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# Factors that describe the use of digital devices in Latin American universities

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**Abstract**

Mobile digital devices are at the same time a tool for social interaction, an individual learning resource and can be a valuable contribution in the context of higher education to develop and promote new teaching and learning models. Recent studies show that both the more traditional pedagogical models of face-to-face teaching and distance teaching mediated by Virtual Learning Environments (VLE) can be enhanced by the use of these devices on and off campus. Likewise, the current context of Higher Education urges university institutions to promote a series of generic and specific competencies, where the use of these devices in a personal, academic and professional way acquires an outstanding value in the European Higher Education Area (EHEA), and represents an enrichment of university educational practice. This paper presents a study of the didactic and social use made by Hispanic American university students in 10 universities in several areas in order to establish common and divergent patterns of use so that useful conclusions can be extrapolated to improve the educational context of Higher Education in the Hispanic world.



*Keywords:* Digital devices; ubiquity; Mobility; Higher education.

## 1. Introduction

Mobile and ubiquitous learning refers to the possibilities that mobile technology offers for the development of teaching-learning activities inside and outside the classroom [1]. Ubiquitous learning is a new educational paradigm

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in which the student is positioned to learn from a more global perspective and where physical space is not a determining variable for learning [2]. Non-formal environments and places - the coffee shop, the street, the means of transportation, the home, the social network, the playground, the media and popular culture, the workplace, etc. - become new learning scenarios [3]. This type of society is called the "Society of Ubiquity" [4]. This term refers to a society in which anyone can enjoy, at any time and in any place, a wide range of services through various terminal devices and broadband networks. Its motto is "anyone, anywhere, anytime".

In recent years, the growth of mobile digital devices is constant and exponential. Latin America leads this ranking with an increase in mobile data traffic of 133% in the last year 2014, followed by Europe with an increase of 98%. Global mobile device subscriptions reached 7.1 billion in 2014 and are estimated to reach 9.5 billion in 2020. A clear example of this trend is in Latin America, where in the first half of 2014, in a study covering more than 50 million users, computer use fell by 11.3%, while smartphone use grew by 70.1% and tablets by 32% [5].

The use of digital devices in the university can help develop theoretical content more effectively and make it more practical and collaborative, encouraging adaptive and interactive learning [6]. This type of functionality can be developed from augmented reality applications, with mini videos of specific content, with the development and design of modular apps for university subjects, with the educational use of social networks and microblogging, among other activities.

For this reason, many universities worldwide have begun to promote mobile learning with the use of digital devices on and off campus. For example, students at the University of Phoenix, Arizona, use an app created by the institution that allows them to access course materials, thematic online and offline forums, and participate in academic chats from anywhere. In line with these initiatives, Stanford University (California) offers, in addition to different apps, a program called: SMILE (Stanford Mobile Inquiry Learning Environment) that allows students to create, collaborate and evaluate questions related to educational issues through their devices. At Florida International University (USA), students have an app that allows them to consult the availability of the library's bibliographic collections and access audiovisual content related to the subjects [7,8].

## 2. Method

The aim of this study is to check the kind of activities and processes university students carry out with mobile digital devices in the academic and social environment and whether significant differences can be established between the Spanish and Latin American context [9]. The participants make up a total sample of 3524 university students (1762 Spanish and 1762 Hispanic-American) corresponding to five Spanish and five Hispanic-American universities (for reasons of confidentiality, the names of the sample universities will not be provided). The sample obtained by age and differentiated by geographical area (Spain/Hispanic America) is presented in Table 1.

The research was carried out during two academic years (2018/1 and 2018/2) with students of engineering in the second and third years so that the sample was as homogeneous as possible in order to establish comparative criteria in the analysis. This research is part of the National R&D&I Plan (Ubiquitous learning with mobile devices: elaboration and development of a map of competencies in Higher Education). In a first phase, during the 2018/1 academic year, a questionnaire was designed and validated [10]. Thirteen university professors participated in the development of this questionnaire (7 Hispanic Americans and 6 Spanish corresponding to each of the universities involved in the research). One part of this questionnaire was composed of three macro-categories corresponding to three digital devices: tablet, smartphone and laptop computer, which were asked on a Likert scale (1 nothing/5 much) about academic and social use with reference to the following items: preparation of academic papers, search for academic information, study, exchange of notes, coordination of group work with colleagues, consultation of university services, search for non-academic information, chat and instant messaging, e-mail and social networks.

In the second phase -developed during the 2018/2 school year- the statistical analysis was carried out using a mixed factorial method [11], which considered that the correlation between two items or variables in the questionnaire depends on their substantive similarity (the content of the item) [12].

Therefore, a first factor analysis was carried out with the Factor 9 program to generate the most representative factors of the ubiquitous use of mobile digital devices in the total sample (Spain and Latin America) [13].

Table 1. Sample by age

| | Spain /Latin America | | Geographical area | | Total |
|---|---|---|---|---|---|
| **Age** | 18-20 | Counting | 351 | 424 | **775** |
| | | % of total | 13,2% | 15,3% | **28,5%** |
| | 21-23 | Counting | 353 | 210 | **563** |
| | | % of total | 17,3% | 18,2% | **35,5%** |
| | 24-27 | Counting | 412 | 421 | **833** |
| | | % of total | 10,4% | 4,8% | **15,2%** |
| | 28-31 | Counting | 245 | 269 | **514** |
| | | % of total | 3,5% | 7,4% | **10,9%** |
| | More than 31 | Counting | 401 | 438 | **839** |
| | | % of total | 5,2% | 4,7% | **9,9%** |
| **Total** | | Counting | 1762 | 1762 | **3524** |
| | | **% of total** | **49,6%** | **50,4%** | **100,0%** |

## 3. Results

First, the reliability of the questionnaire was evaluated by means of the Bartlett sphericity test and the KMO sample suitability test (Table 2a and b). The significance for the Bartlett test ($p<0.05$) indicates that the matrix is different from the unit matrix with a confidence level of 96%, and that there are significant correlations between the variables that point to the possible existence of latent variables - the factors - that explain them. The KMO sample adequacy test gives a value close to 1 (0.899), so the partial correlations of the variables are very small. Likewise, the result of Cronbach's Alpha was 0.885. The main axes method was adopted as the best method to unravel the latent structure of the variables [14].

Table 2a. Adequacy of the Correlation Matrix

| | |
|---|---|
| Matrix determinant | 0.0000000046587 |
| Bartlett's Statistics | 14587.1 (gl = 1725; P = 0.000010) |
| Kaiser-Meyer-Olkin (KMO) Test | 0.89912 |

Table 2b. Total explained variance based on the self-scores

| Variable | Self-score | Proportion of Variance | Accumulated Proportion of Variance |
|---|---|---|---|
| 1 | 9.235 | 20,123 | 20,123 |
| 2 | 7.698 | 19,254 | 39,377 |
| 3 | 3.214 | 18,475 | 57,852 |
| 4 | 2.647 | 9,358 | 67,210 |
| 5 | 1.987 | 5,324 | 72,535 |

In other words, since this method works with standardized variables (correlation matrix and not covariance matrix), their variances are always 1. A parallel analysis of the "optimal implementation" type is performed with the Factor program for the final determination of the number of factors. Of all these, the first 5 comply with the criterion

of having self-scores greater than 1 and represent a total explained variance of 72.53%. The self-scores are detailed in Table 2a and b.

In these circumstances, the oblique rotation of the factors is carried out for their interpretation. This change of axes helps to better separate and discriminate how the variables relate to them. Next, the matrix of factor weights for the extracted and rotated factors is included (eliminating those that do not exceed a value of 0.30) (Table 3).

Table 3. Total explained variance

| Variables | F1 | F2 | F3 | F4 | F5 |
|---|---|---|---|---|---|
| V1. Tablet. Production of academic papers | | | | | |
| V2. Tablet. Search for academic information | 0.881 | | | | |
| V3. Tablet. Study | 0.791 | | | | |
| V4. Tablet. Sharing academic information | | | | | |
| V5. Tablet. Coordination of group work | | | | | |
| V6. Tablet. Consulting university services | 0.835 | | | | |
| V7. Tablet. Search for non-academic information | | | | | 0.535 |
| V8. Tablet. Chat and instant messengers | | | | | 0.633 |
| V9. Tablet. Email | | | | | 0.814 |
| V10. Tablet. Social networks | | | | | 0.982 |
| V11. Smartphone. Production of academic papers | | | | | |
| V12. Smartphone. Search for academic information | | | | | |
| V13. Smartphone. Study | | | | | |
| V14. Smartphone. Sharing academic information | | | | 0.875 | |
| V15. Smartphone. Coordination of group work | | | | 0.625 | |
| V16. Smartphone. Consulting university services | | | | 0.870 | |
| V17. Smartphone. Search for non-academic information | | | | | |
| V18. Smartphone. Chat and instant messaging | | | 0.982 | | |
| V19. Smartphone. Email | | | 0.514 | | |
| V20. Smartphone. Social networks | | | 0.775 | | |
| V21. Laptop. Production of academic papers | | 0.825 | | | |
| V22. Laptop. Search for academic information | | 0.792 | | | |
| V23. Laptop. Study | | 0.687 | | | |
| V24. Laptop. Sharing academic information | | | | | |
| V25. Laptop. Coordination of group work | | | | | |
| V26. Laptop. Consulting university services | | 0.673 | | | |
| V27. Laptop. Search for non-academic information | | | | | |
| V28. Laptop. Chat and instant messaging | | | | | |
| V29. Laptop. Email | | | | | |
| V30. Laptop. Social networks | | | | | |

Based on geographical area the interpretation of the factors is:

*Factor 1. Educational use of the tablet:*

- V2. Search for academic information (0,8881).

- V3. Study (0,791).
- V6. Consulting university services (0,835).

Factor 1 represents a total variance of 20.123% and shows significant results of educational use of the tablet among Spanish and Hispanic American students for educational purposes. Especially relevant is the use of this device for searching academic information (.881), for study (.791) and for consulting university services (.835).

*Factor 2. Educational use of the laptop*:

- V21. Production of academic papers (0,825).
- V22. Search for academic information (0,792).
- V23. Study (0,687).
- V26. Consulting university services (0,673).

Factor 2 accumulates 19.254% and shows the incidence of educational use of the smartphone by university students. It is significant that the portable computer is used for the elaboration of academic works (0.825). Secondly, its use is focused on the search for academic information (0.792) and, finally, on study (0.687) and consultation of academic services (0.673).

*Factor 3. Social use of the smartphone:*

- V18. Chat and instant messaging (0,982).
- V19. Email (0,514).
- V20. Social networks (0,775).

Factor 3 significantly decreases its impact on the variance explained (18.475%) and shows the social use of the smartphone. Educational use of this device is widespread among Spanish and Hispanic-American college students. Its use is concentrated in the use of chat and instant messaging (0.982) and in the interaction in social networks (0.775) and the consultation of email (0.514).

*Factor 4. Educational use of the smartphone:*

- V14. Sharing academic information (0,875).
- V15. Coordination of group work (0,625).
- V16. Consulting university services (0,870).

Factor 4 represents 9.358% of the total variance explained and corresponds to the educational use of the smartphone. The main educational use is developed in the area of group and collaborative work, which represents a very positive aspect for the promotion of transversal competences. It is significant that this device is used to exchange academic information among students (0.875) and to coordinate group work (0.625).

*Factor 5. Social use of the tablet:*

- V7. Search for non-academic information (0,535).
- V8. Chat and instant messaging (0,633).
- V9. E-mail (0.814).
- V10. Social networks (0.982).

Factor 5 represents 5.324% of the total variance explained.The social use of the tablet is related to communication activities: messaging and chat (0.633), e-mail (0.814) and, mainly, interaction in social networks (0.982).

Next, a check was made to see if the factors have normal distributions. The "Kolmogorov-Smirnov" test was applied to test for normality (Table 4).

Table 4. Kolmogorov-Smirnov test

| | | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|---|
| N | | 3524 | 3524 | 3524 | 3524 | 3524 |
| Normal parameters | Mean | ,00001 | ,00001 | ,00001 | ,00001 | -,00001 |
| | Standard deviation | 1,000714 | 1,000717 | 1,000701 | 1,000700 | 1,000711 |
| More extreme differences | Absolute | ,322 | ,288 | ,120 | ,079 | ,236 |
| | Positive | ,322 | ,291 | ,120 | ,079 | ,185 |
| | Negative | -,242 | -,200 | -,099 | -,049 | -,269 |
| Z of Kolmogorov-Smirnov | | 9,145 | 7,145 | 3,145 | 2,125 | 6,325 |
| Sig. asymptot. (bilateral) | | ,000 | ,000 | ,000 | ,000 | ,000 |

The first five factors have non-normal distributions so successive Mann-Whitney U tests (Table 5) were applied to check for significant inter-group differences: Spanish and Hispanic Americans.

Table 5. Mann-Whitney contrast statistics

| Contrast statisticsa | | | | | | |
|---|---|---|---|---|---|---|
| | | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
| U de Mann-Whitney | | 45987,500 | 52987,000 | 58333,500 | 42541,000 | 61899,000 |
| W de Wilcoxon | | 100475,514 | 127589,002 | 128569,540 | 113698,040 | 119824,070 |
| Z | | -5,148 | -2,758 | -1,582 | -6,968 | -,275 |
| Sig.asymptot. | (bilateral) | ,000 | ,023 | ,185 | ,000 | ,814 |

a. Grouping variable: Country (national and foreign sample without disaggregating)

Note how factors 1, 2 and 4 show differences between the two geographical groups. The inter-group results were as follows:

For Factor 1: there are significant differences between both groups: U (1253)= 45987.5, $p < 0.001$
For Factor 2: there are significant differences between both groups: U (1253)= 52987.0, $p = 0.015$
For Factor 3: no significant difference between the two groups: U (1253)= 58333.5, $p = 0.148$
For Factor 4: there are significant differences between both groups: U (1253)= 42541.0, $p< 0.001$
For Factor 5: no significant difference between the two groups: U (1253)= 61899.0, $p = 0.806$

To check these differences a contingency table was used which allows to observe the unpleasant differences by geographical areas and countries (Table 6).

Table 6. Contingency table for factors disaggregated by country.

| | Factor 1. Educational use of the tablet | | | | | |
|---|---|---|---|---|---|---|
| Country | Nothing | Almost nothing | From time to time | Often | Always | Total |
| Spain Colombia Panama Peru Mexico Chile | 17,3% | 17,2% | 16,3% | 30,2% | 17,0% | 100,0% |
| | 41,2% | 18,4% | 21,7% | 10,1% | 8,6% | 100,0% |
| | 32,3% | 24,5% | 19,5% | 11,2% | 12,5% | 100,0% |
| | 34,4% | 20,7% | 23,9% | 12,2% | 8,8% | 100,0% |
| | 33,6% | 19,6% | 29,3% | 12,3% | 5,2% | 100,0% |
| | 28,5% | 21,2% | 29,2% | 10,7% | 10,4% | 100,0% |
| | Factor 2. Educational use of the laptop | | | | | |
| Country | Nothing | Almost nothing | From time to time | Often | Always | Total |
| Spain Colombia Panama Peru Mexico Chile | 16,2% | 23,8% | 26,7% | 14,2% | 19,1% | 100% |
| | 8,7% | 18,2% | 24,2% | 20,0% | 28,9% | 100% |
| | 22,7% | 12,3% | 24,2% | 20,0% | 20,8% | 100% |
| | 15,6% | 20,2% | 26,9% | 22,8% | 14,5% | 100% |
| | 6,2% | 18,2% | 25,3% | 23,8% | 26,5% | 100% |
| | 23,3% | 16,2% | 22,6% | 17,7% | 20,2% | 100% |
| | Factor 4. Educational use of the smartphone | | | | | |
| Country | Nothing | Almost nothing | From time to time | Often | Always | Total |
| Spain Colombia Panama Peru Mexico Chile | 26,1% | 11,0% | 12,4% | 20,0% | 30,5% | 100% |
| | 32,0% | 16,4% | 23,6% | 13,0% | 15,0% | 100% |
| | 17,6% | 16,6% | 33,0% | 10,0% | 22,8% | 100% |
| | 33,5% | 17,4% | 24,0% | 10,6% | 14,5% | 100% |
| | 31,6% | 18,3% | 23,2% | 11,2% | 15,7% | 100% |
| | 30,3% | 18,0% | 22,4% | 19,9% | 9,4% | 100% |

Factor 1 (educational use of the tablet) shows significant differences between the two geographical areas. In Spain, the tablet is used more for the study. The cumulative percentage of Spanish students who do so "often" or "always" is 47.2%, compared to other Spanish American countries: Chile (21.1%), Colombia (18.7%), Mexico (17.5%), Panama (23.7%) and Peru (21.0%). Likewise, Factor 2 (Educational use of the laptop), presents a greater educational use in Hispanic American students than Spanish students in aspects such as the search for academic information and study. Factor 4 (Educational use of the smartphone) also presented percentage differences between the two geographical areas. Spanish students use the smartphone in a much higher percentage for the exchange of academic information with respect to the average of the rest of the analyzed Hispanic-American countries.

## 4. Discussion and Conclusions

The results of the global factorial statistical analysis show that the educational use of mobile digital devices in the Hispanic world is mainly concentrated in the use of the tablet and laptop for academic information search, study and consultation of university services. Similar results have been highlighted in other geographical areas such as Japan [15] and Africa [16]. The smartphone is used in an educational way for the exchange of academic information and the coordination of group work and is the device that is being studied most as a precursor and facilitator of ubiquitous teaching-learning processes [17]. UNESCO (2013) considers the smartphone one of the educational tools

with the greatest educational projection in developing countries. The two digital devices that Spanish and Hispanic Americans use socially are the smartphone and the tablet, mainly for chatting via instant messaging, checking email and interacting on social networks. These results have also been endorsed by the main usage reports made by different companies worldwide [14].

The "Mann-Whitney" contrast statistics shows significant differences between Spanish and Hispanic Americans in three factors: Factor 1. Educational use of the tablet, Factor 2. Educational use of the laptop, and Factor 4. The most significant differences allow to observe that in Spain the tablet is used more for the study than in Latin America. Likewise, Hispanic American students use the laptop more educationally than Spanish students, mainly for searching for academic information and for study. Finally, the educational use of the smartphone is the one with the highest percentage differences between the two geographical areas. Spanish students use the smartphone in a much higher percentage for sharing academic information with respect to the average of the rest of the analyzed Spanish-American countries.

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