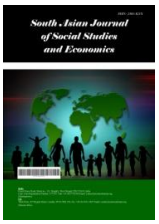

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Determinants of the Digital Divide among French Higher Education Teachers

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

The widespread use of technology in daily life, and particularly in education in higher education institutions has devoted growing attention to the nature of ICT usages by Higher Education Teachers which has seen as an increasingly important factor for the successful integration of these technologies. This study aims to analyze the determining factors of the various uses of ICT by teachers in the university environment and to characterize their variety and intensity. For this end, we conducted a survey of a sample of 2,079 teachers from public universities in France. Our approach consisted in measuring the intensity of use of ICT in academia in order to appreciate the resulting digital divides between different groups of teachers. Multinomial logistic regression shows that the differences in the use of ICT are linked to the differences in initial digital skills between teachers. Furthermore, the training in ICT, age, gender and social context appear to have a manifold influence on ICT use. Our results clearly confirm the existence of digital divides, it prompts us to analyze more precisely the role of innovative users and that of first-time adopters when they appear to be actors involved in the diffusion of ICT within universities.

Keywords: Higher education; ICT; technology Integration; digital competences; digital divide.

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1. INTRODUCTION

Information and communication technologies (ICT) offer real potential for significantly improving the quality of higher education offered at the university and for modifying the relationship to knowledge [1]. However, it must be recognized that after already more than two decades of heavy investments in ICT, changes in teaching practices and learning processes remain weak in Europe and in France. Some existing technologies have potential that has not been fully exploited ("*the potential of ICT in higher education is not fully used*"; [2]. To some extent one could speak of a "productivity paradox" affecting the university sector [3] [4]. While the expand ICT infrastructure in universities, the effectiveness of the mechanisms put in place has not been fully demonstrated or evaluated and were the additional educational value remains difficult to appreciate. This situation seems even more problematic as the new generation of students who has grown up with technology are savvy with advanced technologies and social-communication technologies (Digital Natives). The gap between their prior expectations as users and their actual experience at university accentuates the pression weigh upon the teachers so that they are more particularly involved in the implementation of the necessary changes to contribute to the quality of learning environments and make use of the potential of ICT [5] [6]. The objectives of enhancing digital skills and competences for the digital transformation and fostering the development of a high-performing digital education ecosystem could depend on the structural changes to be implemented to promote the digitization of higher education [7].

From an analytical point of view, a widely literature has sought to circumscribe the factors that influence the adoption of ICT by higher education teachers. This literature highlighted a variety of factors that may lead teachers to integrate ICT into their work practices. Factors may include, for example, contextual factors, social factors, personal factors, institutional factors or educational factors [8-11].

There is a lack of work on the issue of uses and intensities of ICT use. Two main reasons explain this finding. On the one hand, the literature often confused the use of technologies with the equipment of universities. Indeed, having a computer or an Internet connection informs little, if at all, about the time devoted by teachers to online educational activities or about the methods of interactions that they talk to their students and colleagues. Thus, studies on ICT equipment in universities were primarily intended to address issues relating to the uses of ICT without really addressing them. On the other hand, the question relating to uses and intensities of use constitutes a new line of research in social sciences and for which there is no specific methodology responding to the issues in question. Real advances have been observed in economics and management which could be transposed to the study of uses in academia.

Previous studies on the integration of ICT in higher education institutions have devoted growing attention to the nature of ICT usages by Higher Education Teachers (HET) which has seen as an increasingly important factor for the successful integration of these technologies. At least, two lines of research are identified. The first relates to the nature of uses according to the possibilities offered by new technologies [12] [13]. This approach tries to identify the patterns of adoption and uses of ICT in order to understand the approaches adopted by teachers in specific contexts of learning. The second line of research shows how HET are different not only in the extent of use, but also in the ways in which ICT is utilized and the impacts deriving from them. Hence, several authors suggest that the thesis of digital divides can be clearly defended [14] [15].

Concerning the first approach, many studies have sought to shed light on how information technology affects the HET experience and practices [16] [12] [6] [9]. They found interesting results about how skilled teachers work with these technologies; how they perceive technology affects their teaching experience; and their preferences for ICT in classrooms. While at first step, economic analysis has restricted the attention on old technologies such as computers and the Internet there is a new and dynamic area of research that has emerged as a direct response to changes in teachers' ICT practices related to the emergence of a new kind of collaborative work and information exchange [17].

For the second approach, an emerging literature has sought to characterize the differences in use of ICT according to the characteristics of the teachers. The objective was to understand the impacts of teachers' socio-demographic characteristics and background on the intensity

of ICT adoption and use. Thus, several research studies have found ICT competences, which are directly related to teacher confidence, are the critical factors influencing the level of ICT usage and integration by higher education teachers [18] [19].

Lack of time was reported by other studies as a barrier to the intention of higher education teachers to use ICT in teaching and learning as one of its objectives. This related to the time needed to set up new equipment, to learn how to use it and how to embed it with their teaching in an appropriate way. Bingimlas [20] indicate that many teachers have competence and confidence using ICT, but they still make little use of these technologies because they do not have enough time. The studies of Smith [21] or Maddux and Johnson [22] can give one explanation for this last statement. Smith [21] argues that teachers have less time to use ICT because of more administrative tasks. Also, studies inform us that the adoption and use of ICT in educational processes still faces a certain resistance from teachers [23] [9].

Various other variables can influence this meaning of technology, such as personal, behavioral and environmental variables [24]. Personal and behavioral variables refer to knowledge, competence, attitude, perception, beliefs and commitment, while environment variables refer to facilities, equipment and support. Other studies have shown the effects of external variables, among which is the perceived enjoyment of using these tools in the teaching process [9], the presence of facilitating conditions [25], the social influence [26] [25], the concept of self-efficacy [27] [28], the experience in the use of ICT and training [8]. In particular, gender, teachers' age, tenure, work experience before, online teaching experience and the research activities has turned out to be a particularly influential variable to measure the degree of acceptance and to determine the intention to use ICT in teaching [8] [11].

Based on these observations, the purpose of this study is to analyze the determining factors of the various uses of ICT by teachers in the university environment and to characterize their variety and intensity. For this end, we conducted a survey of a sample of 2,079 teachers from public universities in France. Our approach consisted in measuring the intensity of use of ICT in academia in order to appreciate the determinants of the resulting digital divides between different groups of higher education teachers.

2. DATA AND METHODOLOGY

2.1 Data Collection

The data was collected directly from a survey conducted in French public universities. The teachers were investigated about the role of ICTs on their profession, level of use, and about the ICT status of use and utilization. Teachers were also queried on core questions about factors influencing technology acceptance. The questionnaire contains some questions about socio-economic characteristics of respondents. We used the survey approach, instrumented via a web-based questionnaire data-gathering technique.

A pilot study of a group of 200 teachers was undertaken to ensure that questions were adapted appropriately to the research context. The purpose was to find out potential problems and misunderstandings of instruction and question items. After the pilot test, some adjustments were necessarily made to represent the ideas clearly. Finally, a total of 2262 teachers took part in the survey.

Furthermore, to accomplish the research objectives and the econometric analysis of the data, it was necessary to exclude respondents that reported abnormal responses and respondents who didn't answer all the questions. After these adjustments the sample was then reduced to 2079 observations. Among the 183 respondents who were excluded from further analysis 108 were male and 81 female. These respondents did not differ significantly from the remaining sample with regard to gender, research experience status, tenure position or age.

2.2 Sample Characteristics

The final sample included 2079 teachers representing 68 higher education institutions in France. The majority of participants were male (976 female and 1103 male). Almost 81.3% of the respondents were tenured (9.6% untenured and 9.1% had other status).

Most respondents were in the middle-age bracket of 31-50 years. The largest group of respondents were aged between 31- and 40-year-old which corresponds to 717 respondents (34.5%), followed by 41-50 age group (29.1%) and 51-60 age group (22.5%). The smallest

group of respondents was aged more than 61-year-old corresponds to 135 respondents (6.5%).

Concerning their research activities, around 25.7% of respondents have no active research activities, while 10.7% were junior researcher, 26% young researcher, 33.2% senior researcher and only 4.5% of the survey respondents reported that they are considered as international experts in their fields.

A total of 16.9% of respondents reported that they have online teaching activities. Nearly half of the respondents (45.5%) of the survey respondents reported that they had work experience before being HET.

A majority of respondents (78%) reported that their institutions have developed ICT teacher training programs for them. This proportion is only 36.1% of respondents that they had attended an ICT training program in their institutions or outside these institutions to use ICT effectively for learning purposes.

Table 1 details the descriptive statistics such as means, standard deviations, minimum and maximum values for the variables of interest.

Table 1. Descriptive statistics of the variables used in the research

Variable	Freq.	Percent	Mean	Std. Dev.	Min	Max
Gender						
Women	976	46.95	0.470	0.499	0	1
Men	1103	53.05	0.531	0.499	0	1
Tenure						
Tenured	1691	81.34	0.813	0.390	0	1
Contractual	200	9.62	0.096	0.295	0	1
Other status	188	9.04	0.090	0.287	0	1
Age						
20 to 30 years	155	7.46	0.075	0.263	0	1
31 to 40 years	717	34.49	0.345	0.475	0	1
41 to 50 years	605	29.10	0.291	0.454	0	1
51 to 60 years	467	22.46	0.225	0.417	0	1
61 years and older	135	6.49	0.065	0.247	0	1
Work experience before						
Have not work experience before	1133	54.50	0.169	0.375	0	1
Having work experience before	946	45.50	1.268	0.709	0	1
Online teaching						
0%	1728	83.12	0.111	0.314	0	1
1 to 25%	231	11.11	0.029	0.169	0	1
26 to 50%	61	2.93	0.015	0.123	0	1
51 to 75%	32	1.54	0.013	0.113	0	1
76 to 100%	27	1.30	0.743	0.437	0	1
Research status						
Non-researcher	534	25.69	0.257	0.437	0	1
Junior researcher	222	10.68	0.107	0.309	0	1
Young researcher	540	25.97	0.260	0.439	0	1
Senior researcher	690	33.19	0.332	0.471	0	1
International expert	93	4.47	0.045	0.207	0	1
Computer at work						
Have not computer at work	246	11.83	0.118	0.323	0	1
Having a computer at work	1833	88.17	0.882	0.323	0	1
Computer at home						
Have not computer at home	175	8.41	0.084	0.278	0	1
Having a computer at home	1904	91.58	0.916	0.278	0	1
Hours spent per week on surfing the web						

Variable	Freq.	Percent	Mean	Std. Dev.	Min	Max
Less than one hour	382	18.37	0.184	0.387	0	1
1 to 5 hours	855	41.13	0.411	0.492	0	1
6 to 9 hours	431	20.73	0.207	0.406	0	1
10 to 14 hours	226	10.87	0.109	0.311	0	1
15 hours and more	185	8.90	0.089	0.285	0	1
Need of the Internet in classroom						
Don't need Internet in classroom	1275	61.33	0.613	0.487	0	1
Need Internet in classroom	804	38.67	0.387	0.487	0	1
Use of the Internet in classroom						
Don't use the Internet in classroom	1313	63.16	0.632	0.483	0	1
Use of the Internet in classroom	766	36.84	0.368	0.483	0	1
Use the Internet to extend the course						
Don't use the Internet to extend the course	719	34.58	0.346	0.476	0	1
Using the Internet to extend the course	1360	65.42	0.654	0.476	0	1
ICT facilities in classroom						
Have not ICT facilities in classroom	915	44.01	0.440	0.497	0	1
Having ICT facilities in classroom	1164	55.99	0.560	0.497	0	1
Teacher ICT training						
Doesn't training at the use of ICT	1329	63.92	0.639	0.480	0	1
Training at the use of ICT	750	36.08	0.361	0.480	0	1
Providing ICT training by the university						
University doesn't provide ICT training	458	22.03	0.220	0.415	0	1
University provides ICT training	1621	77.97	0.780	0.415	0	1
Teacher ICT skills						
Basic ICT skills	553	26.60	0.266	0.442	0	1
Medium ICT skills	829	39.87	0.399	0.490	0	1
Advanced ICT skills	697	33.53	0.335	0.472	0	1
Intensity of ICT use						
Basic use of ICT	647	31.12	0.311	0.463	0	1
Administration and information ICT use	744	35.79	0.358	0.480	0	1
Information and pedagogy ICT use	476	22.90	0.229	0.420	0	1
Use of ICT for all purposes	212	10.20	0.102	0.303	0	1

2.3 Econometric methodology

2.3.1 The model

The objective of this study is to identify the determinants of the intensity of ICT adoption and use by Higher Education Teachers. We assume that the probability that a HET is in one of these four different categories of ICT usages depends on its individuals' characteristics, his availability of ICT facilities and its level of e-skills. Under this assumption of a discrete choice, the appropriate model is a multinomial logit, shown in Eq. (1). This model determines if the relevant factors identified in the literature review (presented above) influence the probability of higher education teacher to be in one of the four different ICT usages categories. To give an example of this, let ICT_Usages denote the i^{th} teacher's category of usages variable, which can then be observed as:

$$\text{ICT\_Usages} = \begin{cases} = 1 \text{ if the teacher has a basic use of ICT} \\ = 2 \text{ if the teacher has an "administration and information" ICT usages} \\ = 3 \text{ if the teacher has an "information and pedagogy" ICT usages} \\ = 4 \text{ if the teacher use of ICT for all pedagogical purposes} \end{cases} \quad (1)$$

The multinomial logit model is then defined by the following equation.

$$\text{Prob}\left(\text{ICT\_Usages} = m \middle| X_i\right) = \frac{\exp\left(\beta_m^{'} X_i\right)}{\sum_{j=1}^{4} \exp\left(\beta_j^{'} X_i\right)} \qquad (2)$$

Where m = 1, 2, 3 or 4 and j = 1,…, m, ICT_Usages denotes the observed outcome, β denotes a vector of coefficients, X is a vector consisting of ICT skills variables and other explanatory variables such as age, gender, tenure, researcher status and other related ICT facilities, etc. The coefficients are then estimated by maximum likelihood.

When estimating a multinomial logit model, it is required to choose a reference category with coefficients normalized to 0. Due to the requirement of a reference group, the coefficients from other groups should be compared to the said reference group. The reference group is then defined by the following equation.

$$\text{Prob}\left(\text{ICT\_Usages} = 0 \middle| X_i\right) = \frac{1}{\sum_{j=1}^{4} \exp\left(\beta_j^{'} Y_i\right)} \qquad (3)$$

2.3.2 Variables

2.3.2.1 Dependent variable: intensity of ICT use

The participants in our survey were asked to rate the frequency with which they use twenty-four ICT applications. These ICT variables are specified through five response levels, ranging from value “1” for teachers who have neither adopted, nor tested these technologies to value “5” for the earliest adopters or who use them intensively.

To characterize the different modes of ICT usages, a Principal Component Analysis (PCA) was conducted with the twenty-four variables. The PCA resulted (see Table 2) in six factors with an eigenvalue larger than 1. The total variance explained by these factors is 56.11%. Generally, in social sciences this rate is considered as satisfactory [29]. We defined the factors as following:

- Factor F1: Information and documentation
- Factor F2: Cooperation and collaboration
- Factor F3: Communication
- Factor F4: Pedagogy and coordination
- Factor F5: Administration
- Factor F6: Planning

To test the reliability of the summated scale, the internal consistency reliability was verified by Cronbach’s alpha. The coefficient varies from 0 to 1, and a value of 0.6 or less generally indicates unsatisfactory internal consistency reliability [30]. In social sciences, acceptable reliability estimates range from 0.7 to 0.8 [31]. The results (see Table 3) reveal that the Cronbach’s alpha values for each of the ten dimensions were greater than 0.7 excepted for pedagogy and coordination and administration dimension (0.68 and 0.62 respectively).

The Bartlett’s Test of Sphericity shows that non-zero correlations exist at the significance level of 1%. The reduced set of variables meets the necessary threshold with a Kaiser-Meyer-Olkin measure of sampling adequacy value of 0.90. All of these findings are the evidence of the appropriateness of the sample for the principal components analysis.

To identify the different patterns of ICT diffusion, namely in terms of intensity of use and adoption, we group the 2079 HET using cluster analysis. Cluster analysis was conducted using Stata (version 16) software to explore options for grouping the different teachers’ ICT usages. The objective of cluster analysis is to find homogeneous groups and to maximize the difference between groups. Unlike most parametric statistical techniques, cluster analysis doesn’t explicitly provide a clearly acceptable or unacceptable solution. Bocquet [32] and Sharma [33] recommend that one should use different approaches, compare the results for consistency and use the method that results in an interpretable solution.

A non-hierarchical cluster analysis (ICT_USAGES) based on *k-means* methodology is then carried out based on the scores revealed by the principal factor analysis to the purpose of determining the final number of clusters, we use three usual criteria:

- the statistical accuracy of the classification measured by the ratio of within-cluster and between-clusters variances (Fisher’s test),
- the number of teachers per cluster,
- the economic significance of the clusters identified.

According to these criteria, the version with four clusters of ICT usages is adopted. Thus, to

interpret these four clusters, we calculate the mean of each ICT indicator in each cluster.

The modes of ICT usages of the four clusters (profiles) are illustrated in Table 4 and can be interpreted as following:

Profile 1: Basic ICT use (ICT_USAGES_1)

This group (647 teachers) is characterized by teachers that are later adopters of the ICT and that don't use them intensively. These teachers have a low usage of ICT for pedagogy and coordination, cooperation and collaboration or communications tasks.

Profile 2: Administration and information ICT use (ICT_USAGES_2)

Teachers from this group (744 teachers) are the ones who have low scores of usages in almost all ICT resources, except for the administration and information tasks in which they have a slightly upper value.

Table 2. Results of the Principal Component Analysis for modes of ICT usages

	F1	F2	F3	F4	F5	F6
Web development of tests assessments and quizzes	0.610					
Use of learning objects developed by other teachers	0.444					
Use of educational platforms	0.612					
Use of simulations and serious games	0.550					
Collaboration in the preparation of an assignment using ICT tools	0.668					
Online tutoring	0.636					
Use of blogs and wikis and forums as environments for on-line collaboration between students	0.471					
General information about the courses		0.558				
Recommendations on useful digital resources and websites		0.494				
Sending course materials /exercises via the Internet and e-mail		0.756				
Send and receive homework via the Internet or e-mail		0.610				
Make course materials available for students on the Web		0.635				
Use of e-mail		0.506				
The use of audio and/or video conferencing to communicate with students or colleagues			0.586			
Use of VoIP applications to communicate with students, colleagues, or faculty staff			0.777			
Use of Internet social networks to interact with students and colleagues			0.636			
Use online chat to interact with students or colleagues			0.730			
Updating a personal website on a regular basis				0.709		
Participation in creating and updating content and information for the institution website				0.659		
Participation in content development for websites outside of the institution				0.737		
Use of ICT to communicate schedule classrooms, schedule of sessions					0.823	
Invitations to educational meetings					0.819	
Use ICT to send examination subjects						0.646
Sending marks to the administration by Internet or by e-mail						0.760

Notes: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations

Table 3. Reliability and goodness of fit of factors statistics for teachers ICT usages PCA

Factor	Eigenvalue	Percent of variance	Cumulative percent of variance	Cronbach's alpha
F1: Information and documentation	6.4844	27.02	27.02	0.76
F2: Cooperation and collaboration	2.2279	9.28	36.30	0.77
F3: Communication	1.4550	6.06	42.36	0.72
F4: Pedagogy and coordination	1.1852	4.94	47.30	0.68
F5: Administration	1.1045	4.60	51.90	0.72
F6: Planning	1.0093	4.21	56.11	0.62
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			0.901	
Bartlett's Test of Sphericity	Approx. Chi-Square		14292.84	
	df		276	
	Sig.		0.000	

Table 4. Interpretation of ICT_USAGES clusters

ICT USAGES	Mean					
	ADMIN	INFO DOC	PLAN	PEDAG COOR	COOP COLLAB	COM
No. 1= Basic ICT use (ICT_USAGES_1) (N=647)	3.23	2.43	2.38	1.47	1.30	1.16
No. 2= Administration and information ICT use (ICT_USAGES_2) (N=744)	4.14	4.03	3.81	1.69	1.60	1.32
No. 3= Information and pedagogy ICT use (ICT_USAGES_3) (N=476)	3.91	3.84	3.20	3.14	1.71	1.36
No. 4= Use of ICT for all purposes (ICT_USAGES_4) (N=212)	4.26	4.11	3.86	3.23	3.12	2.97

Notes: The mean is in bold value when it is significantly higher in the considered cluster. ADMIN: Administration. INFO DOC: Information and documentation. PLAN: Planning. PEDAG COOR: Pedagogy and coordination. COOP COLLAB: Cooperation and collaboration. COM: Communication

Profile 3: Information and pedagogy ICT use (ICT_USAGES_3)

This group (476 teachers) is represented by teachers who are not proficient in ICT but have sophisticated pedagogical conceptions are willing to learn new ICT to reconstruct their instructional practices. In addition, information and pedagogy use of ICT loaded relatively strongly on this cluster.

Profile 4: Use of ICT for all purposes (ICT_USAGES_4)

Teachers belonging to this group (212 teachers) are earlier adopters and use the ICT intensively and are characterized by high ICT skills and intensive use of ICT. Apparently, teachers who are experts in ICT also intensively use ICT in planning and doing their teaching. In addition, the use of cooperation and coordination applications like wikis, serious gaming, online study aid or learning platforms was loaded rather strongly on this cluster indicating that especially teachers who have expertise in and access to theses ICT tools are using ICT to support collaborative learning. Further, ICT support for communication like social networking, Voice Over IP (VoIP), video conferencing or student chat had a high loading on this cluster.

The four dummy variables ICT_USAGES_1, ICT_USAGES_2, ICT_USAGES_3 and ICT_USAGES_4 used in the econometric analysis below result from this procedure. They represent the four identified modes of ICT usages.

2.3.2.2 Independent variables: determinants of ICT adoption

Building on the previous literature review, gender, teachers' age, tenure, work experience before, online teaching experience and the research activities are expected to influence the intensity of ICT adoption and use by higher education teachers.

ICT facilities: The ICT facilities are measured by different items: the level of ICT equipment of the teachers such as possession of a computer at home or at university, the hours spent per week on surfing the web for pedagogical purposes, the need and the use of the Internet in the classroom or outside the classroom to extend the course and the access to equipment/devices in the classroom. The teachers were further asked to assess a set of items connected with availability ICT training programs provided by their institutions. They were asked if they had attended an ICT training program in their institutions or outside.

Teachers' ICT skills: In the questionnaire, ICT skills of the teachers were also assessed by measuring knowledge of several ICT applications such as text processing, multimedia presentation, spreadsheets, databases, specialized software, image processing and Web development. Each respondent was asked to rate their own ICT skills and competences level on nineteen activities using a five-point Likert scale ranging from "1 = do not use at all" to "5 = use a lot".

To identify the different kinds of ICT skills, factor analysis was conducted utilizing principal component analysis with Varimax as an extraction method and Kaiser normalization as a rotation method. The results of the PCA are illustrated in Table 5.

Table 6 presented the reliability and goodness of fit of factors. The results of the internal consistency reliability test reveal that the Cronbach's alpha values for each of the ten dimensions were greater than 0.7 excepted for specialized software and spreadsheets skills dimensions (0.66 and 0.67 respectively). The Bartlett's Test of Sphericity shows that non-zero correlations exist at the significance level of 1%. All of these findings are the evidence of the appropriateness of the sample for the principal components analysis.

The PCA revealed the presence of five factors with eigenvalues greater than 1 accounted for 58.49% of total variance. The rotated component matrix presented in Tables 3.6 shows the factor loadings for all retained items in the research. All the items loaded above 0.40, which is the minimum recommended value [34]. Each factor was linked to general skills to perform tasks with a category of tools.

The first factor is called the *"text processing skills"*. This factor represents tasks, such as producing courses materials.

Table 5. Results of the principal component analysis for ICT skills

	F1	F2	F3	F4	F5
Produce course materials	0.714				
Produce plans of course	0.779				
Produce exams	0.572				
Produce reports of interactions and student supervision	0.667				
Produce meeting minutes	0.634				
Produce graphs to be integrated into course content		0.631			
Calculations of specific results to be integrated into course content		0.639			
Presentation of research or administrative activities		0.461			
Statistical and econometric software		0.705			
Use of discipline-specific software		0.540			
Presentation of course chapters			0.635		
Uploading course presentations			0.716		
Image processing to be integrated into course content			0.599		
Making website			0.683		
Databases for student tracking				0.705	
Databases to be integrated into course content				0.844	
Databases for research or administrative activities				0.798	
Attendance records and student tracking					0.769
Calculation of average marks					0.698

Notes: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 7 iterations

Table 6. Reliability and goodness of fit of factors statistics for teachers ICT skills PCA

Factor	Eigenvalue	Percent of variance	Cumulative percent of variance	Cronbach' s alpha
F1: Text processing skills	5.3993	28.42	28.42	0.76
F2: Specialized software skills	1.8961	9.98	38.40	0.66
F3: Multimedia and Web development skills	1.5379	8.09	46.49	0.75
F4: Database's skills	1.2189	6.42	52.91	0.77
F5: Spreadsheet's skills	1.0608	5.58	58.49	0.67
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			0.834	
Bartlett's Test of Sphericity	Approx. Chi-Square		13043.68	
	df		171	
	Sig.		0.000	

The second factor is *"specialized software skills"*. This factor refers to tasks that are performed with specialized computer applications, such as statistical packages or graph software, e.g., usages of statistical software packages to generate statistics, tables and graphs which can be combined with other course materials.

The third factor, the *"multimedia and Web development skills"*, includes activities such as creating web pages, provision of relevant multimedia content and support the communication and discussion boards for student to aid learning by providing slides, notes, documentation, or other core course materials.

The fourth factor, appropriately named the *"databases skills"*, deals with tasks aimed at the data management, such as management of students or data management included in course materials.

Finally, the fifth factor is the *"spreadsheets skills"*. Teachers use spreadsheets software, such as generating tables and graphs which can be combined with other learning objects.

According to the same procedure as used before in the ICT_USAGES cluster analysis, a non-hierarchical cluster analysis (ICT_SKILLS) based on k-means methodology to the factor scores from the PCA revealed was undertaken in regard to identify the different levels of teachers ICT skills. The final result gave us three clusters (profiles) and teachers were divided into "low", "medium" and "high" level skills categories based on average scores for ICT knowledge across all applications and technologies as illustrated in Table 7 and can be interpreted as following:

Profile 1: Low level ICT skills (ICT_SKILLS_1)

This group includes 26.60% of teachers (553 teachers) who are the later adopters of the ICT and don't use them intensively. They typically have text processing skills and have used some aspects of presentation and spreadsheets software. Generally, Profile 1 teachers have not used specialized software or database applications such as statistical packages or web development software.

Profile 2: Medium level ICT skills (ICT_SKILLS_2)

This group includes 39.87% of teachers (829 teachers) who in addition to possessing the ICT skills listed in Profile 1, declared to use presentation applications and spreadsheets to a greater extent. Profile 2 teachers also tend to have some databases applications and specialized software skills.

Profile 3: High level ICT skills (ICT_SKILLS_1)

This group counts 33.53% of teachers (697 teachers) who are the later adopters of the ICT and use them intensively. They have typically undertaken most of the tasks in each of the listed ICT applications, including databases applications, Web development and specialized software.

The three dummy variables ICT_SKILLS_1, ICT_SKILLS_2 and ICT_SKILLS_3 used in the econometric analysis below as explanatory variables result from this procedure. They represent the three identified levels of teachers' ICT skills.

3. EMPIRICAL RESULTS

This section presents the empirical results of the determinants of the intensity of ICT adoption and use by HET in France. First, the goodness-of-fit tests for the model are presented. Second, the

results from the estimated multinomial logit model and the marginal effects related to ICT Usages variable are presented and discussed. Finally, the results of the appropriateness of the model test are presented.

The empirical results from the estimated multinomial logit model and the marginal effects are presented in Tables 8 and 9. The log-likelihood value for the model is -1654.4341.

Table 7. Results of the principal component analysis for ICT skills

ICT Skills	Mean				
	TEXT PROC	SPREAD SH	MEDIA WEB DEV	SPEC SOFT	DATA
Profile 1= Low level ICT skills (ICT_SKILLS_1) (N=523)	2.83	2.73	2.23	2.08	2.02
Profile 2= Medium level ICT skills (ICT_SKILLS_2) (N=829)	4.26	3.34	2.70	2.56	1.57
Profile 3= High level ICT skills (ICT_SKILLS_3) (N=797)	4.46	4.05	3.25	3.25	3.80

Notes: The mean is in bold value when it is significantly higher in the considered cluster. TEXTPROC: Text processing. SPREADSH: Spreadsheets. MEDIA WEB DEV: Multimedia and Web development. SPECSOFT: Specialized software. DATA: Databases

Table 8. Results from the multinomial logit model

Dependent variables: (ICT_USAGES_1: "Basic use of ICT" is the reference category)	ICT_USAGES_2: "Administration and information ICT use"	ICT_USAGES_3: "Information and pedagogy ICT use"	ICT_USAGES_4: "Use of ICT for all purposes"
Independent variables			
Teacher characteristics			
Gender			
Women	Ref.	Ref.	Ref.
Men	-0.24*	0.60***	0.66***
Tenure			
Tenured	Ref.	Ref.	Ref.
Contractual	-0.04	0.65*	2.01***
Other status	-0.14	0.21	0.46
Age			
20 to 30 years	Ref.	Ref.	Ref.
31 to 40 years	1.21***	1.90***	1.44***
41 to 50 years	1.39***	1.67***	1.32**
51 to 60 years	0.86***	-1.93***	-2.76***
61 years and older	0.99***	-1.05*	-2.34**
Work experience before			
Have not work experience before	Ref.	Ref.	Ref.
Having work experience before	-0.02	0.08	0.49**
Online teaching			
0%	Ref.	Ref.	Ref.
1 to 25%	0.57***	-0.43	1.19***
26 to 50%	1.17**	-0.32	1.34**
51 to 75%	-10.81	4.79*	5.27**
76 to 100%	-0.40	2.04***	2.34***
Research status			
Non-researcher	Ref.	Ref.	Ref.
Junior researcher	0.57**	-0.61	0.79
Young researcher	0.20	0.49*	1.28***
Senior researcher	-0.56***	1.10***	1.43***
International expert	-0.77**	2.55***	3.22***
ICT facilities			
Computer at work			

Dependent variables: (ICT_USAGES_1: "Basic use of ICT" is the reference category)	ICT_USAGES_2: "Administration and information ICT use"	ICT_USAGES_3: "Information and pedagogy ICT use"	ICT_USAGES_4: "Use of ICT for all purposes"
Have not computer at work	Ref.	Ref.	Ref.
Having a computer at work	0.87***	1.86***	3.06***
Computer at home			
Have not computer at home	Ref.	Ref.	Ref.
Having a computer at home	2.88***	4.31***	0.64
Hours spent per week on surfing the web for pedagogical purposes			
Less than one hour	Ref.	Ref.	Ref.
1 to 5 hours	-0.11	0.83***	2.56***
6 to 9 hours	-0.13	1.55***	3.77***
10 to 14 hours	-0.06	2.51***	4.84***
15 hours and more	-0.19	1.81***	4.31***
Need Internet in classroom			
Don't need Internet in classroom	Ref.	Ref.	Ref.
Need Internet in classroom	0.44**	-0.01	1.37***
Use of the Internet in classroom			
Don't use the Internet in classroom	Ref.	Ref.	Ref.
Use of the Internet in classroom	-0.03	1.30***	1.62***
Use the Internet to extend the course			
Don't use the Internet to extend the course	Ref.	Ref.	Ref.
Using the Internet to extend the course	0.96***	1.45***	2.04***
ICT facilities in classroom			
Have not ICT facilities in classroom	Ref.	Ref.	Ref.
Having ICT facilities in classroom	-0.03	-0.05	0.66**
Teacher ICT training			
Doesn't training at the use of ICT	Ref.	Ref.	Ref.
Training at the use of ICT	-0.01	0.64***	1.16***
Providing ICT training by the university			
University doesn't provide ICT training	Ref.	Ref.	Ref.
University provides ICT training	0.62***	0.66***	1.56***
Teachers' ICT skills			
Basic ICT skills	Ref.	Ref.	Ref.
Medium ICT skills	1.09***	0.86***	0.53
Advanced ICT skills	1.54***	1.37***	2.00***
Log likelihood	1654.4341		
LR(90)	2102.1608***		
Concordance	65.42%		

*Note: The notation ***, **, and * denotes significance at the 1%, 5% and 10%*

The likelihood ratio (χ^2) value of 2102.16 is greater than the critical chi-square value $(\chi^2_{0.001},90)$ of 137.208, and $(\chi^2_{0.01},90)$ of 124.116 at the 1% level of significance. This test confirms that all the slope coefficients are significantly different from zero. The alternative hypothesis is thus accepted at these levels of significance.

The likelihood ratio index ρ^2 value of 0.3885 also confirmed that all the slope coefficients are not equal to zero which is indicative of good fit for the estimated model. In other words, the explanatory variables are collectively significant in explaining the classification of the teachers by the intensity of ICT usage.

The parameter estimates indicate the impact of a unit change in the explanatory variables on log-odds ratios. The results confirm the expected signs of the coefficients of the teachers' characteristics. The results indicate that teachers' characteristics, ICT facilities and teachers' ICT skills are crucial when explaining the probability that a teacher will be classified in one of the different categories of ICT usages.

Table 9. Marginal effects of the multinomial logit model

Dependent variables: (ICT_USAGES_1: "Basic use of ICT" is the reference category)	ICT_USAGES_2: "Administration and information ICT use"		ICT_USAGES_3: "Information and pedagogy ICT use"		ICT_USAGES_4: "Use of ICT for all purposes"	
	Exp(β)	Marginal Effects	Exp(β)	Marginal Effects	Exp(β)	Marginal Effects
Independent variables						
Teacher characteristics						
Gender						
Women	Ref.	–	Ref.	–	Ref.	–
Men	0.79*	-0.109	1.83***	0.097	1.94***	0.008
Tenure						
Tenured	Ref.	–	Ref.	–	Ref.	–
Contractual	0.96	-0.092	1.92*	0.094	7.47***	0.052
Other status	0.87	-0.054	1.24	0.041	1.59	0.007
Age						
20 to 30 years	Ref.	–	Ref.	–	Ref.	–
31 to 40 years	3.34***	0.112	6.71***	0.169	4.20***	0.006
41 to 50 years	4.02***	0.175	5.33***	0.112	3.75**	0.003
51 to 60 years	2.37***	0.318	0.15***	-0.216	0.06***	-0.020
61 years and older	2.68***	0.289	0.35*	-0.137	0.10**	-0.013
Work experience before						
Have not work experience before	Ref.	–	Ref.	–	Ref.	–
Having work experience before	0.98	-0.014	1.09	0.012	1.63**	0.006
Online teaching						
0%	Ref.	–	Ref.	–	Ref.	–
1 to 25%	1.77***	0.157	0.65	-0.086	3.29***	0.016
26 to 50%	3.22**	0.275	0.73	-0.105	3.83**	0.010
51 to 75%	0.00	-0.527	120.10*	0.742	193.87***	0.093
76 to 100%	0.67	-0.321	7.71***	0.447	10.34***	0.047
Research status						
Non-researcher	Ref.	–	Ref.	–	Ref.	–
Junior researcher	1.76**	0.171	0.54	-0.100	2.20	0.008
Young researcher	1.23	0.001	1.62*	0.048	3.60***	0.017
Senior researcher	0.57***	-0.237	3.02***	0.214	4.18***	0.022
International expert	0.46**	-0.411	12.85***	0.545	25.06***	0.085
ICT facilities						
Computer at work						
Have not computer at work	Ref.	–	Ref.	–	Ref.	–
Having a computer at work	2.39***	0.116	6.43***	0.130	21.28***	0.014
Computer at home						
Have not computer at home	Ref.	–	Ref.	–	Ref.	–
Having a computer at home	17.75***	0.421	74.34***	0.183	1.90	-0.006
Hours spent per week on surfing the web for pedagogical purposes						
Less than one hour	Ref.	–	Ref.	–	Ref.	–
1 to 5 hours	0.89	-0.114	2.30***	0.117	12.94***	0.043
6 to 9 hours	0.88	-0.234	4.71***	0.230	43.32***	0.143
10 to 14 hours	0.94	-0.359	12.36***	0.346	127.05***	0.268
15 hours and more	0.82	-0.312	6.14***	0.244	74.65***	0.264
Need Internet in classroom						

Dependent variables: (ICT_USAGES_1: "Basic use of ICT" is the reference category)	ICT_USAGES_2: "Administration and information ICT use"		ICT_USAGES_3: "Information and pedagogy ICT use"		ICT_USAGES_4: "Use of ICT for all purposes"	
	Exp(β)	Marginal Effects	Exp(β)	Marginal Effects	Exp(β)	Marginal Effects
Don't need Internet in classroom	Ref.	–	Ref.	–	Ref.	–
Need Internet in classroom	1.55**	0.101	0.99	-0.037	3.95***	0.016
Use of the Internet in classroom						
Don't use the Internet in classroom	Ref.	–	Ref.	–	Ref.	–
Use of the Internet in classroom	0.97	-0.128	3.66***	0.193	5.03***	0.020
Use the Internet to extend the course						
Don't use the Internet to extend the course	Ref.	–	Ref.	–	Ref.	–
Using the Internet to extend the course	2.61***	0.130	4.26***	0.110	7.67***	0.013
ICT facilities in classroom						
Have not ICT facilities in classroom	Ref.	–	Ref.	–	Ref.	–
Having ICT facilities in classroom	0.97	-0.008	0.95	-0.005	1.93**	0.008
Teacher ICT training						
Doesn't training at the use of ICT	Ref.	–	Ref.	–	Ref.	–
Training at the use of ICT	0.99	-0.062	1.90***	0.089	3.20***	0.015
Providing ICT training by the university						
University doesn't provide ICT training	Ref.	–	Ref.	–	Ref.	–
University provides ICT training	1.87***	0.104	1.93***	0.039	4.74***	0.010
Teachers' ICT skills						
Basic ICT skills	Ref.	–	Ref.	–	Ref.	–
Medium ICT skills	2.99***	0.198	2.35***	0.026	1.70	-0.002
Advanced ICT skills	4.65***	0.242	3.95***	0.052	7.37***	0.013

*Note: The notation ***, **, and * denotes significance at the 1%, 5% and 10%*

Table 8 shows that teachers man, tenure status, age, online teaching experience, research activities, work experience before being a HET, ownership of computer at home and at work, ICT accessibility, ICT affordability, effective ICT use and high ICT skills level have the effects of increasing the probability of being in the information and pedagogy ICT use class or in the high ICT use class compared to the probability of being in the basic ICT use reference category.

The associated negative values (effects) imply, in the case of the ICT_USAGE_2 category, that a unit increase in the variable of interest reduces the probability of being an enhanced ICT user compared to the probability of being a basic-level ICT reference user. In the case of the ICT_USAGE_3 category, it means that a unit increase in the variable reduces the probability of using ICT for information and pedagogy purposes compared to the probability of being in basic ICT use reference category. In all cases the effects tend to be stronger for moderate-level ICT use versus basic ICT use than for moderate-level ICT use versus high-level ICT use class.

The marginal effects (ME) and the odds-ratios (reported under the $Exp(\beta)$) show the magnitude of the already identified increases. The model reveals that the gender of the teacher has a statistically significant effect on the probability of being an enhanced ICT user. Male respondents are significantly related to the probability of using ICT intensively. The estimated odds-ratio for male are respectively

1.83 and 1.94 for ICT_USAGE_3 and ICT_USAGE_4 categories suggesting the predicted odds for male to be classified in the intensive ICT use category increases by a multiplicative factors of 1.83 and 1.94 respectively or simply that the increase increases the odds of being in high ICT use instead of in the basic ICT use by 83% and 94% in the considered categories. Similarly, for each unit increment in gender multiplies the odds of being in the ICT_USAGE_2 class rather than in the basic ICT use class by 0.79, or that it reduces the odds by 21%.

As concerned tenure status, a unit increase would multiply the odds of being in the ICT_USAGE_3 compared to being in the reference category by 1.92 and the odds of being in the ICT_USAGE_4 class rather than in the reference category by 7.47, implying increase in the odds by 92% and more than six times respectively. In addition, tenured teachers and other tenure status categories are not significant.

Regarding teachers' age, the older teachers are less likely to use ICT innovatively compared to relatively young ones (31-50 age group). This means that an increase by one unit of teacher age will significantly enhances the probability of being in the low-level ICT use categories by 85% and 65% respectively for the 51-60 and 61 and above age group in the ICT_USAGE_3 category. Similar deductions can be made with respect to ICT_USAGE_4 category.

Our results suggest also that having work experience before being HET have no or little influence on the probability of using ICT intensively. While this variable is statistically insignificant for the second and third categories of ICT use, their influence on the odds of being in the high-level ICT use becomes clearer. In fact, having work experience before being HET will significantly enhances the probability of being in the high-level ICT use category by 63%.

With regard to online teaching, teachers who experienced e-learning as part of their teaching activities tend to use ICT more intensively than other teachers. This is particularly the case when considering the odds of being in high ICT use categories, relative to be in the basic ICT category, e.g., an increase by one unit of online teaching, for teachers who have 51 to 75% of their teaching activities as e-learning form, will significantly enhances the odds of being in a high-level ICT use classes by more than 120 times for Information and pedagogy ICT use class and more than 193 times for Use of ICT for all purposes class.

Relative to non-researchers, the odds of having high-level ICT use are significantly affected by the fact of having a research activity. Young researcher, senior researcher and international expert are more likely to use ICT intensively. The estimated odds-ratio for senior researcher and international expert are 3.02 and 4.18 for ICT_USAGE_3 class and 12.85 and 25.06 for the ICT_USAGE_4 class respectively. The results also revealed that junior researcher status doesn't significantly affect the odds of being an enhanced ICT user.

Regarding the influence of ICT facilities, the larger values in odds ratios show that teachers who had a computer in their institutions are likely to use ICT intensively. Furthermore, teachers who spend more than 10 hours per week on surfing the web for pedagogical purposes are generally more likely to be profiled as enhanced ICT users. As showed in Table 9, an additional hours spent per week on surfing the web for pedagogical purposes will significantly enhances the odds of being in a high-level ICT use categories by more than 12 times for Information and pedagogy ICT use category and more than 127 times for Use of ICT for all purposes category.

A positive and significant relationship was found between effective use of Internet services by HET and the probability of being in the high-level ICT use classes. The relationship implies that teachers who intend to increase on their usages of Internet services inside and outside of the classrooms to extend classroom lesson are more likely to be an enhanced ICT users. The results reveal that an increase by one unit of Internet effective use inside and outside of the classroom will significantly enhances the odds of being in a high-level ICT use class by more than five times and more than seven times respectively.

It was expected that the availability of ICT facilities in classroom could have a positive influence on the odds of being in high ICT use categories. However, the *a priori* expectations hold true for the high-level ICT use category only. There is sufficient evidence (odds-ratio value of 1.93) to support that the availability of ICT infrastructure is likely to encourage teachers to develop appropriate pedagogical concepts to effectively exploit ICT opportunities.

As we claimed at the start, appropriate teachers ICT training play a pivotal role in determining the pattern of teachers' ICT uses and enable teachers to acquire the confidence and skills to make use of and to integrate ICT into their lesson plans and teaching of the subjects in the classroom; the factor indeed has a strong odds-ratio. In absolute terms, compared to teachers who never attend an ICT training program in their institutions to use ICT effectively for learning purposes odds-ratio is larger for Use of ICT for all purposes class (4.74) than for Information and pedagogy ICT use class (1.93).

We found out that some variables have a specific impact. Relative to teacher with basic ICT skills, the odds of being classified in the Use of ICT for all purposes class are significantly affected by the level of ICT competencies. While medium ICT skills level positively affects the odds of being Information and pedagogy ICT use class this variable is statistically insignificant for the high-level ICT use class. This suggests that the reason why teachers are represented so highly in ICT for all purposes class is due to their relatively high level of ICT skills confirmed by the odds ratios which tell us that it is 7.37 times more likely that a teacher with advanced ICT skills will use intensively ICT for all purposes rather than a basic ICT use.

In testing for the appropriateness of the model, the likelihood ratio test is used. The likelihood ratio test for the model lambda (λ) is 2102.1608 which is significant at 1%. This implies that the teachers' ICT usages as classified are truly heterogeneous groups. Hence, they cannot be treated as being homogeneous in characteristics, e-skills and ICT usages. This finding confirms the appropriateness of the use of a polychotomous model in this study. The model's ability to correctly predict 65.42% of the observations imply a reasonable goodness of fit.

4. FINDINGS AND DISCUSSIONS

As discussed in introduction, ICT integration in higher education has been gaining steady interest over the past decade. However, challenges remain in gaining widespread support and use of ICT for teaching and learning as well as for conducting research. Challenges include a lack of social and political support as well as the perception that ICT might be incompatible with the educational beliefs of some teachers. Higher education institutions also may be blatantly or inadvertently blocking ICT development due to lack of funding or incoherent plans for inclusion. Factors that support effective integration of ICT include previous involvement of teachers in teaching innovations; involvement of the staff and the availability of peer support; and an acceptance that all innovations have inherent risks.

4.1 Teacher Level Factors and Effective Implementation of ICT

The study suggests that teachers with less experience have a higher ICT usage score indicating that less experienced teachers are heavy use of technology in respect to experienced teachers. The reason relies on the level of comfort and confidence that less experience teacher has constructed during their education.

Merely owning a computer at home was a significant factor in teachers' use of ICT. However, teachers reporting usage of a home computer was a factor in their use of ICT. The more time a teacher actually spends in familiarizing themselves with computers, the more likely they will be to integrate ICT into lesson plans. It should be noticed that while exposure to a computer at home is not a guarantee that teacher invests time in enhancing their computer literacy. Although some teachers do not have computers at home, they may effectively use technology to teach if they have had exposure to computers in other venues. Some teachers' enthusiasms to use computers in their teaching might be due to their previous training programs in using educational technologies. Systematic and comprehensive training should therefore be provided by the higher education institution to enhance teacher's comfort and familiarity with new technologies.

As reviewed above, research on ICT training suggests that despite the time and effort required for teachers to integrate technological innovation into their teaching practices, outcomes justify the effort and new initiatives appear to be sustainable over the long term. However, the degree to which the innovation requires a shift to a "student-centered" approach may impact the degree to which the teachers' current practice must be radically altered. Teacher-centered impacts such as this should be considered in the design of how ICT infrastructure are introduced to the university setting and how teachers are

taught to engage with and utilize the new technology.

4.2 University Level Factors and Effective Implementation of ICT

The results show that different factors impact the effective implementation of ICT in the teaching, e.g. university-wide planning and implementation of the innovation, including ICT facilities in classroom; university-wide use and development of resources in order to encourage information sharing and support among peers; knowledge sharing and computer training; and adequate staffing of technical support personnel may also have an impact on the extent to which they are willing and able to take up ICT related innovation.

Study results indicated that teachers who had a computer lab in their institutions used ICT significantly more than teachers who did not have ICT facilities in their classroom. This might support the idea that installing new computers might increase the frequency with which higher education teachers use technology in their teaching.

As evident in the results, teachers who participated in ICT literacy training sessions were more likely to use computers in their teaching. Thus, it is important to provide teachers with frequent technology training opportunities. Such training might be provided at local colleges or training facilities belonging to the educational district. Such training should continue, for the mere fact that newer computer technologies emerge very frequently. The significance of professional development for teaching staff must be underscored. A variety of approaches are available and often a combination of approaches is needed to accommodate differences among teacher awareness and willingness to participate.

University-based or external support can be provided to fill the need for teacher training. Teacher inclusion in the design of training courses is, however, recommend. Such involvement can ensure to teachers to gain the required confidence and capability in ICT teaching innovations. Confidence in the material allows teachers to feel competent in their abilities and can be supported through the observation of teachers using ICT effectively. Support for teachers is also vital which includes provision computer labs and training, but also continuous technical and methodological staff to provide help during implementation. Universities that support continual efforts in improving teaching methods and embracing technological innovation gain a reputation for cutting edge educational practices and are better able to build on past experiences with innovation in a quickly changing world.

5. CONCLUSION

The purpose of this article was to propose a model of the differences observed in terms of behavior and adoption by French teacher-researchers in the field of educational ICT. To this end, we first recalled the main theoretical results already obtained in this area in order to subsequently propose an econometric modeling involving a large random sample of teacher-researchers to assess their practices and their uses when it is for them to use educational ICT.

Mainly, three explanations have been proposed to explain the differences observed in the use of ICT and the performance associated with it. First, the differences in the use of ICT are linked to the differences in initial digital skills between teachers. Extensive literature has shown how these differences in ICT use rates come from differentiation in uses. The initial work of Rogers [35] provided a first framework of analysis showing the existence of five categories of users of a given technology defined on the basis of different motivations and behaviors with regard to ICT. Advanced users (early adopter) are able to influence the direction of developments in these technologies.

Second, the differences in usage have been attributed to the existence of socio-economic differences such as age, gender and social status. Thirdly, a series of barriers preventing certain uses have been highlighted. These barriers mainly concern lack of confidence, lack of time, lack of skills, lack of equipment or resistance to change. For example, the many tasks in which the teacher is called upon to contribute reduce his propensity to use ICT.

However, the results of our econometric analyzes confirm that there is a high probability of finding a heavy user of ICT among the group of individuals with high qualifications. Our analysis also made it possible to emphasize the role of training in ICT as a vector for accelerating the intensity of use of these technologies. The same is true of the university environment.

While our results clearly confirm the existence of digital divides, it prompts us to analyze more precisely the role of innovative users and that of first-time adopters when they appear to be actors involved in the diffusion of ICT within universities. The influence exerted by these two categories of actors seems to be diffused in a “mimetic” way on the other teachers. Pedagogical innovation could then be seen as the main element of discrimination between groups of teachers and in their behavior.

CONSENT

As per international standard or university standard, respondents’ written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Durazzi N. The political economy of high skills: higher education in knowledge-based labour markets. J Eur Public Policy. 2019;26(12):1799–1817. DOI:10.1080/13501763.2018.1551415.
2. Ben Youssef A, Dahmani M. The Impact of ICT on Student Performance in Higher Education: Direct Effects, Indirect Effects and Organisational Change. RUSC. Revista de Universidad y Sociedad del Conocimiento. 2008;5(1):45–56. DOI:10.7238/rusc.v5i1.321.
3. Ben Youssef A, Dahmani M, Ragni L. Technologies de l’information et de la communication, compétences numériques et performances académiques des étudiants. GREDEG Working Papers 2020-25; 2020. French.
4. Sharpe A. Ten Productivity Puzzles Facing Researchers. International Productivity Monitor. 2004;9:15–24.
5. Kabakci Yurdakul I. Modeling the relationship between pre-service teachers’ TPACK and digital nativity. Educ Technol Res Dev. 2018;66(2):267–281. DOI:10.1007/s11423-017-9546-x.
6. Lei J. Digital natives as preservice teachers: what technology preparation is needed? J Comput Teach Educ. 2009;25(3):87–97.
7. Annette L. A digital learning future. Impact (Sydney). 2021;2021(3):4–5. DOI:10.21820/23987073.2021.3.4.
8. Jorgensen M, Havel A, Fichten C, King L, Marcil E, Lussier A, Budd J, Vitouchanskaia C. “Simply the best”: professors nominated by students for their exemplary technology practices in teaching. Educ Inf Technol. 2018;23(1): 193–210. DOI:10.1007/s10639-017-9594-1.
9. Teo T. Factors influencing teachers’ intention to use technology: model development and test. Comput Educ. 2011;57(4):2432–2440. DOI:10.1016/j.compedu.2011.06.008.
10. Venkatesh V, Morris MG. Why don’t men ever stop to ask for directions? Gender social influence and their role in technology acceptance and usage behaviour. Manage Inf Syst Q. 2000;24(1):115–139. DOI:10.2307/3250981.
11. Wong K, Teo T, Russo S. Influence of gender and computer teaching efficacy on computer acceptance among Malaysian student teachers: an extended technology acceptance model. Australas J Educ Technol. 2012;28(7):1190–1207. DOI:10.14742/ajet.796.
12. Bowen WG. Higher education in the digital age. Princeton University Press; 2013. DOI:10.1515/9781400847204.
13. Phillips R. Pedagogical, institutional and human factors influencing the widespread adoption of educational technology in higher education. ASCILITE 2005 - The Australasian Society for Computers in Learning in Tertiary Education; 2005.
14. Centeio EE. The have and have nots: an ever-present digital divide. J Phys Educ Recreat Dance. 2017;88(6):11–12. DOI:10.1080/07303084.2017.1331643.
15. Cruz-Jesus F, Vicente MR, Bacao F, Oliveira T. The education-related digital divide: an analysis for the EU-28. Comput Human Behav. 2016;56:72–82. DOI:10.1016/j.chb.2015.11.027.
16. Ben Youssef A, Dahmani M, Omrani N. Information technologies, students’ e-skills and diversity of learning process. Educ Inf Technol. 2015;20(1):141–159.DOI:10.1007/s10639-013-9272-x.
17. Weinberger Y, Shonfeld M. Students’ willingness to practice collaborative learning. Teach Educ. 2020;31(2):127–143.DOI:10.1080/10476210.2018.1508280.

18. Sieverding M, Koch SC. (Self-) Evaluation of computer competence: how gender matters. Comput Educ. 2009;52(3):696–701. DOI:10.1016/j.compedu.2008.11.016.
19. Vázquez-Cano E, Meneses EL, García-Garzón E. Differences in basic digital competences between male and female university students of Social Sciences in Spain. International Journal of Educational Technology in Higher Education. 2017;14(1):27. DOI:10.1186/s41239-017-0065-y.
20. Bingimlas K. Barriers to the successful integration of ICT in teaching and learning environments: A Review of the literature. Eurasia J Math Sci Technol Educ. 2009;5(3):235–245. DOI:10.12973/ejmste/75275.
21. Smith T. Strategic factors affecting the uptake, in higher education, of new and emerging technologies for learning and teaching. York: Technologies Centre; 2002.
22. Maddux CD, Johnson DL. Information Technology in Higher Education: tensions and Barriers. Comput Schools. 2010;27 (2):71–75. DOI:10.1080/07380561003801574.
23. Kafyulilo A, Fisser P, Voogt J. Factors affecting teachers' continuation of technology use in teaching. Educ Inf Technol. 2016;21(6):1535–1554. DOI:10.1007/s10639-015-9398-0.
24. Dusick DM. What social cognitive factors influence faculty members' use of computers for teaching? A literature review. J Res Comput Educ. 1998;31(2): 123–137. DOI:10.1080/08886504.1998.10782246.
25. Terzis V, Economides AA. The acceptance and use of computer based assessment. Comput Educ. 2011;56(4):1032–1044. DOI:10.1016/j.compedu.2010.11.017.
26. Moran M, Hawkes M, Gayar OE. Tablet personal computer integration in higher education: applying the unified theory of acceptance and use technology model to understand supporting factors. J Educ Comput Res. 2010;42(1):79–101. DOI:10.2190/EC.42.1.d.
27. Ahmad TBT, Madarsha KB, Zainuddin AMH, Ismail NAH, Nordin MS. Faculty's acceptance of computer based technology: cross-validation of an extended model. Australas J Educ Technol. 2010;26(2): 268–279. DOI:10.14742/ajet.1095.
28. Chen R. Investigating models for preservice teachers' use of technology to support student-centered learning. Comput Educ. 2010;55(1):32–42. DOI:10.1016/j.compedu.2009.11.015.
29. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate Data Analysis. 7th ed. Upper Saddle River: Prentice Hall; 2009.
30. Malhotra NK. Marketing Research: An Applied Orientation. Upper Saddle River (New Jersey): Prentice Hall; 2009. DOI:10.1108/S1548-6435(2009)5.
31. Nunnally JC, Bernstein IH. Psychometric theory. New York: McGraw-Hill; 1994.
32. Bocquet R, Brossard O. The variety of ICT adopters in the intrafirm diffusion process: Theoretical arguments and empirical evidence. Struct Change Econ Dyn. 2007;18(4):409–437. DOI:10.1016/j.strueco.2007.06.002.
33. Sharma S. Applied Multivariate Techniques. New York: John Wiley and Sons, Inc; 1996.
34. Straub D, Boudreau M-C, Gefen D. Validation guidelines for is positivist research. Comm Assoc Inform Syst. 2004;13:380–427. DOI:10.17705/1CAIS.01324.
35. Rogers EM. Diffusion of innovations. 5th ed. New York: Free Press; 2003.

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