom	ICT Competency Standards for Teachers	Provide guidance and guidelines for all teachers to plan training programs and course selection to improve their development; also facilitate the technological training of students under their tutelage.
European Community	European Pedagogical ICT	Ascertain the level of teachers and of the use of DCT in order to contribute to an improvement in teaching practices.
Australia	Department of Education and Training.	Implement a valid and reliable assessment to assure: • The level and nature of the skills that teachers have about DCT • The extent to which they are integrating them • The impact on DCT skills development • Determine the potential of enhanced DCT
Chile	Center of Education and Technologies	Provide guidance to teachers for the appropriate use of new tools for creating rich learning environments in learning activities, opportunities for access to knowledge and creative value.

Table II. Importance of Science, Math and DCT in the National Education Programs since 2001

National Education Program (NEP)	Objective/ Strategy	Description
2001- 2006	3.2.2 2.4	Evaluations in the last decade showed unsatisfactory results at all levels, especially in the area of science, math and verbal reasoning. At the same time, there are marked disparities in educational attainment in demographic segments of poverty, as well as among rural and indigenous areas. In this objective, educational innovation considers the DCT will attend opening new perspectives for wider and better educational needs, increasingly urgent and different every day, not only for those who have not completed their basic education, but also for those who have already graduated from higher levels.
2007- 2012	1.5 Objetive 3	Coordinate efforts and establish mechanisms to ensure the development of cognitive skills and basic numeracy skills to enable all students to continue learning. Create a National Program focused on mathematical and logical thinking and the application of science in daily life. This objective center its attention on the development and use of DCT in the educational system to support student learning, expand their life skills and promote their integration in the society of knowledge.
2013- 2018	III.1 Diagnostic VI.3 Strategy 3.1.4	The quality of basic education remains a major challenge. In the latest PISA assessment (2009) in which assessed areas as reading, math and science in Mexico ranked 48th in the 65 participating countries and in the last of the then 33 member countries of the OECD. The *Mexico with Quality Education Strategy* seeks to promote the incorporation of ICTs in the teaching-learning process. Promoting a national policy on computer education for students to develop their skills of learning to learn through the use of ICT.

Table III. Characteristics of the participant schools.

School Name	School Type	Shift	Postal Code	Participating Teachers
SBB	Federal	Morning / Afternoon	97100	6
JV	Federal	Morning / Afternoon	97280	4
EVR	Federal	Morning / Afternoon	97070	5
ABV	Federal	Morning / Afternoon	97219	4
JEVG	Federal	Morning / Afternoon	97240	4
EAG	Federal	Morning / Afternoon	97169	5
JRH	Federal	Morning / Afternoon	97248	4
GNB	State	Morning / Afternoon	97160	4
SR	State	Morning	97285	6
AVC	State	Morning / Afternoon	97155	3
GSA	State	Morning	97200	4
LAB	State	Morning / Afternoon	97156	4
RM	State	Morning	97000	3
CCA	State	Morning	97110	3
AFV	State	Night	97000	2
BJG	State	Morning	97022	2
HLyL	State	Afternoon	97000	4
ACC	State	Morning	97146	3

Table IV. Reliability of the Three Sections of the Instrument

Sections of the scale	Cronbach Alpha
Domain	.986
Importance	.950
Interest	.925
Total	.970

Figure 1. Example of Statement and Format Response Scales

<table>
<tr><td>To what extent I have the competence? (HPTC)</td><td colspan="7">1. I do not possess it at all, I do not have the knowledge.
2. I barely possess it
3. I moderately possess it
4. I greatly possess it
5. I fully possess it, I have full domain of it.</td></tr>
<tr><td>Is it important to do my job? (EIT)</td><td colspan="7">1. Yes ☐ 2. No ☐</td></tr>
<tr><td>Am I interested in learn it? (EIA)</td><td colspan="7">1. Yes ☐ 2. No ☐</td></tr>
<tr><td rowspan="2">Competence: Using Technology Platform</td><td colspan="5">HPTC</td><td>EIT</td><td>EIA</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Yes ☐ No ☐</td><td>Yes ☐ No ☐</td></tr>
<tr><td>Incorporates electronic links to facilitate the use of open access materials to students</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Yes ☐ No ☐</td><td>Yes ☐ No ☐</td></tr>
</table>

Table V. Normality Test Kolmogorov-Smirnov for Integrative Variables

Code	Integrted Variable Name	$\bar{X}$	*DE*	*p*
MadVar1	Knowledge of computer systems	3.61	1.01	.064
MadVar2	Use of the operative system (OS)	3.27	1.21	.291
MadVar3	Search and selection of information through internet	3.49	1.12	.347
MadVar4	Interpersonal communication and online collaborative work	3.10	1.30	.374
MadVar5	Word processing	3.65	1.12	.160
MadVar6	Image processing	3.18	1.37	.125
MadVar7	Use of spreadsheets	2.85	1.27	.100
MadVar8	Use and construction of databases	2.40	1.21	.054
MadVar9	Entertainment and learning with DCTs	3.36	1.21	.108
MadVar10	Online procedures	2.47	1.51	*.007
MadVar11	General attitudes towards the DCT	3.78	1.25	*.028
MadVar12	Use of technology platforms	2.41	1.41	.304
MadVar13	Use of web 2.0 tools	1.84	1.07	*.002

*p<.05

Table VI. Rankings of Means Competency Variables

Code	Competency Areas	$\bar{X}$	σ
Var11	General attitudes towards the DCT	3.78	1.25
Var5	Word processing	3.65	1.12
Var1	Knowledge of computer systems	3.61	1.01
Var3	Search and selection of information through internet	3.49	1.12
Var9	Entertainment and learning with DCTs	3.36	1.21
Var2	Use of the operative system (OS)	3.27	1.21
Var6	Image processing	3.18	1.37
Var4	Interpersonal communication and online collaborative work	3.10	1.30
Var7	Use of spreadsheets	2.85	1.27
Var10	Online procedures	2.47	1.51
Var12	Use of technology platforms	2.41	1.41
Var8	Use and construction of databases	2.40	1.21
Var13	Use of web 2.0 tools	1.84	1.07

Table VII. Characteristics of the Sample

Characteristics of the Sample	*n*	%
Gender		
Male	44	62
Female	26	38
Total	70	100.0
Academic level		
Undergraduate	49	70
Graduate	21	30
Total	70	100.0
Seniority		
Up to 10 years	7	10
11 to 20 years	21	30
21 to 30 years	31	44
31 to 40 years	11	16
Total	70	100.0

Table VIII. Significance Levels with Competency Variables and Variables of Gender, Highest Earned Degree and Seniority.

	Non parametric Statistics		
Variables	U de Mann Whitney		Kruskall Wallis
	Gender	Highest Earned Degree	Seniority
MadVar1 (Knowdege of Computer Systems)	*.038	*.008	*.038
MadVar7 (Use of Spreadsheets)	*.034	*.029	*.002
MadVar8 (Use of Databases)	.090	*.004	*.008
MadVar10 (Online Procedures)	.135	*.005	*.031
MadVar11 (General Attitudes Towards DCT)	.927	*.023	.297
MadVar13 (Use of Web 2.0 Tools)	*.017	*.001	*.000

*p<.05