# Dimensions of digital divide and relationships with social factors: A study of Greek pre-service teachers

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## Abstract

In this paper the dimensions of digital divide (DD) are explored among Greek pre-service teachers. The participants (N=309) were asked to complete an instrument with questions about their access and use of Information and Communication Technologies (ICT). Data were analysed by Principal Component Analysis (PCA); Six dimensions were extracted: Entertainment Activities at the University (EAU), Entertainment Activities at Home (EAH), Knowledge & Skills (K&S), Academic Work at the University (AWU), Academic Work at Home (AWH) and Sources of Learning (SL). The above dimensions measured by the factor scores calculated by PCA were used as depended variables and the effects of independent variables, such as gender, age, residency, parents' residency, type and location of school and parents' education were explored via a general linear model (GLM). The analysis showed that age, school location, mother's education and the university department were significantly correlated with DD. Moreover, a two-step cluster analysis based on the extracted dimensions of DD revealed four groups/clusters of students, which have distinct behavioural profiles associated with their access and use of digital technologies. The implications of the findings are discussed.

**Keywords:** ICT, digital divide, pre-service teachers, university studies

## Introduction

### *The digital challenge*

Over the past two decades, the current post-industrial and post-modern societies have been establishing their economic and social prosperity on the introduction, diffusion and effective use of Information and Communication Technologies (ICT) in all every-day and professional activities of their citizens (Wong et al., 2009). Thus, considerable efforts have been made by the governments of developed countries, in order to adopt strategies for promoting the construction of the so-called network society; a society of knowledge and information, which will be consisted of digitally literate people (Pilat & Lee, 2001; Selwyn, 2002; Jimoyiannis, 2015). In particular, citizens are encouraged to acquire knowledge and skills of a new forms of literacy that go beyond the traditional notion. The individuals should become capable of adapting to the requirements of the society through their acquaintance with computer-digital literacy (Eynon, 2009). The diffusion and enhancement of computer and Internet applications have led inevitably to a new form of computer-digital revolution, which continuously affects the overall crowning of the society (Keniston, 2003; Pagán, Martínez & Máiquez, 2018; Tsiotakis & Jimoyiannis, 2016).

Nevertheless, despite the fact that ICT has brought a radical change in the society, its benefits are not widely acknowledged. What the modern citizen acquires from this revolution has been an issue of debate in the international scene between supporters and opponents of ICT. The main counter-argument is related to the issue of equal opportunities supposedly secured for each active member of the society (Hargittai, 2003). A crucial question has been raised in the ongoing discussion

"whether new forms of social inequality are aggravated, exacerbated or maintained" (DiMaggio & Hargittai, 2001), an issue that contemporary scholars and researchers have focus on.

### *The digital gap/divide*

Access to knowledge via the modern forms of communication and networking, such as computers and Internet, goes through a new form of social partnership, which potentially creates a type of social inequality known as digital exclusion (Bristow, 2009). Social scientists being aware of this problem have made efforts to probe it. International research on this issue reveals a considerable discrepancy between the "privileged", who have access to and are familiar with ICT, and the "underprivileged", who come short of this capacity. In fact, despite the ambitious governmental programs the diffusion of ICT has not reached the desired level for the entire population even in the developed countries with high computer and Internet access (Lenhart & Horrigan, 2003). These disappointing data show a problem that is rooted in various factors, mainly of social origin, which prevent a large proportion of citizens from having the benefits of the modern digital era (DiMaggio et al., 2004).

Theoretical conjectures in examining the above social phenomenon, that is, the ensuing inequality despite the rapid and continuous technological development and the subsequent diffusion of ICT in all human activities, proposed the term digital inequalities and/or digital divide (DD). These inequalities occur among societies with different social, educational and economic level; however the term could be applied among citizens of the same society as well (Chen & Wellman, 2004). Initially, the notion of digital divide referred to the differences found among populations of countries; between those who have access to the digital technology and make use of computer and Internet applications, and the ones that do not have access to new digital media, nor have the ability to use digital applications (Robinson, DiMaggio & Hargittai, 2003; Chen & Price, 2006; Tien & Fu, 2008; Goode, 2010).

DD as complex and multilevel phenomenon has instigated the international research interest since the late 20th century and it still remains a central topic of discussions and an issue debates in various studies (Nielsen, Rohman & Lopes, 2018). In the early 21st century some theorists reconsidered the term digital divide in an attempt to describe variations in digital literacy among people of different ages. In particular, they refer to the gap created among individuals belonging to different generations (Prensky, 2001; Waycott et al., 2010). There are young people, the so-called digital natives who are born in the era of digital technology, i.e., contemporary students who seem to have been adopted to the digital world (Selwyn, 2009). On the other hand, there are the digital immigrants, older generations, which include, i.e., in-service teachers who find it difficult to intergrade their activities into the new social context (Bristow, 2009; Thinyane, 2010).

Furthermore, the notion of DD does not apply merely among members of societies belonging to different generations (Goncalves, Oliveira & Cruz-Jesus, 2018). The term intra-generational DD focus on individuals of the same generation, that have different access to computers; they use digital applications and have acquired knowledge and skills that are part of the computer-digital literacy, but at a different level (Salajan, Schonwetter & Cleghorn, 2010). Thus, the literature has extended the notion of DD between the "haves" and the "have-nots" regarding access to digital applications and those who use or not use ICT and the Internet. Behind this division, a number of underlying variables might exist, which could facilitate or inhibit the attainment of digital literacy (Cruz-Jesus, Oliveira & Bacao, 2018). Among them, gender, age, place of residence, education levels, geographic areas, socio-cultural level, income, as well as their personal beliefs and assumptions about ICT and their usefulness, have been proposed as causally related to DD (Lenhart et al., 2003; Kennedy, Wellman & Klement, 2003; Looker & Thiessen, 2003; Losh, 2003; Martin, 2003; Selwyn, 2002; Demunter, 2005; Wong et al., 2009; Goode, 2010; Ritzhaupt et al., 2013).

Contemporary research has focused on both first-level and second-level DD (Prensky, 2001; Pagán, Martínez & Máiquez, 2018). The former refers to inter-generational digital gap, but also to different familiarity and use of ICT programs and the Internet by certain age-groups. The latter, appears in the same generation and refers to the digital gap, due to various socio-cultural and environmental factors, such economic status, parents education, origin and/or living conditions (Cinca, Soro & Brusca, 2018). Literature review is out of the scope of the present paper, however, it is worth mentioning that the most interesting areas focus on secondary education students (Levin & Arafeh, 2002; Looker & Thiessen, 2003; Demunter, 2005), in-service teachers (Chen & Price, 2006; Chapman, Masters & Pedulla, 2010) and people regardless of their age or professional identity (Hargittai, 2003; Lenhart et al., 2003; Jackson et. al., 2003; Martin, 2003; Hargittai & Hinnant, 2008; Eynon, 2009). Last, but not least, a research area which is related to the present paper, has studied pre-service education students (Zin et al., 2000; Cotten & Jelenewicz, 2006; Salajan, Schonwetter & Cleghorn, 2010; Waycott et al., 2010) and pre-service teachers (Tien & Fu, 2008).

The present paper, following the international interest for the digital divide, attempts to address the related crucial question regarding the existence of social-digital inequalities among Greek pre-service teachers, and adds to literature by proposing a systematic approach in assessing DD and establishing relationship with potential predictors.

## Rationale and Research Hypotheses

The present study aims to explore the digital divide among pre-service teachers. DD as a theoretical term has been operationalized by various empirical indices obtained by subjects' responses to questions related to their access and use of digital technology. Research has revealed many aspects of this well-recognized social problem of inequality, however, measurement issues have not been systematically discussed (Tien & Fu, 2008). A first step towards DD measurement is the development of an appropriate scale, which in terms of research methodology is the extraction of the latent variables or dimensions (or components) of the theoretical term based on the subjects' responses. Principal Component Analysis (PCA) is an appropriate statistical procedure for this purpose and it was applied in an exploratory mode. Thus, the main research question concerns the dimensionality and the characterization of the DD dimensions.

Four dimensions were initially hypothesized: 1) *Academic Work (AW)*. AW corresponds to activities that students are engaged with, as part of their course requirement, such as writing, finding bibliography or making presentations. 2) *Entertainment Activities (EA)*. EA corresponds to activities that students do for fun, such as listening music, chat or exchanging e-mails. 3) *Knowledge & Skills (K&S)*. K&S is the dimension which measures students' digital literacy and their skills in performing task with the use of computers. 4) *Sources of Learning (SL)*. SL depicts the sources that the students have acquired their knowledge from, such as school or university.

In addition, the present research examined the effect of independent variables, such as, gender, place of residence, location of Gymnasium (lower secondary school) and Lyceum (upper secondary school), socio-cultural level of their parents, university department and familiarity with ICT.

Thus, six additional research hypotheses were stated:

1. Gender makes a distinction in terms of access and use of computers at home as well as in terms of different digital applications, which the participants use.

2. Age makes a distinction in terms of access and use of computers at home as well as in terms of different digital applications, which the participants use.

3. Pre-service teachers, who originate from rural areas and have attended schools there, will report difficulties in accessing the Internet from their home area and will differentiate from students of urban/sub-urban areas.

4. The use of computers at home, the frequency of the use of digital applications and the types of applications of computers by pre-service teachers, will correlate to the social and educational level of their parents.

5. The university education of pre-service teachers will be a key factor in influencing both the use of computer applications and the level of their digital literacy.

6. Based on dimensions of DD, it is possible to obtain certain meaningful behavioural profiles of the participants regarding their use of ICT.

The originality-importance of the present research lies not only on hypotheses testing, which applies, of course, merely to the Greek case, but on the methodological approach proposed here, which has an international interest for research probing digital divide. Note the most researches in the field rely on bivariate correlations and simple statistics. Thus, combining various multivariate analyses, adds to the field by pointing out more effective data analysis, and ways for promoting theory.

## Research method

### *Participants*

The participants were pre-service teachers (N=309), 83.2 % female, belonging to three different departments: a) Philosophy and Education (52.1%) b) Literature (30.4%) and c) History and Archaeology (17.5%) at Aristotle University of Thessaloniki, which is the largest University in Greece. 89% of the participant were from urban areas. The sample corresponds to 5% of the students' population studying in School of Philosophy. The data were collected through a paper-and-pencil procedure, which lasted about 30 min.

### *The survey instrument*

The survey instrument was a questionnaire developed for the present research, which included 40 Likert-scale questions corresponding to various hypothesized dimensions: 1) Academic Work (AW), 2) Entertainment Activities (EA), 3) Knowledge & Skills (K&S), and 4) Sources of Learning (SL).

The questionnaire was synthesized using items abounded in the related literature (e.g., Kent & Facer, 2004; Snyder et al., 2008), thus enhanced content validity is expected, while the factorial validity was supported by PCA. Reliability measures were made using Cronbach's alpha coefficient. The items which were finally kept as valid indicators after PCA analysis are shown in Table 2 (see next section). The coefficient Cronbach's alpha for the whole instrument was 0.86.

## Results

### *Principal Component Analysis of the Questionnaire -The dimensions of digital divide*

Principal Component Analysis (PCA) was applied in order to reduce the number of variables, that is, to classify variables. The procedure led to extraction of six components (Table 1). In order to determine the number of factors in PCA, a combination of various criteria were implemented: 1) The Kaiser's criterion, that is, the factors with eigenvalues greater than 1 should be retained; 2) the scree test, which is a graphical method, using the plot of the factor eigenvalues; 3) The importance and the meaning of a particular factor and its interpretation. The Varimax rotation method was used,

which leads to a pattern of loadings on each factor that is as diverse as possible, leading itself to easier interpretation (Anderson, 1984). Tests for multivariate normality and sampling adequacy provided values of 0,783 and 0,000 for KMO Test and Bartlett's Test of Sphericity respectively.

From PCA six factors were extracted with eigenvalues 4.99, 4.39, 3.75, 3.34, 2.82 and 2.02 respectively, which lead to accumulated variance-explained of 12.5%, 23.5%, 32.9%, 41.3%, 48.3 and 53.3%, respectively (Table 1).

Table 2 shows the factor loadings for the six *dimensions of DD*. An interest finding in this analysis is that the initial hypothesized dimensions of *Entertainment Activities* (EA) and *Academic Work* (AW) both include two subscales, thus each of them split and differentiated the *Home* activities from the *University* activities. That is, the *latent variables* driving students' responses to items that refer to activities performed at home and at the university are different. The dimensions extracted from PCA (Table 2) are the following: *Entertainment Activities at the University* (EAU), *Entertainment Activities at Home* (EAH), *Knowledge & Skills* (K&S), *Academic Work at the University* (AWU), *Academic Work at Home* (AWH) and *Sources of Learning* (SL). The corresponding reliability coefficients Cronbach's alpha for each subscale are 0.86, 0.84, 0.80, 0.79, 0.69 and 0.67 respectively. The marginal values of the last two coefficients are due to some items with low loadings, which however were kept for interpretability reasons.

**Table 1. Results of Principal Component Analysis for the Total Sample (N = 309)**

| Component | Rotation Sums of Squared Loadings | | |
|---|---|---|---|
| | Total | % of Variance | Cumulative % |
| 1 | 4.990 | 12.474 | 12.474 |
| 2 | 4.395 | 10.986 | 23.461 |
| 3 | 3.754 | 9.386 | 32.846 |
| 4 | 3.348 | 8.369 | 41.216 |
| 5 | 2.822 | 7.054 | 48.269 |
| 6 | 2.022 | 5.056 | 53.325 |

**Table 2. Results of Principal Component Analysis for the Total Sample (N = 309)**

| ICT activities | Components | | | | | |
|---|---|---|---|---|---|---|
| | UnFun | HoFun | K & S | UnWork | HoWork | Sources |
| Sending messages (e-mails) | .542 | | | | | |
| Reading news | .584 | | | .445 | | |
| Entertainment Information | .598 | | | .403 | | |
| Communication/Chat | .678 | | | | | |
| Playing with images/photos | .724 | | | | | |
| Watching DVDs | .727 | | | | | |
| Playing online/serious games | .799 | | | | | |
| Copying music files | .875 | | | | | |
| Listening music | .914 | | | | | |
| Familiarity with the Web | | .480 | | | | |
| Recording music | | .503 | | | | |
| Playing with images/photos | | .510 | | | | |
| Entertainment information | | .621 | | | | |
| Sending messages (e-mails) | | .693 | | | | |
| Reading news | | .696 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Frequency of use | .736 | | | | |
| Listening music | .740 | | | | |
| Communication/Chat | .746 | | | | |
| Designing graphs | | .451 | | | |
| Statistical packages (SPSS) | | .454 | | | |
| e-mails | | .483 | | | |
| Self-education | | .516 | | | |
| Educational software | | .548 | | | |
| Word processing | | .615 | | | |
| PowerPoint | | .647 | | | |
| Data Bases | | .739 | | | |
| Spreadsheets | | .795 | | | |
| Finding information (educational material) | | | .495 | .493 | |
| Frequency of use | | | .602 | | |
| Design (graphs. Figures) | | | .720 | | |
| Word processing | | | .839 | | |
| PowerPoint | | | .881 | | |
| Word processing | | | | .700 | |
| PowerPoint | | | | .589 | |
| Finding information (educational stuff) | | | | .604 | |
| Bibliography searching | | | | .532 | |
| Gymnasium | | | | | .776 |
| Lyceum | | | | | .812 |
| University | | | | | .515 |

## *Hypotheses Testing*

In order to test the research hypotheses, that is, to correlate a number of independent variables with the dimensions of DD, the General Linear model (GLM) is implemented. GLM utilizes least squares procedures and can incorporates both categorical and scale variables. The factors scores for each dimension resulted from PCA were used as dependent variables.

The results are summarized in Table 3. *Gender* does not have any significant statistical effect and thus Hypothesis 1 was not supported. *Age* is shown to affect K&S ($p$<0.05) and AWAH (($p$<0.01), supporting therefore the second Hypothesis.

Elder students demonstrate higher *knowledge & skills* and this is reasonable since more years of practicing probably enhance digital literacy. Elder students also, prefer to do their *Academic Work* at home. Parents' or students' residency seem to have no association with DD, while the location of Gymnasium (i.e., lower secondary education school) seem to be correlated with AWU ($p$<0.05). Students graduated from Gymnasia located in big cities prefer to use the computers of the University to perform their *Academic Work*. The above support Hypothesis 3.

The *type of school*, public or privet is not associated with DD. An interesting finding is that while *father's education* is not correlated with any dimension, *mother's education* is shown to affect three of them, K&S ($p$<0.05), AWH ($p$<0.01) and EAH ($p$<0.05). Students whose mothers have higher education use more computes at home either for *Academic Work* or *Entertainment Activities*, while they appear more knowledgeable and skillful, and thus Hypothesis 4 was partially supported.

**Table 3. Results of multiple regressions on the dimensions of digital divide**

| Variables | K & S | SE | AWU | SE | AWH | SE | EAH | SE | EAU | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender (male=1) | -.059 | .159 | .140 | .530 | -.056 | .161 | .055 | .161 | .051 | .166 |
| Age | 0.190* | .066 | -.036 | .065 | 0.213** | .067 | .033 | .067 | -.033 | .069 |
| Parents' residency (City=1) | .234 | .241 | .020 | .237 | .105 | .244 | -.017 | .244 | .135 | .251 |
| Students' residency (City=1) | .301 | .345 | -.314 | .338 | .366 | .349 | .294 | .348 | -.608 | .360 |
| Gymnasium location (City=1)# | -.463 | .336 | -0.774* | .329 | -.215 | .339 | .159 | .339 | -.075 | .350 |
| Lyceum location (City=1) # | 2.408 | 1.057 | .390 | 1.037 | -1.215 | 1.069 | -.742 | 1.068 | -.589 | 1.102 |
| Type of School (Public=1) | -.055 | .379 | .551 | .372 | -.109 | .383 | -.080 | .383 | .569 | .395 |
| Father's education | -.117 | .080 | -.052 | .079 | .031 | .081 | .117 | .081 | .025 | .084 |
| Mother's education | 0.182* | .087 | .085 | .085 | 0.242** | .087 | 0.182* | .087 | .080 | .090 |
| Department (Ph.& Ed.=1) # | -0.308* | .126 | -0.703*** | .124 | 0.338** | .128 | -.209 | .128 | -.099 | .132 |
| N | 309 | | 309 | | 309 | | 309 | | 309 | |
| F | 5.90* | | 32.1*** | | 7.01** | | 2.67 | | 0.45 | |
| Adjusted $R^2$ | 0.01 | | 0.12 | | 0.06 | | 0.04 | | 0.06 | |

*$p < 0.05$, **p<0.01, *** p<0.001, # It denoted the category taken as the point of reference in calculating differences

Coming to comparison between departments, Philosophy and Education students declare to possess higher *knowledge and skills* (K&S, $p<0.05$) and perform their *Academic Work at the University* (AWU, $p<0.05$). Students from the other departments in the Faculty of Philosophy declare to possess lower *Knowledge and Skills* and they perform *Academic Work* at home (AWH, $p<0.01$). These findings, which support Hypothesis 5, could be easily explained if one considers the curricula in the different departments. Philosophy and Education is the department which includes in the Curriculum computer science courses and in addition it has a better infrastructure in terms of computer facilities, so that pre-service teachers are attracted to work at the University. The effect of formal university education then is a key factor in influencing both the use of computer applications and the level of their digital literacy.

Moreover, in order to test the effect of social and educational level of parents on the frequency of use and the types of digital applications that students make use of, the GLM was implemented with specific items as independent items. The analysis showed that three of the *Activities at home*, are correlated significantly ($p<0.05$) with mother's education. These are: making Power Point presentation, playing with images/photos and listening to news via the Internet.

## *Cluster Analysis*

The Hypothesis 6, put forth regarding the existence of certain participants' profiles of the ICT-use, was addressed by performing a cluster analysis. The two-step-cluster analysis was applied, which is an exploratory tool designed to reveal clusters within a data set based on a number of input variables. The variables used for cluster analysis were the factors scores of the dimensions extracted from PCA procedure. Four Clusters were identified; their characteristics are summarized in Table 4 and depicted in Figure 1.

**Table 4. Cluster model**

| | K & S | EAH | AWH | AWU | % |
|---|---|---|---|---|---|
| **Cluster 1** | High | High | Low | High | 18.8 |
| **Cluster 2** | High | High | High | Low | 29.5 |
| **Cluster 3** | Low | High | Low | Low | 29.5 |
| **Cluster 4** | Moderate | Low | Low | Low | 22.2 |

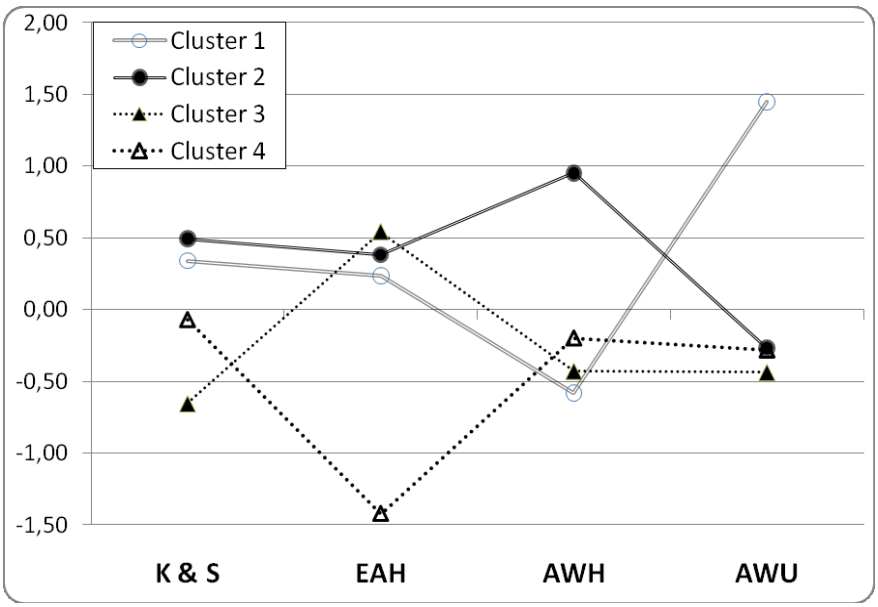


**Figure 1. Characteristics of the four Clusters (1, 2, 3 & 4) in relation to the Dimensions of Digital Divide extracted from PCA analysis**

The four cluster model is interpreted as follows:

- **Cluster 1:** Accounts for approximately 19% of our sample and represents those students who are rated as 'high' in *Knowledge & Skills* (K&S), in *Entertainment Activities at the Home* (EAH), in *Academic Work at the University* (AWU), but are rated as 'Low' in *Academic Work at Home* (AWH). These are devoted students, knowledgeable in digital technologies and who like to work and complete their academic duties at the university.
- **Cluster 2:** Accounts for approximately 29% of our sample and represents those students who are rated as 'high' in *Knowledge & Skills* (K&S), in *Entertainment Activities at the Home* (EAH), in *Academic Work at Home* (AWH), but are rated as 'Low' in *Academic Work at the University* (AWU). These are devoted students, knowledgeable in digital technologies and who like to work and complete their academic duties at home. Both, Cluster 1 & Cluster 2 sum up to 48% of the sample and represent student who have knowledge and skills in computers, use them at home for entertainment and for academic activities as well.
- **Cluster 3:** Accounts for approximately 30% of our sample and represents those students who are rated as 'Low' in *Knowledge & Skills* (K&S), in *Work Activities at the University* (WAU), in *Work Activities at Home* (WAH) but they are rated as 'High' in *Entertainment Activities at*

*Home* (EAH). Those are students with low competence in computer literacy, but interested in using them for playing games and having fun.

- **Cluster 4:** Accounts for approximately 22% of our sample and represents those students who are rated as 'Moderate' in *Knowledge & Skills* (K&S), but rate as 'Low' in *Work Activities at the University* (WAU), in *Work Activities at Home* (WAH) and in *Entertainment Activities at Home* (EAH). Those are the students who know the basics on computer, but show no interest to use them in their personal and academic life.

The dimension *Entertainment Activities at the University* (EAU) had not included in the cluster model, because the four resulted clusters did not have statistical difference in the dimension of EAU. That is, students in all clusters spend a comparable amount of time in using computers for fun at the university.

The application of cluster analysis and the extraction of behavioral profiles is a novel element in DD research. The merit of the above classification is two-fold. First, the encountered profiles could inform theory at psychological level. That is, certain behaviors associated with the use ICT could be driven by latent variables of categorical type; fact which has important implications for measurement and the methodology followed (Bartholomew, 1987). Second, these results inform practice, that is, knowing the specific profiles makes easier and more effective any planed intervention toward bridging the digital gap.

## Discussion

The present study, aiming to explore the digital divide (DD) among pre-service teachers, has proposed a factor structure and an instrument for measuring the DD underlying dimensions. Data analysis suggests that the contemporary Greek pre-service teachers could be considered, to some extent, digitally literate. They use fluently, on a daily basis, and with great frequency, programs and computer applications, various ICT applications and the opportunities offered by social media and communication, at home and at University as well. However, differences exist depending on age, social-educational background of their parents and their university studies. These findings are in line with previous studies reported in the literature. It became evident that the participants of this study have similarities with the modern student generation and pre-service teachers at international level (Conole et al., 2006; Bulfin & Koutsogiannis, 2012).

Specifically, among pre-service teachers, first-level DD exists in the use of various digital media and computers, at different ages (Prensky, 2001; Lindblom & Räsänen, 2017). Younger student (aged 18-19 years), having just entered the university, spend more time on their home computers for entertainment and social networking (Entertainment Activities at Home-EAH) compared to their elder colleagues (aged 20-22 years). Elder students are more often engaged in activities related to writing a text, preparing a presentation on PowerPoint or searching bibliography and sources in electronic data bases. This finding is reasonable considering that elder students, being more advanced in their studies, have additional academic duties related to their assignments and internship, and moreover, they have possibly enhanced awareness of their future role as teachers. Conclusively, it is undoubted that elder students attain a higher level of digital literacy compared to their younger peers.

Regarding the social-educational level of participants' parents, the present data analysis support the finding whereby students whose mothers possess a higher socio-cultural background, are more involved with the ICT programs and web applications related to the so-called *academic literacy*. This finding is aligned with relevant researches reporting that students of low socio-cultural background utilize computer in their home, especially, for entertainment, communication and social networking and not so often for academic digital literacy practices (Selwyn, 2009). These students are in general

considered as less familiar with ICT and possess a lower digital literacy in comparison with students whose parents are at a higher socio-cultural level.

The above findings combined, support a sociocultural perspective in DD theory and adds to our understanding how the different tendencies in utilizing ICT arise within the educational environment. Some factors encourage communication, entertainment and social networking and some other encourage the ICT utilization for scientific inquiry and learning associated with the school and academic literacy. It is imperative to repeated that parents' education of the participants in such studies seem to maintain or, in some cases, to exacerbate the so-called second-level DD (Tien & Fu, 2008).

The third factor probed in this study, the university department reflecting the specific curriculum, was correlated to ICT-use. This formal education could significantly affect not only students' digital literacy level, but also their awareness about their decisive role as future teachers in the digital-gap issue. More specifically, students who are studying at the Faculty of Philosophy and Education appeared to be more familiar with basic computer programs and Internet applications and to be engaged in work related to the digital academic literacy, both at home and University, compared with students of the other two departments. The explanation of the observed DD is directly reduced to the curriculum of the department, given that students of Philosophy and Education department have frequent contact with the educational technology through relevant theoretical courses and/or laboratory exercises. Moreover, their mandatory internship in public schools motivate them to engage with ICT and various multimedia. The last finding, even though it is limited to specific University Schools raise crucial questions about curricula, training and their relationship to potential DD. Teachers' education can be a key factor for an effective involvement of the next generation teachers in confronting the so-called second-level DD (Pagán, Martínez & Máiquez, 2018). Thus, digital literacy should be a formal declaration for the existing and the new curricula inspired by envision for the innovative school (OECD, 2012).

## *Limitations and future directions*

Despite the clear findings, the present research has a number of limitations originating predominantly from its exploratory character. Since it is the first endeavor on this matter and the sample was not representative of the Greek pre-service teachers the results should be treated with caution as far as generability issues is concerned. Moreover, concerning the established relationships causal inferences are only suggested given that the cross-sectional correlational design. Therefore, future research should attempt to replicate the present results by confirming the proposed DD structure and even to extent it to a more complete content. The independent factors affecting the DD dimensions are not limited to those examined in the present work; there is a plethora of variables, cultural or individual differences, playing an important role in the digital divide and they are worth investigating.

## *Concluding remarks*

Measuring digital divide among pre-service teachers and university students in general, is a prerequisite in appraising the potency of the future education. A determined step towards this goal has been made by the present work, which proposed a systematic approach to investigate digital divide. The methodological aspects of this endeavor adds to the DD literature by specifying influential ways of theory building through multivariate analyses. The applied statistics provided empirical evidences for first- and second- level digital divide The former is age-related and the latter is associated with social factors (Prensky, 2001; Pagán, et. al., 2018) The findings which inform theory and practice open an era for a continuing inquiry. The final remark, is that the university education, should systematically create further motives for learning and engagement with ICT (Hilla & Lawtonb, 2018). Curricula should focus on training via digital tools and enriching the modern

educational programs, and furthermore on aiming to strengthen the future teacher's role in ameliorating digital inequalities.

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