Telematics and Informatics 34 (2017) 171–183

Contents lists available at ScienceDirect

Telematics and Informatics

journal homepage: www.elsevier.com/locate/tele

Empirical study of a sequence of access to Internet use in Ecuador

Ramón Tirado-Morueta [a,*], Damian Marilú Mendoza-Zambrano [b], José Ignacio Aguaded-Gómez [a], Isidro Marín-Gutiérrez [c]

[a] Departamento de Educación, Universidad de Huelva, Campus de El Carmen, 21007 Huelva, Spain
[b] Facultad de Psicología, Universidad Laica Eloy Alfaro de Manabí, Manta, Ecuador
[c] Departamento de Comunicación, Universidad Técnica Particular de Loja, Loja, Ecuador

ARTICLE INFO

Article history:
Received 20 July 2016
Received in revised form 24 November 2016
Accepted 31 December 2016
Available online 13 February 2017

Keywords:
Media literacy
Digital literacy
Digital divide
Secondary school
Internet access
Internet use

ABSTRACT

Ecuador is a country that represents the efforts that a few countries in the Latin American and the Caribbean region are making on infrastructures, regulations and policies that are favorable towards the use of the Internet. However, although the digital divide in its most basic form (physical access and use) is closing with respect to developed countries, a new, more complex digital divide is moving forward, and is related to the socio-economic advantages of the Internet. This study, which used a random sample stratified by provinces and which comprised 3754 respondents representing the secondary school students in Ecuador, had as objectives: (a) to verify the relationship and sequence among the different levels to access the Internet found on secondary school students; and (b) to verify to what degree the student's family status influenced the different levels of Internet access. Through the empirical analysis of a structural model, the results showed a sequence between the relationships found among the different levels of Internet access, as well as the cumulative effect of the technical resources and levels of digital literacy on the academic use of the Internet. Likewise, it was observed that the influence of the student's family status lost strength as the level of Internet access increased.

1. Introduction

The presence of the Internet is becoming more and more evident in social relations, economic transactions and production processes in Ecuador (López et al., 2014). The growing activity on the Internet is a reflection of the activities and economic, social and cultural relationships that exist offline, including the inequalities (Witte and Mannon, 2010; Zillien and Hargittai, 2009). In this sense, the ownership of the technology by part of the population is a factor for social inclusion (Haddon, 2000; Van Deursen et al., 2015). The arguments about the fact that the Internet has had an effect on social inclusion are mirrored on the «digital divide». These types of studies are related with research on Internet access related to socio-demographic variables.

As the physical access to the Internet has been relatively overcome in developed countries (Van Dijk, 2006, 2012; Van Deursen and Van Dijk, 2014), other types of access have been gaining the attention of studies on the digital divide:

* Corresponding author.
E-mail addresses: rtirado@uhu.es (R. Tirado-Morueta), damiamarilu@hotmail.com (D.M. Mendoza-Zambrano), ignacio@aguaded.es (J.I. Aguaded-Gómez), imarin1@utpl.edu.ec (I. Marín-Gutiérrez).

http://dx.doi.org/10.1016/j.tele.2016.12.012
0736-5853/

attitudinal access, skills access and usage and benefits access (Blank and Groselj, 2014; Van Deursen and Van Dijk, 2011, 2015; Van Dijk, 2006, 2006; Van Deursen and Helsper, 2015; Van Deursen et al., 2015).

Studies conducted by international agencies (Bilbao-Osorio et al., 2014; ITU, 2014) on developing countries, have shown that although some notable advances have taken place on physical access and frequency of use of the Internet, their situation is even farther from other, more developed parts of the world (Table 1). For example, the Networked Readiness Index (NRI) concludes that although the distance between developed countries and developing countries in terms of infrastructure, policies and regulations on the use of the Internet have been reduced, the digital divide related to the social and productive advantages of the ICTs has been maintained (Bilbao-Osorio et al., 2014).

The study presented in this article was conducted in Ecuador, which is placed 82nd on the list of the 144 countries that comprise the NRI report. Ecuador is representative of the technological readiness of the Latin America and the Caribbean area. As shown in Table 1, although the percentage of the population that use the Internet daily is very similar to that measured for the European Union (EU) (28), the fraction of high-quality Internet access is inferior. In spite of the fact that Internet access divide is closing (as compared to more developed countries), the type of Internet use by the population, as well as the degree of literacy possessed by the population possesses in order to exploit the medium, are unknown.

The present study is focused on a population of young secondary school students, aged 16–18, who reside in Ecuador. This group is found within the age group that more frequently uses the Internet, and who are also the human resources for the future development of the country. Although these young citizens tend to use the Internet frequently, their abilities of Internet access are unknown, especially in the advanced levels of use as opposed to the mere frequency of use (Cerbino and Belotti, 2016). These more advanced levels of use are denominated second level (Hargittai, 2002; Witte and Mannon, 2010; Zillien and Hargittai, 2009) and third level (Van Deursen and Helsper, 2015) of digital divide in the sphere of research on this subject matter.

Alternatively, other models have been developed, some empirically validated (Van Deursen and Van Dijk, 2015), that show the sequence (or scaling) between the first level of Internet access (physical and operational access), the second level (use and literacy), and the third level (social, economic and production benefits). This study, which was centered on the population from a developing country mentioned above, had as the main objective the empirical validation of a model that shows the sequence and cumulative effect between the different levels of Internet access. More specifically, the objectives were the following: (a) to verify the existence of a relationship and a sequence between the different levels of ability for accessing the Internet among the young secondary school students in Ecuador; and (b) to verify to what degree the family' status was associated with the different levels of Internet access.

A literature review on the different levels of the student's Internet access, physical and operational skills, analytical skills, evaluation and creation of content, and academic progress will be presented in the following section. Likewise, the hypothesis and the methodology used to test them are presented. Lastly, the findings and the limitations of the study will be discussed.

2. Literature review

2.1. Digital divide and the levels of access to Internet use

The term «digital divide» has an American origin, dating from the 90s decade of the 20th century, and it was used for the first time in an official publication written by the National Telecommunications and Information Administration (NTIA) (Gunkel, 2003). On the first reports on its state (Servon, 2008; Compaine, 2001), the term «digital divide» was identified with the physical/material access to the ICTs, using as independent variables factors such as race, gender, age, economic status, level of education, type of household and geographic location.

As the presence of computers and the Internet increased in the developed countries, the term began to evolve, and more complex conceptualizations were developed, including a set of indicators of Internet access (Warschauer, 2002, 2004; Livingstone and Helsper, 2007; Selwyn, 2004; Riggins and Dewan, 2005; Van Deursen and Van Dijk, 2011; Van Dijk,

Table 1
Indicators of physical access to the Internet, frequency of use of the youth and digital illiteracy in Ecuador vs the EU (28).

	Ecuador	UE(28)
Households with at least one portable/desktop PC	27.5%	68%[a]
Households with Internet access	28.3%	79%
Households with broadband Internet access	24.9%	76%
Individuals that use the Internet at least once a day	64%	62%
Individuals aged 16 to 18 that use the Internet	64.9%	84%[b]
Digital illiteracy	20%	1%[c]

Sources: National Employment, Unemployment and Under Employment (ENEMDU) (2010–13); EUROSTAT, 2015.

[a] Data from 2010.

[b] Daily use.

[c] Data from 2015.

2006; Hargittai and Hinnant, 2008; Brandtzæg et al., 2011). As a result of these more complex conceptualizations, there is now a certain consensus that differentiates between the three (successive) levels of digital divide.

The first level focuses on the differences in access of the individuals to the infrastructure, including factors such as autonomy and the continuity of access (Newhagen and Bucy, 2004; Selwyn, 2004; Van Dijk, 2006). Therefore, the first level has special relevance on the development of infrastructure and the weaving of goods and services that are accessible by the population. In this study, on the one hand, the physical access to the Internet, the number of devices and the quality of the Internet signal were taken into account, and on the other hand, the operative ability that includes the skills possessed by the students in order to work with the Internet as well as the frequency of operational use were also deemed important.

As access to Internet resources has been generally overcome by the citizens of developed countries, the second level of division presents itself in the type of use and the abilities required to make productive use of the ICTs (Hargittai, 2002; Riggins and Dewan, 2005; Witte and Mannon, 2010; Zillien and Hargittai, 2009). The studies on the second level of digital divide have contributed a great number of classifications of the types of activities that people conduct online, and on the type of skills needed for this (Buckingham, 2007; Celot & Tornero, 2009; Hobbs, 2010, 2011; Blank and Groselj, 2014; Van Deursen and Van Dijk, 2014). This study takes into account the knowledge possessed by the students for managing of information found and circulated on the Internet, as well as their dominance of the languages of expression, creation and production of content.

The third level of digital divide refers to the use of the Internet to obtain some type of benefit. This third level goes beyond the mere use of the Internet. The current conceptualizations on the digital divide result insufficient for finding the reasons why two individuals who have the same degree of digital autonomy and literacy can obtain very different benefits when using the Internet. In this sense, the development of a theoretical framework that is well cemented and that brings to light the relationship between different uses of the Internet and its benefits, has been suggested (Dornaleteche et al., 2015; Blank and Groselj, 2014; Van Deursen and Helsper, 2015). Even though this topic is not analyzed in depth in this study, it does takes into account the use given to the Internet by the students when conducting academic tasks. Therefore, this study tries to understand the academic usefulness of the Internet for secondary school students.

2.1.1. Hypothesis (a)

Although many studies have revealed the existence of interactions between the different types of access (Hoffman et al., 2000), the current understanding of these interactions is limited (Van Deursen and Van Dijk, 2015). In general, this study will try to show that there is a sequence between the different types of Internet access. We assume that physical access to the Internet facilitates the acquisition of the abilities required and the taking advantage of the Internet (ITU, 2014; Bilbao-Osorio et al., 2014). More specifically, we expect that physical access (defined in this study as the number of devices available at home, and the quality and bandwidth used by the secondary school students [at home and on their mobile device] to access the Internet), is associated with the frequency of use and the operational skills needed for using the Internet. And to a lesser degree, it is associated with the more advanced levels of access, such as analytical and evaluation skills and the ability to create digital content. Lastly, we assume that the more advanced levels of access and use are the ones that have a greater relation on the taking advantage/exploitation of the Internet for conducting academic tasks. Based on this reasoning, the following hypotheses are posited:

H1. A (higher) physical access (PA) to the Internet is associated with the operational skills needed for the use of the Internet (OIS) (H1a), on the ability to analyze and evaluate the information found on the Internet (A&E) (H1b), on the ability of creative use (CU) (H1c) and the capacity for academic use of the Internet (AU) (H1d).

H2. The high level of operational Internet skills (OIS) is associated with the skills of analysis and evaluation of the information found on the Internet (A&E) (H2a), creative use (CU) (H2b) and taking advantage of the Internet for educational/academic purposes (H2c).

H3. A high degree of analysis and evaluation skills of the information found on the Internet (A&E) is associated with creative use of the Internet (CU) (H3a) and its academic use (AU).

H4. The ability of creative use (CU) of the Internet is associated with its exploitation/academic use (AU).

2.2. Influence of the socio-economic status

Barzilai-Nahon (2006) conducted a rigorous literature review on digital divide research and the direct influence of demographic factors (socio-economic condition, gender, age or education). However, the socio-demographic factors, to a greater degree than the simple socio-economic indicators, were usually interpreted as a factor of social status. From this, Van Dijk (2012) proposed a cyclical and causal model of technology appropriation. In this model, the social status of the citizens was a factor that facilitated or impeded their access to new communication media (Van Deursen and Van Dijk, 2015). Therefore, the socio-demographic factors will have an effect on the access to communication media and the different types of use given to them (such as online banking, search for information, social networks, or work) (Dueñas et al., 2016; Kolodinsky et al.,

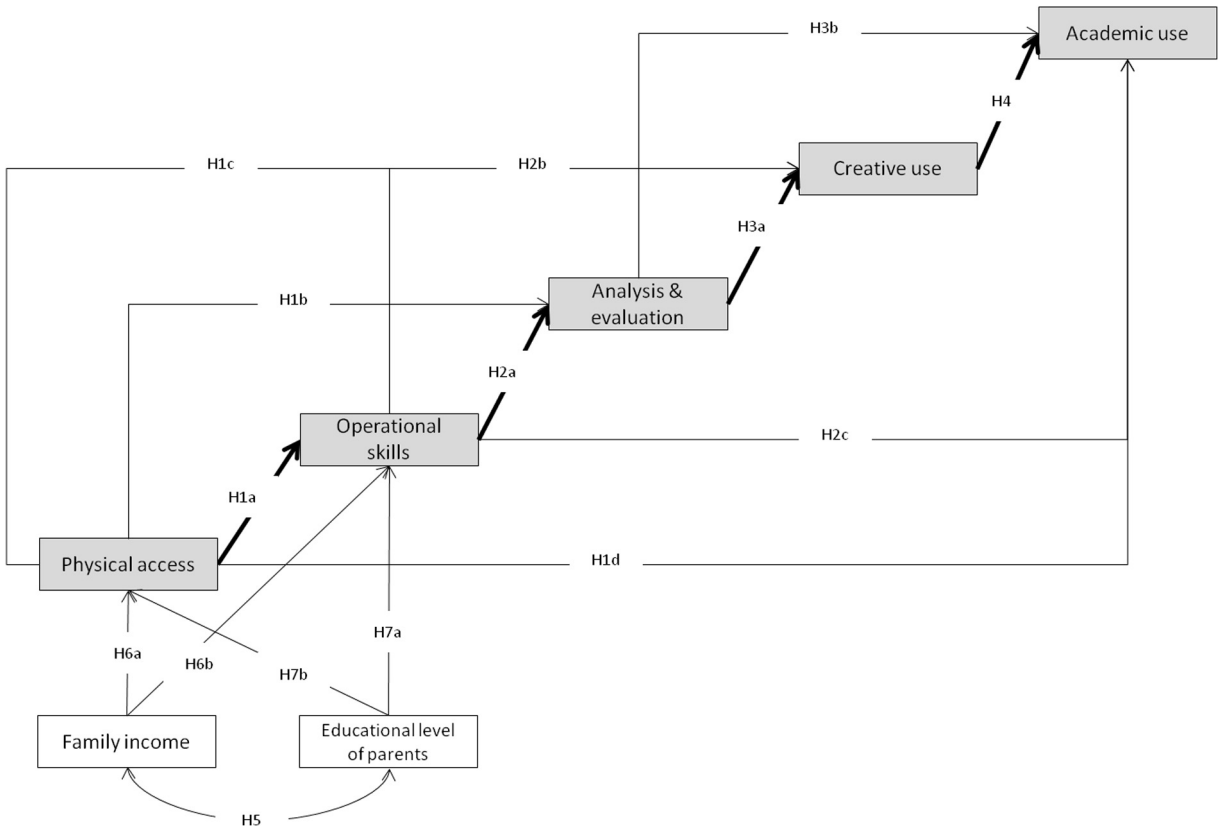

Fig. 1. Model that will be empirically tested.

2004; Hogarth et al., 2008; Zhang et al., 2010; Zhang, 2013; Harambam et al., 2013; Haight et al., 2014; Van Deursen and Van Dijk, 2014).

Therefore, taking into account these previous studies, the present study considers that the socio-economic status of the secondary school students' families in Ecuador conditions their ability to access the Internet. However, previous studies such as the one conducted by Van Deursen and Van Dijk (2015) have shown that these factors mainly affect the first levels of Internet access.

2.2.1. Hypothesis (b)

As mentioned above, social status is a factor that is usually employed in digital divide studies, and usually appears related to the attitude towards the use of the Internet. In this study, the two variables that are usually utilized (the level of income and the educational level of the parents), are taken into account.

In this regard, the following hypotheses are posited:

H5. The level of family income is related to the level of the parent's education.

H6. The family's income level is associated with the capacity of physical access (H6a) and the ability of OIS (H6b).

H7. The (higher) level of the parent's education is associated with the capacity of physical access (H7a) and ability of OIS (H7b).

Fig. 1 shows the model that will be subjected to analysis.

3. Methods

3.1. Sample

The population that was used in the study was composed of 858,262 students from public, private, rural and urban educational centers in Ecuador, aged 16–18 years old (INEC, 2014). In order to determine the total size of the sample, an infinite

population assumption was used, with Z = 2.57, which meant a 99% degree of confidence with ±2.1% used as the margin of error. In order to select the subjects for the study, a proportional and stratified sampling was conducted on the country's 24 provinces.

For the sampling, the following formula was used: $n_i = n * (P_i/P)$, where i = number of provinces, n = size of the sample, n_i = size of the sample from strata i (province); P_i = population of province i; P = the population of those aged from 16 to 18.

Table 2 shows the size of the sample from each of the provinces and the total size as well (3754 subjects).

Once the sample size was determined for each of the 24 provinces, a simple random sampling was applied so that each individual from the sample had the same probability of begin chosen during the sampling process.

Table 2 shows the sample for each strata (province). The gender data showed that 1786 (47.6%) were men, and 1952 (52%) were women, with the rest N/A. As for the ethnicity data, the mixed-race predominated (78%), with the Montubio people (3%) being the least represented. The rest of the racial groups did not account for more than 6.5% each (Caucasian [6.5%], Native [6%], N/A [2%]).

3.2. Measurements

In first place, five constructs were created for measuring the five types of access to Internet use investigated (Buckingham, 2007; Celot & Tornero, 2009; Hobbs, 2010, 2011; Blank and Groselj, 2014; Aguaded et al., 2014; Van Deursen and Van Dijk, 2014). Each of the constructs used an ordinal number measuring scale, Likert-type, with values ranging from 1 to 4. Each construct corresponded to one of the three types of access (see Appendix 1).

The first level referred to the physical access (PA) (DiMaggio and Hargittai, 2001; Warschauer, 2004) and the capacity of operational Internet use (OIS). For the creation of the PA construct, a few indicators from the ICT Development Index (IDI) (ITU, 2014) and the Network Readiness Index (NRI) (Bilbao-Osorio et al., 2014), were used to measure the infrastructure resources (i.e. number of computers at home, internet bandwidth ...). Likewise, for the OIS construct, a few indicators from the instrument developed by van Deursen et al. (2012) were used to measure the abilities related to the medium of the Internet. This construct takes into account the basic operations needed for the use of a computer (i.e. Mossberger et al., 2003).

After attaining operational abilities, one need to have the abilities needed to search, select, understand and process the information that is accessible on the Internet (van Dijk, 2005). The second level refers to the skills used to locate, evaluate and use the information found on the Internet (Warschauer, 2004). For the creation of the A&E construct, we took into account the definitions of "informational ability" by Warschauer (2004) and Mossberger et al. (2003), as well as a few indicators from the instrument developed by van Deursen et al. (2012) to measure the abilities related to the content of the Internet. The authors believed that these abilities are necessary for the production of valid and reliable information and content on the Internet. For the creation of the CU construct, a few of the production activities analyzed in the study by Schradie (2011), were used.

Table 2
Sample size per province.

i	Province i	Population Pi	Proportionality factor Fp = Pi/P	Sample ni
1	Azuay	38,349	0.0447	168
2	Bolívar	10,044	0.0117	44
3	Cañar	15,750	0.0183	69
4	Carchi	10,728	0.0125	47
5	Chimborazo	31,272	0.0364	137
6	Cotopaxi	27,848	0.0324	122
7	El Oro	66,425	0.0775	291
8	Esmeraldas	38,349	0.0447	168
9	Galápagos	9587	0.0111	42
10	Guayas	183,069	0.2136	802
11	Imbabura	23,968	0.0279	105
12	Loja	29,218	0.0340	128
13	Los Ríos	41,088	0.0479	180
14	Manabí	85,599	0.0998	375
15	Morona Santiago	8674	0.0101	38
16	Napo	4794	0.0055	21
17	Orellana	4794	0.0055	21
18	Pastaza	5250	0.0061	23
19	Pichincha	143,351	0.1672	628
20	Santa Elena	19,631	0.0229	86
21	Santo Domingo de los Tsáchilas	26,251	0.0306	115
22	Sucumbíos	14,381	0.0167	63
23	Tungurahua	13,239	0.0154	58
24	Zamora Chinchipe	5250	0.0061	23
	Total	P = 856 908		n = 3754

In this study, the third level makes reference to the use the students make of the Internet to obtain some type of benefit for conducting academic activities (Dornaleteche et al., 2015; Blank and Groselj, 2014; Van Deursen and Helsper, 2015). For the constructing of the AU construct, some activities used in the study by Torres-Díaz et al. (2016) were used as references.

For the validation of the five constructs, the following properties were analyzed: unidimensionality, reliability and convergent validity.

The unidimensionality results showed that in first place, the variables that comprised each construct were unidimensional. A principal component analysis was performed for each construct, and the Kaiser criteria (1960) was applied, meaning that a value greater than 1 was only given to the first component. Another important detail was that the first component explained the greater part of the variance. The analysis results showed that the value of the first component for all the constructs was >1. Likewise, the values obtained for the second set of constructs PA, A&E, CU and AU were less than 1. However, the values of the second component of the construct OIS were greater than 1. In this sense, it should also be mentioned that the OIS comprised two visible dimensions when Varimax rotation was applied. On the other hand, the data on the percentage of variance explained by the first factor shows that all the constructs came close to the recommended value of 50% (PA = 57.39%; OIS = 44.20%; A&E = 47.35%; CU = 66.10%; AU = 61.21%).

To measure reliability (the consistency of the indicators that comprise the constructs), Cronbach's Alpha (α) and composite reliability (cr) were calculated. The results showed that all the constructs had values above those recommended (>0.70), except for PA ($\alpha = 0.62$; cr = 0.54), possibly due to the scarce number of indicators that composed it.

To measure convergent validity (degree in which the indicators mirror the construct), the following was used: a) the average variance extracted (AVE), with the minimum value recommended being 0.5; and b) the indicator's factorial load, with a variance above 0.5 recommended for each indicator. The results on the factorial load shown in Appendix 1 indicated that all the constructs' indicators were near 0.50.

Appendix 1 shows the descriptive results of each of the indicators taken into account in each construct, as well as the properties of each one of the constructs used in this study. Likewise, Table 3 shows the descriptive results of each construct.

In second place, with the aim of identifying the influence of the students' family status on Internet access, the following independent variables were used: (a) monthly family income (no income,<$300, from $300 to $1199, and ≥$1200), and (b) the father/mother's level of study (no education, primary school, secondary school and university studies).

3.3. Data analysis

In order to test the hypothesis posited in Fig. 1, Structural Equation Modeling (SEM) was used through Amos 18.0 software. According to this modeling method, each theory consists of a set of correlations, and if the theory is valid, then the correlation patterns (suppositions) can be reproduced in empirical data (Byrne, 2013).

Through SEM, it is possible to statistically test the theoretical model (Fig. 1) through a simultaneous analysis of all the variables and their relationships, in order to verify to what degree the proposed model is consistent with the data. In the case that the goodness-of-fit is suitable, the model supports the plausibility of the relationships presented. However, if it's unsuitable, the plausibility of the model is rejected. With the aim of measuring the goodness-of-fit of the model, the indices that are usually used for the three categories of model adjustment (Hair et al., 2006) (absolute, parsimonious and incremental) were utilized.

For the absolute measurements of adjustment, the following were used: χ^2/df ($0 \geq \chi^2/df \leq 3$; $.01 \leq$ p-value ≤ 1), and the *root mean square error of approximation* (RMSEA) ($0 \leq$ RMSEA ≤ 0.08). And for the incremental measurement of fit, the comparative fit index (CFI) ($0.97 \leq$ CFI ≤ 1) and the *normed fit index* (NFI) ($0.95 \leq$ NFI ≤ 1) were used. Lastly, for the measurement of parsimonious fit, the parsimony normed fit index (PNFI) was used (differences between 0.06 and 0.09).

4. Results

4.1. Structural model

In first place, a statistical analysis was conducted in order to examine the assumption of normality of the variables used in the structural equation model. In this case, the Komogorov-Smirnov test was not used, as it is too sensitive when using large sample sizes. Therefore, an analysis of skewness and kurtosis (see Table 3) was conducted. The results showed that the values of both statistical tests for all the variables were <1, so the condition of normality was accepted (Curran et al., 1996).

Table 3
Descriptive results of the constructs.

	N	Mean	*SD*	Median	Skewness (*SE*)	Kurtosis (*SE*)
PA	3.622	6.47	1.90	7	−0.24 (0.04)	−0.93 (0.08)
OIS	2.606	50.41	10.84	51	−0.49 (0.04)	−0.12 (0.08)
A&E	3.754	38.20	8.15	38	−0.04 (04)	−0.12 (0.08)
CU	3.754	10.24	3.99	10	0.52 (04)	−0.55 (0.08)
AU	3.754	27.74	9.37	27	0.41 (0.04)	−0.05 (0.80)

Table 4 shows the correlations between the variables.

Fig. 2 shows the regression indices of all the paths (relationships) in the model, as well as the explained variances of each variable. After testing the validity of the causal structure of the conceptual model, the fit indices obtained were found to be good: $\chi^2/df = 2.85$ ($p = 0.003$); TLI = 0.98; RMSEA = 0.02 (90% confidence interval [CI] = 0.01, 0.03); CFI = 0.99; NFI = 0.99, and PNFI = 0.24. The model explained 11% of the variance found in PA, 18% in OIS, 31% in A&E, 10% in CU and 44% in AU.

4.2. Review of the hypotheses

Fig. 2 shows the coefficients that reveal the direct and indirect effects between the five constructs. The coefficients that appear between the constructs represent the direct effect of a single determinant variable over one that is endogenous. An indirect effect indicates the effect of a determinant variable on another one, through its effect on other variables that intervene in the model. The total effect on a single variable is the sum of the respective direct or indirect effects. These effects are shown in Table 5. All the hypotheses were confirmed, and therefore, the sequential nature of the model was accepted. Likewise, the influence of the family status (level of education of the parents and family income) on the physical access (PA) to the Internet and the operative Internet skills (OIS) was also accepted.

The model tested supported the sequential nature of the different levels of access (or physical or cognitive capacity/ability), and also validated the existence of a cumulative effect. Table 5 shows the indirect effect of PA on the ability of A&E ($\beta = 0.19$) and on the CU ($\beta = 0.06$) and AC ($\beta = 0.08$). Likewise, an indirect effect of the OIS on the CU ($\beta = 0.17$) and the AU ($\beta = 0.20$) was observed. Lastly, an indirect effect of the capacity of A&E was observed on the AU ($\beta = 0.25$). With respect to the indirect effects of the student' family status, an effect of the family's income ($\beta = 0.04$) and the parent's level of education ($\beta = 0.10$) on the OIS was observed. Other indirect effects of the socio-educational status of the family could also be observed. In first place, it should be noted that the level of the family's education had a greater effect on the levels of access than family income. In second place, the strength of the effect of the socio-educational status decreased as the level of access increased.

5. Discussion

This study tested a model that contained three levels of access to the Internet (physical access, literacy and exploitation/benefits) organized sequentially (Warschauer, 2002, 2004; Livingstone and Helsper, 2007; Selwyn, 2004; Riggins and Dewan, 2005; Van Deursen and Van Dijk, 2011; Van Dijk, 2006). To test the model, a representative sample of secondary students from Ecuador was utilized. Ecuador is a country from the Latin American and Caribbean region of the world, and is representative of countries that are currently under development and that have progressed technologically in the past few years. Although the digital divide in these countries has been closing as far as the level of infrastructure and frequency of use is concerned, the divides related to literacy and the exploiting/benefits of Internet use continue (Bilbao-Osorio et al., 2014; ITU, 2014), as compared with more developed countries.

The data supported, to some extent, the theories on the digital divide that differentiate successive phases/stages of technology appropriation (Van Dijk, 2006; Selwyn, 2004; Livingstone and Helsper, 2007). Likewise, the results of the study by Van Deursen and Van Dijk (2015), conducted in The Netherlands were partly corroborated, which empirically showed the sequence among the types of access proposed by Van Dijk (2006). This study also supported the indirect effect of physical access (in this case on the **academic use** and on the **knowledge of the content** found on the Internet). However, in this study, the attitudes towards the medium were not considered, which is a limitation.

From the perspective of media and digital literacy, many theories have been proposed that define stages (phases) of access, literacy and use that are similar to those investigated in this study (Buckingham, 2007; Celot & Tornero, 2009). The data from this study empirically supported part of the sequence put forward by Hobbs (2010) with respect to these phases, when differentiating among abilities of access, analysis and evaluation, creation/generation of content, reflection (not included in this study) and action (significant use). However, similar studies must be conducted that show this sequence in different contexts and environments (professional, community-based, academic or production).

Table 4
Correlation matrix.

	PA	OIS	A&E	CU	AU	Fam. Income	Edu. attainment
PA	0.1						
OIS	0.410**	1					
A&E	0.243**	0.565**	1				
CU	0.064**	0.177**	0.314**	1			
AU	0.150**	0.244**	0.415**	0.846**	1		
Family income	0.174**	0.105**	0.080**	0.031	0.036*	1	
Educational attainment	0.313**	0.215**	0.143**	0.009	0.073**	0.193**	1

** $p < 0.01$.
* $p < 0.05$.

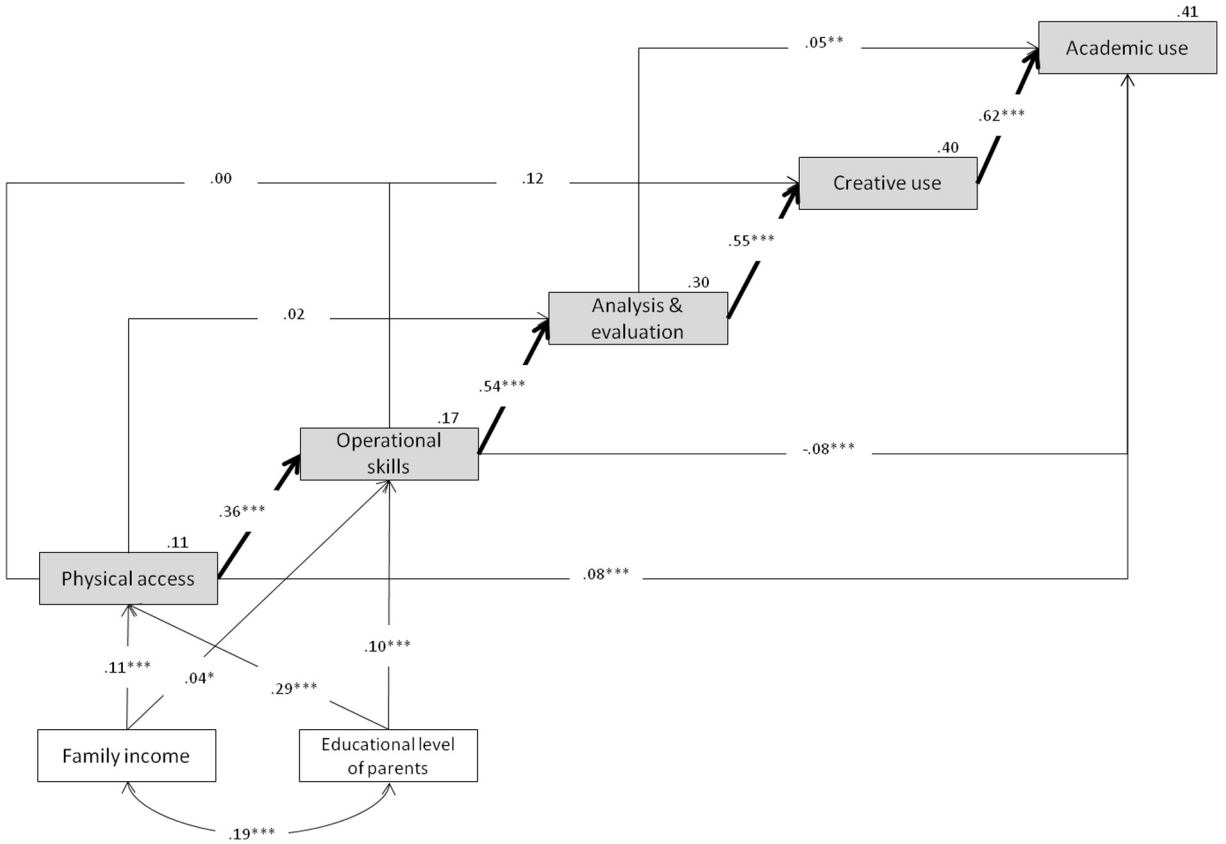

Fig. 2. Results of SEM.

Table 5
Direct, indirect, and total effects of the Internet access sequence.

Hypotheses and effects of intervening variables	Direct effects β	Indirect effects β	Total effects β
H1a. Physical access → Operational Internet skills	0.36		0.36
H1b. Physical access → Analysis & evaluation	0.02	0.19	0.21
H1c. Physical access → Creative use		0.06	0.06
H1d. Physical access → Academic use	0.06	0.08	0.14
H2a. Operational Internet skills → Analysis & evaluation	0.54		0.54
H2b. Operational Internet skills → Creative use	−0.01	0.17	0.15
H2c. Operational Internet skills → Academic use		0.20	0.20
H3a. Analysis & evaluation → Creative use	0.32		0.32
H3b. Analysis & evaluation → Academic use	0.15	0.25	0.40
H4. Creative use → Academic use	0.54		0.54
H6a. Family income → Physical access	0.11		0.11
H6b. Family income → Operational Internet skills	0.04	0.04	0.08
H7a. Educational level of parents → Physical access	0.29		0.29
H7b. Educational level of parents → Operational Internet skills	0.11	0.10	0.21
Family income → Analysis & evaluation		0.05	0.05
Family income → Creative use		0.01	0.03
Family income → Academic use		0.02	0.02
Educational level of parents → Analysis & evaluation		0.12	0.12
Educational level of parents → Creative use		0.03	0.03
Educational level of parents → Academic use		0.06	0.06

In the case of secondary school students, the data showed the importance of physical access on the development of operational Internet skills. But physical access also had indirect effects on the ability of A&E, CU and AU, even though this effect was weakened as the access level or phase increased. Although the influence of physical access diminished as the phases of appropriation moved forward, it was still a necessary factor, so equal access to broadband should be facilitated (DiMaggio

and Hargittai, 2001; Warschauer, 2004). In this sense, in Ecuador, as in other countries in Latin America, although the prices of Internet connectivity are decreasing progressively, the prices of the equipment (*desktop computers, laptops, tablets, smartphones, smart television*), are still high when compared to the cost of living in those countries (ITU, 2014). This makes it so that the connections to the Internet through the Smartphone have grown at the same time that they have decreased through the use of desktop computers. This limits the access to the Internet, to resources/applications and uses that require a larger screen format that could ease multi-tasking (for example, academic tasks).

Likewise, other studies have shown that the lack of the operational domain of the Internet can become an obstacle for the acquisition of information analysis and evaluation skills related to the content found on the Internet (Van Deursen et al., 2012). The results of the present study reinforce the idea that the beneficial use of the Internet (for example the use of the Internet for academic tasks), as the last level of technology appropriation, has to be supported in and by the previous levels of access; the quality of the technical medium, the operational skills, the analysis and evaluation skills, and the ability to create through its different languages. This idea suggests that there is a need for literacy strategies related to the Internet to take into account the different types/levels of access in a gradual manner (sequenced) (technical resources, skills/abilities, knowledge and autonomy) but using as its focus the sought-after purpose (or benefit) (Warschauer, 2004; Van Deursen and Van Dijk, 2015).

The overall results of this study point towards the need to develop policies that act upon the three levels (stages) of Internet access, or even on the different levels of literacy. In every case, these actions should be interconnected, taking into account the sequence between them. This means that the resources/devices required for literacy (operational and content-related) should be made available, but should also be oriented to specific types of use (Van Deursen and Van Dijk, 2015). In the case of secondary school students, it is recommended that they have available, at their educational centers and at home, the type of access (devices and connectivity) that would give them autonomy, as well as training in operational skills such as those related to the access and management of valid and reliable information. Likewise, the use of meaningful context (for the student) in academic use is recommended to the development of these skills and knowledge.

In the Ecuadorian context, as an example of a country under development, it is important to strengthen the development of infrastructure and the reduction of the cost for users that could ease independent access to the Internet and its applications. On the other hand, for true Internet appropriation and its benefits, the policies of incorporation of the ICTs in educational centers should be whole, interconnecting the different levels of literacy, and taking into account the sought-after benefits.

6. Limitations

It should be noted that this study used a single source of information, in the shape of self-reports from those polled, with the poll being based on the use that they give to the Internet and their self-perceived abilities.

Likewise, the data supported a model that aimed to show the successive stages involved in technology (Internet) appropriation by a population (secondary school students in Ecuador). For the creation of the model, the different levels of digital divide (access to the Internet) were used as a reference (Warschauer, 2004; van Dijk, 2006), along with media and digital literacy (Hobbs, 2010; Buckingham, 2007; Celot & Tornero, 2009). However, although the main elements of these theoretical models were similar in general, there were nuances and indicators that differentiated these proposals from each another. Therefore, more research to validate these theoretical proposals is needed.

Related to the above, similar models that included the motivations, beliefs and other subjective aspects should be validated (Van Deursen and Van Dijk, 2015) to better understand the process of acceptance of the Internet and the benefits received from its use. In this sense, it would be interesting to add the analysis of components found in the theories that explain the process of acceptance of technology (Davis, 1993; Venkatesh et al., 2003).

On the other hand, the constructs could be improved as far as their internal consistency and validity. For example, in the A&E construct, indicators related to strategic skills could be added (Van Deursen and Van Diepen, 2013). Likewise, the PA construct has low AVE and reliability values. This is probably due to the scarce number of the indicators used, which might not be enough to the current era of Smartphones. Therefore, more specific indicators should be added to the construct. The weakness of the PA construct impedes learning, to a greater degree, about the resources/devices that could help in increasing operational and informational abilities.

The study was limited to secondary school students aged 16 to 18, and was focused on academic tasks performed as a team. In this sense, it would be interesting to include the analysis of other uses/benefits by/for the students (for example leisure, choosing of studies, search for grants/scholarships, training, contact with businesses or professional training).

Research works such as those by Blank and Groselj (2014) or Van Deursen and Helsper (2015) point to the relevance of establishing a conceptual framework that allows for the delving into the frequency, diversity and types of activities conducted through the Internet, as well as its benefits. Therefore, it would be important to, using as reference the theory of uses and gratification (Papacharissi, 2008; Roy, 2014), differentiate dimensions on the use of the Internet (Van Deursen and Van Dijk, 2014), and associate them to motivations and their consequences/benefits.

The present study has only taken into account two socio-demographic variables: family income and level of education of the parents. It should be noted that the decision to use only these two variables was based on a previous exploratory study of the data, which confirmed that these two factors were the ones that had the most influence on Internet access in Ecuador.

Appendix 1

	Mean (SD)	Convergent validity		Reliability		Unidimensionality		
		Factorial load	AVE	Cronbach's Alpha	Composite reliability	% variance (1st factor)	Eigenvalue 1st factor	Eigenvalue 2nd factor
Operational Internet skills (OIS) (Indicate your degree of knowledge in . . .)								
Make and receive calls on a cellphone	3.49 (0.81)	0.57	0.37	0.91	0.78	44.20%	7.51	1.96
Decode a written or verbal message with a cellphone	3.23 (0.95)	0.64						
Create, modify save contacts on a cellphone	3.40 (0.86)	0.62						
Configuring alarm, ringtones, hour and date on a cellphone	3.49 (0.83)	0.58						
Cellphone configuration for creating groups in social networks	2.70 (0.09)	0.61						
Compress and decompress files	2.69 (1.02)	0.66						
Connect and disconnect devices	2.79 (1.19)	0.72						
Install and replace operating systems	2.95 (0.99)	0.74						
Edit photos, videos, sounds digitally	3.03 (0.96)	0.66						
Transfer information between computers	2.76 (1.04)	0.65						
Use email on the internet	3.20 (0.88)	0.67						
Use multimedia tools	3.34 (0.80)	0.72						
Navigate webpages	3.41 (0.79)	0.70						
Download, print information from the web	3.32 (0.84)	0.71						
Download different kinds of software	2.50 (1.01)	0.67						
Options and configuration of security	2.66 (0.98)	0.69						
Applications and procedures online	2.22 (1.07)	0.58						
Analysis & evaluation (A&E) (Indicate your degree of knowledge in . . .)								
National or international news agencies	2.40 (0.83)	0.62	0.46	0.88	0.83	47.35	5.20	0.94
Sources of information	2.97 (0.77)	0.62						
The sections of communication media	2.75 (0.81)	0.67						
The owners and ideology of communication media	2.55 (0.88)	0.70						
Access to scientific, valid and reliable information	2.44 (0.86)	0.73						
Organization of scientific information	2.34 (0.84)	0.73						
Communication media to share scientific information	2.37 (0.84)	0.72						
Funding sources of communication media	2.51 (0.87)	0.69						
Regulation of the content from mass media information	2.37 (0.83)	0.71						
Regulations and protocols of copyrights	2.39 (0.86)	0.68						
Open source licenses for works on the internet (Creative Commons)	2.21 (0.91)	0.64						

Appendix 1 (*continued*)

	Mean (SD)	Convergent validity		Reliability		Unidimensionality		
		Factorial load	AVE	Cronbach's Alpha	Composite reliability	% variance (1st factor)	Eigenvalue 1st factor	Eigenvalue 2nd factor
Creative use (CU) (Indicate how frequently do you use the Internet for…)								
Comment in a blog	2.24 (0.98)	0.77	0.66	0.86	0.90	66.10	3.30	0.65
Create blogs	2.10 (0.98)	0.84						
Create wiki articles	1.83 (0.95)	0.88						
Creation of wikis	1.81 (0.95)	0.87						
Upload videos to YouTube	2.25 (1.08)	0.68						
Academic usage (AU) (How frequently do you use the Internet for …)								
Manage courses/academic or cultural events	2.26 (1.01)	0.74	0.59	0.90	0.89	61.21%	4.89	0.79
Work in a team, videoconferencing (Skype, Adobe connect …)	2.32 (1.03)	0.76						
Create academic content through wikis as a team	1.85 (0.95)	0.78						
Create academic content through blogs as a team	1.96 (0.96)	0.78						
Create multimedia content, presentations	2.32 (1.04)	0.74						
Create in academic work teams	2.27 (1.03)	0.82						
Co-ordinate team works online	2.19 (1.04)	0.83						
Work as team accessing reliable sources of information	2.32 (1.03)	0.76						
Physical access (PA)								
Number of computers in the household [from 1 to 4 (more than 3)]	2.17 (0.78)	0.74	0.28	0.62	0.54	57.39%	1.72	0.77
Access to the Internet at home [from 1 (no access) to 4 (broadband)]	2.28 (0.88)	0.84						
Access to the Internet on the cellphone [from 1 (no access) to 4 (broadband)]	2.02 (0.84)	0.68						

References

Barzilai-Nahon, K., 2006. Gaps and bits: conceptualizing measurements for digital divide/s. Inf. Soc. 22 (5), 269–278.
Bilbao-Osorio, B., Dutta, S., Lanvin, B., 2014. The Global Information Technology Report. WEF.
Blank, G., Groselj, D., 2014. Dimensions of internet use: amount, variety, and types. Inf. Commun. Soc. 17 (4), 417–435.
Brandtzæg, P.B., Heim, J., Karahasanović, A., 2011. Understanding the new digital divide – A typology of Internet users in Europe. Int. J. Hum Comput Stud. 69 (3), 123–138.
Buckingham, D., 2007. Media education goes digital: an introduction. Learn. Media Technol. 32 (2), 111–119. http://dx.doi.org/10.1080/17439880701343006.
Byrne, B.M., 2013. Structural Equation Modeling With EQS: Basic Concepts, Applications, and Programming. Routledge, London, UK.
Celot, P., Tornero, J.M., 2009. Study Assessment Criteria for Media Literacy Levels: Final Report. Brussels: EAVI, European Association for Viewers' Interests. European Commission, Brussels.
Cerbino, M., Belotti, F., 2016. Community media as exercise of communicative citizenship: experiences from Argentina and Ecuador. Comunicar 47, 49–56. http://dx.doi.org/10.3916/C47-2016-05.
Compaine, B., 2001. Re-Examining the Digital Divide. Communications Policy in Transition: The Internet and Beyond. MIT Press, Cambridge, MA.
Curran, P.J., West, S.G., Finch, J.F., 1996. The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. Psychol. Methods 1 (1), 16.
Davis, F.D., 1993. User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. Int. J. Man Mach. Stud. 38 (3), 475–487.
DiMaggio, P.J.E., Hargittai, E., 2001. From the 'digital divide' to 'digital inequality': Studying Internet use as penetration increases: Working Paper 15. Center for Arts and Cultural Policy Studies, Woodrow Wilson School, Princeton University, Princeton, NJ.
Dornaleteche, J., Buitrago, A., Moreno, L., 2015. Categorization, item selection and implementation of an online digital literacy test as media literacy indicator. Comunicar 44, 177–185. http://dx.doi.org/10.3916/C44-2015-19.
Dueñas, D., Pontón, P., Belzunegui, Á., Pastor, I., 2016. Discriminatory expressions, the young and social networks: the effect of gender. Comunicar 46, 67–76. http://dx.doi.org/10.3916/C46-2016-07.
Gunkel, D.J., 2003. Second thoughts: toward a critique of the digital divide. New Media Soc. 5, 4.
Haddon, L., 2000. Social exclusion and information and communication technologies lessons from studies of single parents and the young elderly. New Media Soc. 2 (4), 387–406.
Haight, M., Quan-Haase, A., Corbett, B.A., 2014. Revisiting the digital divide in Canada: the impact of demographic factors on access to the internet, level of online activity, and social networking site usage. Inf. Commun. Soc. 17 (4), 503–519. http://dx.doi.org/10.1080/1369118X.2014.891633.
Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L., 2006. Multivariate Data Analysis. Prentice-Hall, Englewood Cliffs, NJ.
Harambam, J., Aupers, S., Houtman, D., 2013. The contentious gap: from digital divide to cultural beliefs about online interactions. Inf. Commun. Soc. 16 (7), 1093–1114. http://dx.doi.org/10.1080/1369118X.2012.687006.
Hargittai, E., 2002. Second-level digital divide: differences in people's online skills. First Monday 7 (4).
Hargittai, E., Hinnant, A., 2008. Digital inequality differences in young adults' use of the internet. Commun. Res. 35 (5), 602–621.
Hobbs, R., 2010. Digital and Media Literacy: A Plan of Action. Washington, D.C. 20036. The Aspen Institute.
Hobbs, R., 2011. The state of media literacy: a rejoinder. J. Broadcast. Electron. Media 55 (4), 601–604. http://dx.doi.org/10.1080/08838151.2011.619399.
Hoffman, D.L., Novak, T.P., Schlosser, A., 2000. The evolution of the digital divide: how gaps in Internet access may impact electronic commerce. J. Comput. Mediat. Commun. 5 (3). http://goo.gl/1g5rHy.
Hogarth, J.M., Kolodinsky, J., Gabor, T., 2008. Consumer payment choices: paper, plastic, or electrons? Int. J. Electron. Banking 1 (1), 16–35.
INEC, 2014. Archivo Nacional de Datos y Metadatos Estadísticos (ANDA) Catálogo Central de Datos from. http://anda.inec.gob.ec/anda/index.php/catalog (January 15, 2010).
ITU, 2014. Measuring the Information Society Report. International Telecommunications Union.
Kaiser, H., 1960. The application of electronic computers to factor analysis. Educ. Psychol. Measur. 20, 141–151.
Kolodinsky, J.M., Hogarth, J.M., Hilgert, M.A., 2004. The adoption of electronic banking technologies by US consumers. Int. J. Bank Market. 22 (4), 238–259.
Livingstone, S., Helsper, E., 2007. Gradations in digital inclusion: children, young people and the digital divide. New Media Soc. 9 (4), 671–696. http://dx.doi.org/10.1177/14614448070803351.
López, D., Callejo, G., Cajiao, E., 2014. Evolución del consumo de Internet en el Ecuador entre los años 2010 al 2012: evidencia empírica de una ecología de la comunicación. Revista ComHumanitas 5 (1), 19–30.
Mossberger, K., Tolbert, C.J., Stansbury, M., 2003. Virtual Inequality: Beyond the Digital Divide. Georgetown University Press.
Newhagen, J.E., Bucy, E.P., 2004. Routes to media access. Media Access, 3–23.
Papacharissi, Z., 2008. Uses and gratifications. An Integrated Approach to Communication Theory and Researc. Lawrence Erlbaum, pp. 137–152.
Riggins, F.J., Dewan, S., 2005. The digital divide: current and future research directions. J. Assoc. Inf. Syst. 6 (12), 4.
Roy, S.K., 2014. Determining uses and gratifications for Indian Internet users. Case Stud. Bus. Ind. Gov. Stat. 2 (1), 78–91.
Schradie, J., 2011. The digital production gap: the digital divide and Web 2.0 collide. Poetics 39 (2), 145–168.
Selwyn, N., 2004. Reconsidering political and popular understandings of the digital divide. New Media Soc. 6 (3), 341–362.
Servon, L.J., 2008. Bridging the Digital Divide: Technology, Community and Public Policy. John Wiley & Sons.
Torres-Díaz, J.C., Duart, J.M., Gómez-Alvarado, H.F., Marín-Gutiérrez, I., Segarra-Faggioni, V., 2016. Usos de Internet y éxito académico en estudiantes universitarios. Comunicar: Revista Científica de Comunicación y Educación 24 (48).
Van Deursen, A.J.A.M., Helsper, E.J., 2015. A nuanced understanding of Internet use and non-use amongst the elderly. Eur. J. Commun. 30 (2), 171–187.
Van Deursen, A.J.A.M., Van Diepen, S., 2013. Information and strategic Internet skills of secondary students: a performance test. Comput. Educ. 63, 218–226.
Van Deursen, A.J.A.M., Van Dijk, J.A.G.M., 2011. Internet skills and the digital divide. New Media Soc. 13 (6), 893–911. http://dx.doi.org/10.1177/1461444810386774.
Van Deursen, A.J.A.M., Van Dijk, J.A.G.M., 2014. The digital divide shifts to differences in usage. New Media Soc. 16 (3), 507–526. http://dx.doi.org/10.1177/1461444813487959.
Van Deursen, A.J., Van Dijk, J.A., 2015. Toward a multifaceted model of internet access for understanding digital divides: an empirical investigation. Inf. Soc. 31 (5), 379–391.
Van Deursen, A.J.A.M., Van Dijk, J.A.G.M., Peters, O., 2012. Proposing a survey instrument for measuring operational, formal, information, and strategic internet skills. Int. J. Human-Comput. Interact. 28 (12), 827–837.
Van Deursen, A.J., Van Dijk, J.A., ten Klooster, P.M., 2015. Increasing inequalities in what we do online: a longitudinal cross sectional analysis of Internet activities among the Dutch population (2010 to 2013) over gender, age, education, and income. Telematics Inform. 32 (2), 259–272.
Van Dijk, J.A., 2006. Digital divide research, achievements and shortcomings. Poetics 34 (4), 221–235.
Van Dijk, J., 2012. The evolution of the digital divide: the digital divide turns to inequality of skills and usage. In: Bus, J., Crompton, M., Hildebrandt, M., Metakides, G. (Eds.). Digital Enlightenment Yearbook, pp. 57–75.
Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D., 2003. User acceptance of information technology: toward a unified view. MIS Q., 425–478
Warschauer, M., 2002. Reconceptualizing the digital divide. First Monday 7 (7).
Warschauer, M., 2004. Technology and Social Inclusion: Rethinking the Digital Divide. MIT Press.
Witte, J.C., Mannon, S.E., 2010. The Internet and Social Inequalitites. Routledge.

Zhang, X., 2013. Income disparity and digital divide: the internet consumption model and cross-country empirical research. Telecommun. Policy 37 (6–7), 515–529. http://dx.doi.org/10.1016/j.telpol.2012.
Zhang, G., Wang, Q., Kolodinsky, J., 2010. The digital divide in Internet information searching: a double-hurdle model analysis of household data from Vermont. First Monday 15 (11).
Zillien, N., Hargittai, E., 2009. Digital distinction: status-specific types of internet usage. Soc. Sci. Q. 90 (2), 274–291.

Ramón Tirado-Morueta Ph.D. is a Professor at the Department of Education at the University of Huelva (Spain), lecturing in the field of Educational Technology. His research career has been organized around the variable modulating effects and application of ICT in many educational contexts. Recently, he has published several scientific articles focused on the analysis of processes of cooperative learning and learning communities supported by the use of technological resources, as well as the contrast of theories about the influence of external and internal factors in the integration of teaching information technology and communication in primary schools, secondary schools and universities.

Ignacio Aguaded Ph.D. Chair and Full Professor at the Department of Education of the University of Huelva (Spain). He leads the fields of Technology and Innovation and is the Chairman of Group *Comunicar*, in Andalusia, a veteran in Spain in Education through Mass Media. He is the Editor of «Comunicar», Media Education Research Journal (JCR, Scopus), which is distributed in Europe and America. He is also scientific advisor to several national and international scientific journals, as well as manager of «Agora» Investigation Group, developing various international investigation projects. He has participated in many educational/investigation activities in the didactic use of mass media and has been the organizer and chairman of several scientific committees of international academic events.

Damian-Marilú Mendoza-Zambrano Interuniversity PhD doctoral student in Communication at the Universities of Huelva, Seville, Malaga and Cadiz (line-Educommunication). Master in Audiovisual Communication and Education, UNIA/UHU. Spain. Specialist Curriculum Design Competence (Universidad del Mar-Chile-ULEAM-Ecuador), Diploma in Photography-TV (I. José Martí-Cuba-CIESPAL-Ecuador), BA in Public Relations and Communication (U.T.E. Ecuador).

Isidro Marín-Gutiérrez, Ph.D. BA in Political Science and Sociology from the University of Granada. Doctor (Ph.D.) in Social Anthropology from the University of Granada. Associate Professor at the University of Huelva. Teacher-Principal Investigator of the Universidad Técnica Particular de Loja (UTPL). Member of the Technical Council of the Latin American scientific journal communication and education «Comunicar». Member of the Research Group E6, Social Studies and Social Intervention (SEJ-216). Director of the research group InvestigaUTPL.