Digital competence as an indicator of the impact of ICT educational policies: Validation of a theoretical model using PLS

Jesús Conde-Jiménez

Universidad Loyola Andalucía, Spain, jconde@uloyola.es, ORCID: 0000-0002-4471-5089

Abstract

Currently, there is a need to assess the impact of ICT educational policies in educational centres. In this study, the level of digital competence of students is proposed as an indicator of the impact of these policies. However, there is an international problem when it comes to measuring this competence due to its diversity and conceptual complexity. This study presents a theoretical model of conceptualisation and systematisation of digital competence through various constructs derived from the sociocultural approach (Command, Privileging, Appropriation and Reintegration). The empirical validation of this model is the main purpose of this article. The sample of this study consists of 1,881 students of primary and secondary education of the autonomous community of Andalusia (Spain). For the data collection, an ad hoc questionnaire of 22 items is created. A statistical analysis based on structural equation model (SEM) is applied using the SmartPLS 2.0 M3 programme. The results reveal that the theoretical model is valid and has a predictive power (R^2 0.712 and Q^2 0.7087). To conclude, the validation of this theoretical model is a first step for the consideration and creation of digital competence as an indicator of the impact of ICT educational policies.

Keywords: digital competence, ICT, educational policy, validation, model, indicator

Introduction

Currently, there are different international organisations (European Commission, 2016; OECD, 2015; ECLAC, 2010) that point out the need to achieve citizens' digital literacy. In this way, from the different governments, different strategic political actions are generated, mainly in the field of education, to achieve this purpose, which are called ICT education policies. Broadly speaking, these strategic policy guidelines aim to make ICT become mediating tools for teaching-learning processes. That is, it is intended to ensure that ICT are resources that are used for the personal and educational development of students. Along with the generation of these policies, a line has been created to evaluate the effect and impact of these policies in terms of the levels of implementation of digital technologies in educational contexts. This research line, of an eminently evaluative nature, has arisen in parallel in different geographical regions during the last decade (Area, 2010; De Pablos et al., 2010; González, 2011).

According to Colás et al. (2015) and Conde et al. (2017), this line has been generating indicators to assess the level of impact of ICT education policies in the different education systems. According to these authors, depending on the indicators used to gather information on the application of these policies, there are different studies that can be classified based on three underlying evaluative approaches at the macro-structural, meso-structural and micro-structural levels. At the macro-structural level, the most external, there is an evaluative approach of a descriptive nature that uses indicators that are visible and therefore directly measurable, such as the public economic expenditure dedicated to the technological endowment, the number of hours that teachers use ICT and the ratio of computers per subject. Then, at the meso-structural level, there are studies that investigate the use practices of ICT tools and intend to interpret ICT integration and management models in school contexts. Some indicators located at this level could be the types of practices generated in the classrooms, the perceived usefulness of ICTs by educational agents and the attitudes of teachers and students against the use of ICT, among others.

Finally, at the micro-structural level, an evaluative approach based on the internal changes generated in the subjects is placed, and it would encompass indicators linked to emotional states or the level of achievement of digital competence. At this level, the reference object is people, whose emotional states and

learning are in turn a consequence of digital transformation driven by ICT policies. So in this study, the level of digital competence of teachers and students is presented as an indicator of success of ICT education policies (Colás et al., 2015, 2016a; Conde, 2017).

Specifically, digital competence is one of the key competences for lifelong learning that is included in any international education system and is considered a transversal competence since it allows the acquisition of others (European Commission, 2006, 2018). This crossed and multivariate nature is the origin of the existing difficulty to conceptualise and systematise it (van Deursen & van Dijk, 2009; Sefton et al., 2009; Ala-Mutka, 2011). This difficulty is a handicap to design instruments to objectively measure digital competence (Zhong, 2011). Several international evaluation standards (ISTE, 2007; UNESCO, 2008, 2011; Ferrari, 2013) and specific diagnostic tests (Claro et al., 2012, González et al., 2012) have been created to measure the digital competence of both students and teachers. The important work developed by the European Commission (2017) in this regard should be noted, since it has allowed the development of different proposals to assess key competences through ICT (Redecker & Johannessen, 2013, Redecker et al., 2012). However, despite all these proposals, most of these proposals are based on theoretical models that have not been empirically validated. For this reason, in this paper, we propose an empirically validated theoretical model of digital competence conception from the sociocultural approach that allows it to be constituted as an indicator of the impact of ICT education policies.

1. Digital competence from the sociocultural approach

Previous studies have proposed a conceptual model of digital competence from a sociocultural perspective (Conde, 2017; Colás et al., 2016b). Having as a theoretical basis the Vygotskian sociocultural approach, a comprehensive model of digital competence is constituted by transferring different constructs of this approach: Command, Privileging, Appropriation and Reintegration (Vygotsky, 2000). However, why is this approach selected as the model's foundation? The sociocultural approach has been considerably transferred to the ICT field since digital technologies have been considered as artefacts or mediating tools besieged between the interpsychological and intrapsychological processes that take place in teaching-learning processes (Onrubia, 2005; Coll et al., 2010; Rossi, 2016). In this way, the aforementioned constructs are used to break down the digital competence itself, thus linking to each construct a series of skills, attitudes and values that together make up the digital competence.

To begin with, first, digital competence includes a set of basic instrumental skills and abilities, related to the access and management of ICT at the user's basic level, which demonstrate knowledge and technical application of them. This technical and instrumental level is explained through the sociocultural construct of Command, which corresponds to the uses that people develop through mediating instruments, as a result of adapting to different environments or contexts (De Pablos et al., 1999). Thus, according to Colás et al. (2005), the Command requires the acquisition of elementary instrumental skills, but these skills can be perfected through the formative processes.

Second, digital competence contains knowledge, skills, values and even attitudes, which imply that ICTs are prioritised over other tools and resources to respond to personal development needs. This is where the sociocultural construct of Privileging makes its appearance. It is the people themselves who decide which of the cultural tools that surround them are the most appropriate to achieve a purpose in a given context (Wertsch, 1994). Therefore, Privileging refers to an implicit decision-making process to determine which is the most appropriate tool for each situation (Conde, 2017). According to Colás (2006), in the field of educational technology, this construct manifests itself when people prefer to use certain technological tools, and not others, of a different nature to respond to their school activities, that is, between a wide variety of tools that surround them, the student body or the teacher prioritises ICT in front of other tools to solve their tasks.

Next, and third, digital competence also consists of skills and abilities that show that subjects use ICT to interpret their reality and develop their personal potential, that is, people begin to act according to their immersion in a digital culture, which has a specific mode of operation. In this way, a process of raising awareness about what they must learn to master, manage and control ICT based on that culture begins. This is where the sociocultural construct of the Appropriation is located, which is forged as the process in which subjects seize something, internalise it and make it their own (Wertsch, 1994). According to Conde (2017), there is therefore a cultural appropriation, which goes beyond the technical and instrumental dimension, linked to the Command construct.

Finally, digital competence includes a final stage in which the skills and technological attitudes related to the construction and creation of new things through ICT are included. This last aspect is explained through the sociocultural construct of Reintegration and that, according to De Pablos (2003), involves the transfer of valid cultural devices or tools that work in certain contexts or environments to completely different ones. In this sense, it would imply a translation of specific uses of ICT to other contexts for which they were not primarily envisioned. According to Conde (2017), this creative process must be understood as long as it is linked to unprecedented innovative practices carried out with ICT, which have not been done before and have, if possible, impact and social projection. That is, the expansive and divergent potentials of the ICT tools that surround us must be used to transform and change our current world.

On the other hand, these levels of disaggregation of the digital competence should not be considered as chronological stages in the development of digital competence, that is, as levels that must be overcome to move on to the next. Although it is logical to think that the process of development of competence would respond to this sequential internal logic, however, it is unrealistic based on the complexity and diversity of the educational reality, since there could be subjects who only dominated an ICT tool, but they will develop an activity with an important social projection, which is why it would be at the basic level of Command and Reintegration. So the combinatorial possibilities offered by this model can be as diverse as the use of ICTs by the subjects. Fig. 1 presents the conceptual model of digital competence whose validation is the purpose of this article.
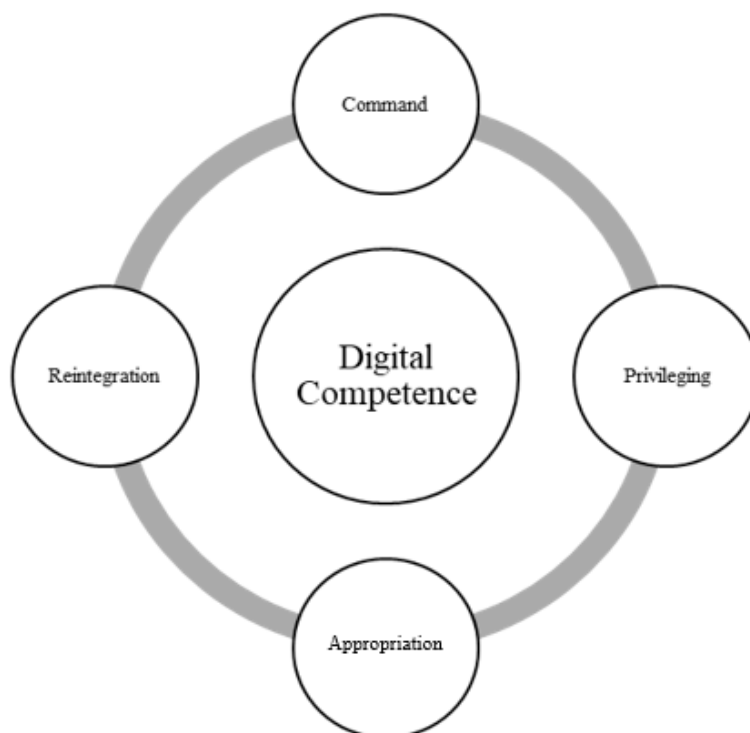

Fig. 1 Theoretical model of understanding of digital competence from the sociocultural approach
Source: Conde (2017) and Colás et al. (2016b)

This conceptualisation and systematisation of digital competence from the sociocultural approach is presented as a first step for the constitution of it as an indicator of the success of ICT education policies in school contexts. The next step corresponds to the empirical validation of said indicator and that, as stated earlier, constitutes the purpose of this article.

2. Methodology

This study, of a quantitative nature, is of an ex post facto, transversal and causal type since it aims to determine the empirical validity of a theoretical model of digital competence from a sociocultural perspective, to consider it as an indicator of the success of ICT education policies. It has a double objective:

1) to explore the validity of a theoretical model proposed to conceptualise the digital competence and 2) to determine the goodness of its structural adjustment. Four hypotheses are established (see Fig. 2) to be tested: H1: The Domain level influences the global level of digital competence; H2: the Privilege level influences the global level of digital competence; H3: the level of Ownership influences the global level of digital competence and H4: the level of Reintegration influences the global level of digital competence.
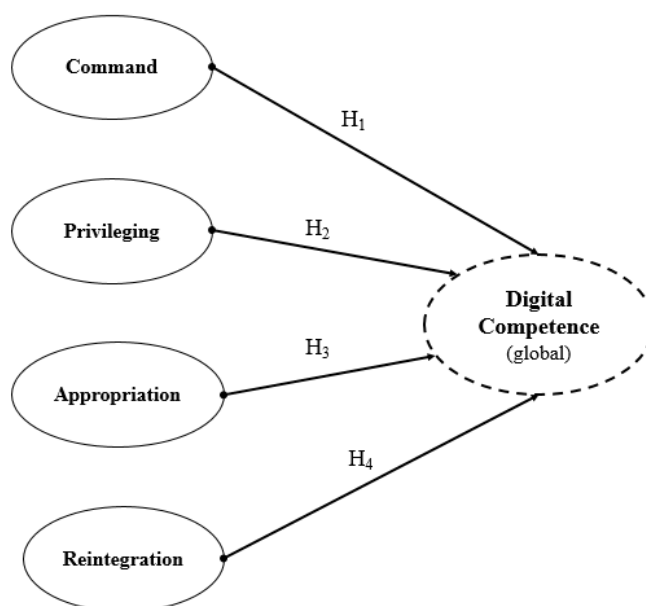

Fig. 2 Initial hypotheses derived from the model

2.1.Sample

The population under study comprises all students enrolled in the Autonomous Community of Andalusia (Spain), which according to the Statistics and Cartography Unit (2015c, 2015d) on the School Pupils in the Andalusian Educational System during the 2014–2015 academic year are 446,482 students in primary education and 281,920 students in secondary education, constituting a total population of 728,402 subjects. To determine the participant sample, the simple random sampling formula nZ2*p*q/e2 for very large samples is applied, where nnumber of elements of the sample, P/Qprobabilities with which the phenomenon occurs, Z2critical value corresponding to the chosen confidence level (sigma value,) and emargin of error or inaccuracy allowed. Thus, the sample of the study is specified in 1,881 students of compulsory education. This sample is representative of the population, within a confidence interval of 99.7% (3), where the presumable values of P and Q are 1% and 99%, respectively, and an error limit of 0.68% is used. Until the number of students in the sample was complete, the participating students were selected because they belonged to educational centres in the Province of Seville (Andalusia, Spain), which had extensive experience and a consolidated trajectory in educational policies of technological immersion.

To guarantee the cognitive validity of the questionnaires, that is, for the students to understand the meaning of all the items on the scale, the data collection was done in person so that one researcher could explain and clarify each of them. This is fundamental for students of the primary school. However, from the secondary stage, the students would have to understand the items raised in the questionnaire.

Among the sociological characteristics of the sample, it is indicated that the participating students have an average age of 12.28 years (SD2.222). The age range is from a minimum of 7 years to a maximum of 17 years. Regarding gender, the distribution of the sample is quite equal, since 51% of men and 49% of women participate. In addition, 47% of students are enrolled in primary education and 53% are enrolled in secondary education.

2.2.Instrument

For this research, an ad hoc questionnaire is created in which, in addition to the collection of sociological data previously exposed in the sample, four scales are included linked to each of the sociocultural constructs:

Command, Privileging, Appropriation and Reintegration. For the elaboration of the items that integrate them, we resort to the digital literacy model (DigEULit) of Martin & Grudziecki (2006) and digital competence, developed within the European framework project DIGCOMP (Ala-Mutka, 2011; Ferrari, 2013; Carretero, Vuorikari & Punie, 2017).

So the specific formulation of the items is based on the proposal of Ala-Mutka (2011) who formulated items linked to digital competence and grouped them into different levels: a) Level 1: items related to instrumental skills and knowledge are included; b) Level 2: items linked to advanced skills and knowledge are proposed (media application, strategic and personal objectives) and, finally, c) Level 3: items linked to attitudes for skills and knowledge application are proposed (p. 47). Based on the formulation of the items elaborated in that study, the items of our scales were formulated. Furthermore, it has also been considered the digital literacy model (divided into three stages: digital competence, digital usage and digital transformation) proposed by Martin & Grudziecki (2006). For reasons of space, it is not possible to break down the entire process of elaboration of the items; it is recommended to review previous works of the author (Conde, 2017; Colás et al., 2016). It is important to clarify that although these two proposals made comprehensive frameworks, they lacked a psychopedagogical approach that supported their proposals.

For this reason, a model of understanding based on the Vygotskian sociocultural approach is created, which systematises the items based on constructs derived from this approach. So the items correspond to a series of actions and respective uses to ICT. According to Conde (2017), the elaboration of these items is based on the premises of the theory of activity (Leontiev, 1971), since each item corresponds to an external action that subjects can do in relation to their applications of ICT, whose realisation would reflect their level of digital competence.

Next, in Fig. 3, the 22 items that make up the questionnaire are exposed, which are linked to each of the constructs of the sociocultural approach used for the breakdown of digital competence.

Scale 1. Command	
Item 1	You know and use basic digital equipment
Item 2	You know and handle different programs to do specific tasks
Item 3	You access and use different digital platforms
Item 4	You create and store digital content
Item 5	You locate, process and organize information through hyperlinks
Item 6	You know legal and ethical issues about digital media
Scale 2. Privileging	
Item 7	You analyze and search for content on the internet
Item 8	You care about the source from which the contents come
Item 9	You find relevant options for your personal learning
Item 10	You find relevant options for your professional learning
Item 11	You recognize the value of the diversity offered by the internet
Item 12	You use your computer to do things you couldn't do with any other means
Item 13	You recognize the value that both digital and traditional tools bring
Scale 3. Appropriation	
Item 14	You treat people in the same way when you are on the Internet as in real life
Item 15	You don't interact with people you do not know
Item 16	You don't share data or passwords with anyone
Item 17	You can do and create new things with computers
Item 18	You use the computer to learn by yourself
Scale 4. Reintegration	
Item 19	You have accounts in some digital platform
Item 20	You participate and/or collaborate in a network
Item 21	You exchange and download things that you like online
Item 22	You communicate and express yourself through the media

Fig. 3 Scales of the Digital Competency Questionnaire from the sociocultural approach

Each of these items is measured using a Likert scale, which ranges from 1 to 5, with 1 corresponding to nothing, 2 to little, 3 to somewhat, 4 to rather and 5 to much. To determine the level of digital competence of the subjects, the average value of all the items is calculated, which is also interpreted according to this scale.

The global questionnaire has good reliability or internal consistency, since a Cronbach's alpha value equal to 0.935 is obtained.

2.3. Data analysis

To answer our objectives of exploring the validity of a theoretical model proposed for the conceptualisation and systematisation of digital competence and determining the goodness of structural adjustment, a statistical analysis based on partial least squares (PLS) is applied (structural equation model [SEM]). For the evaluation of the structural model, the path and R squared (R2) coefficients are analysed to determine the predictive value of the model. To determine if the hypotheses of the model are supported at the statistical level, the bootstrapping technique is applied, which offers the standard error (STERR) and the t-values of the parameters (T statistics), being analysed within a confidence interval of 95%. Finally, to know the degree of the predictive quality of the model, the Q square (Q2) value is analysed. The SmartPLS 2.0 M3 scientific software is used (Chin, 2004).

3. Results

To begin with, the data shown in Fig. 4 offers a first overview of the proposed theoretical relationships between the different sociocultural constructs and the global level of digital competence. All the path coefficients (p, values of the relation) are above 0.2, minimum recommended by Chin (1998). The R Square values (R2) are above 0.1, which is the minimum value proposed to be statistically significant in terms of their predictive value (Falk & Miller, 1992). These coefficients of determination identify the variance explained, that is, how well the regression model PLS predicts the test data.
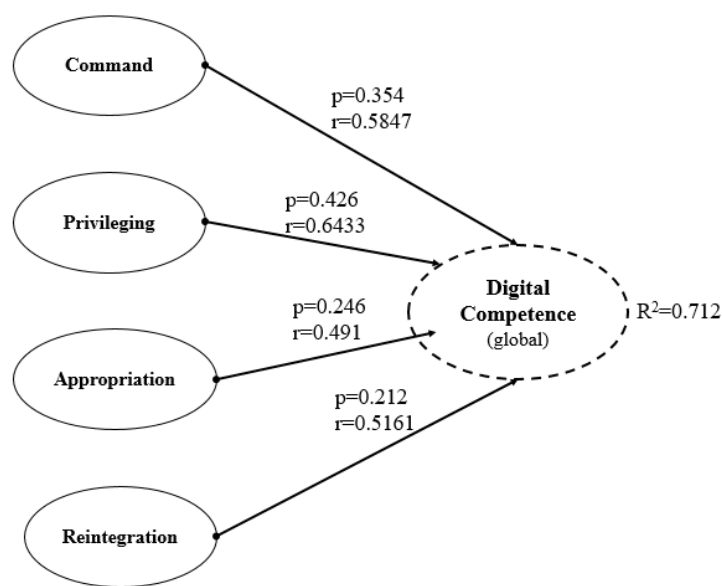

Fig. 4 Results of the evaluation of the structural model

In this way, the obtained R2 values indicate that in our model, digital competence is explained by 20.69% by the Command, 27.40% by Privileging, 12.79% by the Appropriation and 10.94% by the Reintegration (see Figure 4). So the values of the explained variance (p*r, where r is the correlation) are above the minimum 1.5% recommended by Falk & Miller (1992), with which it can be said that the values of the predictor variables are significant. This analysis reveals that it is the skills, values and attitudes linked to Privilege that most predict digital competence in school contexts. The path coefficients are positive, and all are above 0.2, which indicates good intensity in the relationships. In addition, these coefficients are positive, which indicates that the address assigned to the relationship hypotheses has been correct.

To determine the consistency of the proposed model, that is, if the hypotheses proposed in this study are supported empirically (Fig. 2), we proceed to assess the precision and stability of the obtained estimates (for which the bootstrapping technique is applied), which offers the standard error (STERR) and the t values of the parameters (t-statistics). The results obtained are given in Table 1.

Table 1. Results of the contrasts of posed hypotheses.

	Standard error (STERR)	t-statistics (|O/STERR|)	Supported hypothesis (level of significance)
H_1: CommandDigital Competence	0.0697	5.0797	Yes***
H_2: PrivilegingDigital Competence	0.059	7.2115	Yes***
H_3: AppropriationDigital Competence	0.0761	2.7886	Yes**
H_4: ReintegrationDigital Competence	0.0684	3.5955	Yes***

Reference values are taken to measure significance: *p0.05, **p 0.01 and ***p0.001 (based on a Student's t (499) distribution of a tail) and t(0.05; 499)1.964726835, t(0.01; 499)2.585711627 and t(0.001; 499)3.310124157 (Miró, Leal, Cepeda & Miró, 2010).

The results obtained in the contrasts of hypotheses indicate that yes are confirmed all hypotheses raised in the study. To complement the previous results, the confidence intervals are presented to confirm that the results obtained in these contrasts are not due to chance. If the values obtained using the bootstrapping technique for the 500 samples, at a confidence level of 95%, are above zero, it can be affirmed that, with 95% confidence, the relationships raised in the hypotheses are positive. As shown in Table 2, in our model, all the values are above zero, so this premise is met; that is, in the established relationships, there is no room for chance.

Table 2. Intervals of confidence at 95%.

	Percentile	H_1	H_2	H_3	H_4
Lower	2.5%	0.20829	0.3241975	0.0644525	0.0991725
Higher	97.5%	0.4720075	0.5557075	0.350325	0.3691925

Finally, as an indicator of the degree of the predictive quality of this model, the Q2 value is analysed, which for a model to have predictive quality must be greater than zero. The latent variables of our model are reflective; if we observe the Q2 value of the dependent variable (global digital competency level), it is higher than zero (see Table 3), thus determining that our evaluative model has predictive quality.

Table 3. Q^2 values (cross-validated redundancy).

Total	SSO	SSE	$Q^2$1-SSE/SSO
Digital competence (global)	1882	548.2055	0.7087

Conclusions

In this way, each of the hypotheses proposed in this study is confirmed, confirming the validity of the proposed theoretical model of the conception of digital competence from the sociocultural approach. That is, the model designed and validated through structural equations is of quality and has predictive power. The validation of this explanatory model allows us to have a more complex and profound view of the set of dimensions that are activated in relation to digital competence in educational contexts, which allows the conception of it as a good indicator to measure the impact of ICT education policies.

This type of study is necessary to begin to consider digital competence as an indicator of the impact of such ICT education policies in their own educational contexts. As mentioned earlier, this indicator is at the micro level, as it evaluates the internal levels of digital competence of the educational agents (students and teachers), as a consequence of the internalisation of the digital culture, driven by the ICT policies themselves (Conde, 2017).

This contribution aims to present digital competence as an indicator, based on a powerful theoretical model (sociocultural approach) that is validated empirically, although based on perceptions of students and teachers in educational contexts. However, although the measurement is based on the perceptions of the subjects, the proposed model is valid empirically, opting for the use of structural equations, and is a statistically robust technique.

On the other hand, one of the first research questions that would result from this study would be "How do teachers and students perceive the level of digital competence of students?". Among some partial results presented at the Sirem Conference 2018 (Language and Digital Animation School. Territory. University, celebrated in Bologna), students of Spanish schools perceive to have higher levels of digital competence than those perceived by their own teachers (Conde, 2017; Conde, 2018). That is, students perceive themselves as having a medium–high level of digital competence, while teachers consider their students to have a medium level. In addition, teachers perceive themselves as more competent than their students, which would take us to rethink the roles established by Prensky (2009) in relation to digital immigrants (teachers) and digital natives (students). It seems that the conception of digital competence in school contexts is different from the social one, which coincides with previous studies carried out by Sefton et al. (2009).

References

Ala-Mutka, K. (2011). Mapping Digital Competence: Towards a Conceptual Understanding. Seville: Institute for Prospective Technological Studies IPTS-Joint Research Centre (JRC)/European Commission. Retrieved from http://ftp.jrc.es/EURdoc/JRC67075 _TN.pdf

Area, M. (2010). El proceso de integración y uso pedagógico de las TIC en los centros educativos. Un estudio de casos. Revista de Educación, (352), 77-97.

Claro, M., Preiss, D.D., San Martín, E., Jara, I., Hinostroza, E., Valenzuela, S., Cortés, F., & Nussbaum, M. (2012). Assessment of 21st century ICT skills in Chile: Test design and results from High School level students. Computers & Education, 59(3), 1042–1053.

Chin, W. W. (1998). The Partial Least Squares Approach to Structural Equation Modeling. In G.A.Marcoulides (Ed.), Modern Methods for Business Research (pp. 295-336). Mahwah, New Jersey: Lawrence Erlbaum.

Chin, W. W. (2004). PLS-Graph. Version 3.00. build 1060. Texas, USA: University of Houston.

Colás, P. (2006). Metodología pedagógica para e-learning desde un enfoque sociocultural. En VI Conferencia Internacional sobre E-learning y Tecnologías de Educación. Lisboa, Portugal.

Colás, P., Conde, J., & González, T. (2015). Evaluación de políticas TIC: competencias digitales (ICT Policy Evaluation: digital competences). EDUSK. Revista monográfica de Educación, (4), 289-329. São Paulo: Editorial skepsis .

Colás, P., Conde, J., & González, T. (2016a). Spanish teachers' perception of their own and their students' digital competencies. In M. M. Crişan & R. A. Toma (Coord.), Beliefs and Behaviours in Education and Culture: Cultural Determinants and Education (pp 42-53). Bucureşti, Romania: Pro Universitaria.

Colás, P., González, T., Conde, J., & Reyes, S. (2016b). Una aproximación a la comprensión de la competencia digital desde el enfoque sociocultural. J. Gavala (Coord.), Actas 5ª Jornadas de Innovación Docente de la Facultad de Ciencias de la Educación (pp. 24-37). Sevilla, España: Universidad de Sevilla.

Carretero, S., Vuorikari, R., & Punie, Y. (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. Retrieved from https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/digcomp-21-digital-competence-framework-citizens-eight-proficiency - levels-and-examples-use

Colás, P., Rodríguez, M., & Jiménez, R. (2005). Evaluación de e-learning. Indicadores de calidad desde el enfoque sociocultural. Teoría de la Educación. Educación y Cultura en la Sociedad de la Información, 6(2). Retrieved from http://campus.usal.es/teoriaeducacion/rev_numero_06_2/n6_02art_colas_rodriguez_ji menez.htm

Coll, C., Rochera, M. J., & Colomina, R. (2010). Usos situados de las TIC y mediación de la actividad conjunta en una secuencia instruccional de educación primaria. Electronic journal of research in educational psychology, 8(21), 517-540.

Conde, J. (2018). The level of digital competence of students and teachers to measure the impact of ICT educational policies In A. Garavaglia & L. Petti (Ed.), Book of abstract. Convegno Sirem 2018. Linguaggi e animazione digitale. Scuola. Territorio (pp. 45-48). Bologna, Italy: Sirem.

Conde, J. (2017). La mediación de las TIC en la creación de ambientes de aprendizaje y el logro de competencias digitales. Doctoral Thesis. Seville, Spain: Universidad de Sevilla.

Conde, J., Reyes, S., & Colás, P. (2017). La Evaluación de las Políticas Educativas TIC: de lo externo a lo interno. En R. Palmeiro, L. Aires & V. Pereda (Eds.), Literacia e Inclusão Digital: Boas Práticas em Portugal e em Espanha (pp. 40-44). Lisboa, Portugal: Universidade Aberta. Rede ObLID. CEMRI.

De Pablos, J. (2003). La tecnología educativa hoy no es como ayer: nuevos enfoques, nuevas miradas. Tecnología y Comunicación Educativas (TyCE), 37(1), 5-21.

De Pablos, J., Area, M., Valverde, J., & Correa, J.M. (2010). Políticas educativas y buenas prácticas con TIC. Barcelona: Graó.

De Pablos, J., Rebollo, M. A., & Aires, L. (1999) Para un estudio de las aportaciones de Mijaíl Bajtín a la Teoría Sociocultural. Una aproximación Educativa. Revista de Educación, (320), 223-253.

ECLAC (2010). Plan de acción sobre la sociedad de la información y del conocimiento de América Latina y el Caribe (eLAC 2015). Lima, Perú: CEPAL - Naciones Unidas.

European Commission (2006). Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning (2006/962/EC). Official Journal of the European Union, L 394, 10-18.

European Commission (2016). New Skills Agenda for Europe. Retrieved from http://ec.europa.eu/social/main.jsp?catId1223

European Commssion (2017). Learning and Skills for the Digital Era. Retrieved from: https://ec.europa.eu/jrc/en/research-topic/learning-and-skills

European Commission (2018). Proposal for a Council Recommendation on Key Competences for Lifelong Learning. COM(2018) 24 final 2018/0008(NLE). Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uriCELEX:52018DC0024

Falk, R. F., & Miller; N. B. (1992). A Primer for Soft Modelling. Akron, Ohio: The University of Akron.

Ferrari, A. (2013). DIGCOMP: A framework for developing and understanding digital competence in Europe. Seville: IPTS-JRC/European Commission.

González, J., Espuny, C., Cid, M.J., & Gisbert, M. (2012). INCOTIC-ESO. Cómo autoevaluar y diagnosticar la competencia digital en la Escuela 2.0. Revista de Investigación Educativa, 30(2), 287-302.

González, A. (2011). ¿Qué nos interesa evaluar de las políticas educativas TIC españolas? Revista Fuentes, 10, 206-220.

ISTE (2007). NETS for Teachers: National Educational Technology Standards for Teachers, Second Edition. ISTE (International Society for Technology in Education). Retrieved from http://www.iste.org/nets/students

Leontiev, A. N. (1971). The problem of activity in psychology. En J. V. Wertsch (Ed.), The concept of activity in Soviet psychology (pp. 37-71). Armonk, New York: Sharpe.

Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and tools for digital literacy development. ITALICS: Innovations in Teaching & Learning in Information & Computer Sciences, 5(4), 246-264.

Miró, C. J., Leal, A. G., Cepeda, G. A., & Miró, M. A. (2010). Clima de confianza, aprendizaje e innovación: una metáfora biomimética. Revista europea de dirección y economía de la empresa, 19(4), 21-35.

OECD (2015). Students, Computers and Learning. Making the Connection. Paris, France: OECD Publishing.

Onrubia, J. (2005). Aprender y enseñar en entornos virtuales: actividad conjunta, ayuda pedagógica y construcción del conocimiento. RED. Revista de Educación a Distancia, (2), 1-12.

Prensky, M. (2009). H Sapiens Digital: from digital inmigrants and digital natives to wisdom. Innovate: Journal of online education., 5(3), 1.

Redecker, C., & Johannessen, O. (2013). Changing Assessment - Towards a New Assessment Paradigm Using ICT. European Journal of Education, 48(1), 79-96.

Redecker, C., Punie, Y., Ravenscroft, A., Lindstaedt, S., Kloos, C., & Hernández-Leo, D. (2012). eAssessment for 21st Century Learning and Skills. Berlin, Germany: Springer Berlin Heidelberg.

Rossi, P. G. (2016). Gli artefatti digitali e i processi di mediazione didattica. Rivista Pedagogia Oggi, (2), 11-26

Sefton, J., Nixon, H. & Erstad, O. (2009). Reviewing approaches and perspectives on "Digital Literacy". Pedagogies: an International Journal, 4(2), 107-125.

UNESCO (2011). UNESCO ICT Competency Framework for Teachers. Paris, France: UNESCO.

UNESCO (2008). ICT competency standard for teachers. Retrieved from http://www.unesco.org/en/competencystandards-teachers

van Deursen, A., & van Dijk, J. (2009). Using the internet: skill related problems in users' online behavior. Interacting with Computers, 216), 393–402.

Vygotsky, L. S. (2000). Obras escogidas III. Historia del desarrollo de las funciones psíquicas superiores. Madrid, España: Visor.

Wertsch, J. V. (1994). The primacy of mediated action in sociocultural studies. Mind, culture and activity, 1(4), 202-208.

Zhong, Z. (2011). From access to usage: The divide of self-reported digital skills among adolescents. Computers & Education, 56(3), 736–746.