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Uses of Information and Communication Technologies in Europe's Higher Education Institutions: From Digital Divides to Digital Trajectories*

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Abstract

This paper has two objectives, firstly, to identify the three basic levels of educational digital divides and to discuss them in the context of the European Union, and secondly, to develop an alternative hypothesis for educational digital trajectories instead of looking at educational divides.

Section one identifies the three levels of digital divides. The first level of educational digital divide concerns differences in ICT equipment. We identify the sources and the mechanisms that help to bridge this divide (Market Dynamics and Public Policies). Then, focussing on the second level of digital divide (usages divide) we analyse why this seems to be the main problem nowadays in Europe. Finally, a third level of digital divide concerns the performance of ICT in education. We give some possible explanations for the productivity paradox which is observed in European higher education.

Section two is devoted to the explanation of the diversity of usage of ICT between countries and universities. ICT allows different contextualisation and adaptation to the local context. Universities are developing several digital trajectories and instead of benchmarking universities we look at the explanations for this diversity. Two key elements were explored here: competition strategy of universities and students' attitudes towards the technologies.

Keywords

learning process, e-learning, productivity paradox, information and communication technologies, skill based technological change, digital divide

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Usos de las tecnologías de la información y de la comunicación en las instituciones de enseñanza superior de Europa: De las brechas digitales a las trayectorias digitales

Resumen

Este estudio tiene dos objetivos; el primero es identificar los tres niveles básicos de brecha digital educativa y tratarlos en el contexto de la Unión Europea y el segundo es desarrollar una hipótesis alternativa para las trayectorias digitales educativas en lugar de fijarse en las brechas educativas.

La primera sección define los tres niveles de brechas digitales. El primer nivel de brecha digital educativa se refiere a las diferencias en cuanto a equipamiento de TIC. Definimos las fuentes y los mecanismos que ayudan a cerrar esta brecha (dinámica del mercado y política social). Después, centrándonos en el segundo nivel de brecha digital (la brecha de usos), analizamos por qué este parece ser el principal problema en Europa hoy día. Finalmente, un tercer nivel de brecha digital hace referencia al rendimiento de las TIC en la educación. Proponemos algunas explicaciones posibles sobre la paradoja de productividad que se observa en la educación superior europea.

La segunda sección está dedicada a la explicación de la diversidad de usos de las TIC entre países y universidades. Las TIC permiten una contextualización diferente y la adaptación al contexto local. Las universidades están desarrollando varias trayectorias digitales y, en lugar de evaluar comparativamente las universidades, proponemos explicaciones para esta diversidad. Aquí se han tratado dos elementos clave: la estrategia competitiva de las universidades y las actitudes de los estudiantes frente a las tecnologías.

Palabras clave

proceso de aprendizaje, e-learning, *paradoja de la productividad, tecnologías de la información y de la comunicación, cambio tecnológico basado en la habilidad, brecha digital*

"Technology can just as easily worsen inequalities as it can ameliorate them (Servon 2002)"

Introduction

A wide range (*continuum*) of digital pedagogical tools is available nowadays for teachers and students. They include computers, e-mail, electronic presentations, discussion rooms, platforms, video-conferences, interactive white boards and more. These new tools have different impacts on the learning process since they change its scope (new students, people all over the world, worldwide competition), its methods (course size, learning events, online exercises, simulations, auto-evaluation), and its sequencing (full time face-to-face, full time online, blended learning, long-life learning).

To look at the impact of these developments within the context of higher education means examining the ways they challenge the 2500-year-old Socratic, face-to-face, lecturing and discussion modes characterising most of college and university teaching (Nachamias, 2002). Concerns about the quality of learning, financial cost-reduction, qualifications of students (future labour force), worldwide competition of universities, etc. has led many governments to take public initiatives in the field of e-learning and usage of ICT in higher education.

One of the key aspects of the debate is to identify the inequalities caused by the usage of ICT in higher education institutions. Policy makers fear that the rapid technological change may not benefit all students and may cause inequalities among students. Social inequalities are then amplified by e-exclusion even when people reach higher education. During the last two decades, wage inequalities have grown among workers in developed countries. The "Skill Biased Technological Change Hypothesis" gives one of the most popular explanations. Many authors argue that technological change is not neutral and it may benefit some workers by giving them more capabilities and competencies and therefore higher salaries, however, the other workers are less able to use these technologies and they are then less qualified and subsequently their salaries decrease. Higher education

institutions are thought of as playing a significant role in reducing this divide or amplifying it.

This paper has two objectives, firstly, to identify the three basic levels of educational digital divides and to discuss them in the context of the European Union, and secondly, to develop an alternative hypothesis for educational digital trajectories instead of looking at educational divides. The first level of educational digital divide concerns differences in ICT equipment. We identify the sources and the mechanisms that help to bridge this divide. Then, focussing on the second level of digital divide (usages divide) we analyse why this seems to be the main problem nowadays in Europe. Finally, a third level of digital divide concerns the performance of ICT in education. We give some possible explanations for the productivity paradox which is observed in European higher education. Section two is devoted to the explanation of the diversity of usage of ICT between countries and universities. ICT allows different contextualisation and adaptation to the local context. Universities are developing several digital trajectories and instead of benchmarking universities we look at the explanations for this diversity. Two key elements were explored here: competition strategy of universities and students attitudes towards the technologies.

1. The three levels of educational digital divides

Although, the concept of digital divide is very widely used, it is poorly defined. It belongs to the category of concepts which cannot be described by a unique or a universal definition. It reflects various facets of inequalities related to the digitalisation of the economy and diffusion of information and communication technologies (ICT). The concept of the digital divide, sense, measurement and interpretation, has been a focus of various academic research projects since the end of the 1990s (Arquette, 2002; Scadias, 2002; Norris, 2001; EOCD, 2004; Corrocher and Ordanini, 2000; Pohjola, 2002; Antonelli, 2003; Kozma *et al.* 2005)

The most generally accepted definition of digital divide is given by the OECD (2001)

> "The gap between individuals, households, business and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICT) and to their use of Internet for a wide variety of activities. The digital divide reflects various differences among and within countries. The ability of individuals and businesses to take advantage of the Internet varies significantly across the OECD area as well between OECD and non-member countries. Access to basic telecommunications infrastructures is fundamental to any consideration of the issue, as it precedes and is more widely available than access to and use of the Internet."

Here we looked at the digital divides among social groups related to ICT and especially educational information and communication technology (EICT). Starting from the logistic curve technologies' diffusion we can separate three levels of digital divides depending on the stage of diffusion.

The first level concerns the equipment and access to EICT. The second level assumes that people have the same level of equipment and looks at the sources of diverse use of EICT. In the third level, we consider that the equipment and usage rates are equivalent and we look at the performances of students and universities. We discuss each level of these divides to explain their main determinants and to examine certain implications for the European Union.

1.1. The first level of educational digital divides: equipment

Looking at the rapid diffusion of information and communication technologies in the higher education sector leads to worries that the unequipped (by choice or by constraint) face the risk of becoming more and more marginalised from the economic and social point of view. Moreover, economic literature mentions that a gap may separate those who are well-equipped (*Haves*) from those who are not (*Have-nots*). The implicit hypothesis behind this is that individuals with ICT can benefit from better information, education and particularly positive associated externalities. The unequipped may have less wealth of information and education and do not benefit from externalities related to ICT (such as e-competences). Those who are equipped find themselves within the rich networks of relations, skills, knowledge and education, while those not connected risk being excluded from these dynamics.

A great number of studies concerning the first level of digital divide exist nowadays. At the microeconomic level, income gaps between social groups are the main explanation of the digital divide (Quibria *et al.*, 2002). At the macroeconomic level the structure of infrastructure of telecommunications is considered the main reason (Wallsten, 2002, Fink, Mattoo and Rathindran, 2003).

While this digital divide was at the heart of the debate at the turn of the 21st century, two main dynamics have reduced this significantly in recent years: public policies and market dynamics.

1.1.1. Strong public policies have reduced the digital divide among higher education institutions

Since universities are key actors in the "Knowledge Based Economy" a major effort was made in the last decade, worldwide and especially in European countries, in order to equip them with ICT (computers, Internet access, etc.). It is more appropriate to qualify the equipment problem as a delay of diffusion related to these technologies between higher education institutions and not as a persistent gap. However, differences in equipment at home are still observed among categories of students. Related to this first point, it is important to distinguish between persistent inequalities and inequalities related to the diffusion of new goods or services. The first level of digital divide has been strongly reduced by public policies. However, the emergence of waves of new generations of the same technologies continues to exert a "pressure" on ICT equipment.

1.1.2. Market dynamics have also reduced the digital divide among students

The second element reducing the first level of digital divide is the fact that telecommunications and ICT markets are more and more competitive and since the 90's prices have been falling. According to Colecchia and Schereyer (2001), the price fall was approximately 15% per year between 1995 and 2005. These market dynamics benefit consumers who are increasingly better equipped. The more competitive the market is, the better equipped the universities and students are.

These two dynamics seem to work well in the European Union and the first level of digital divide may be considered now as a temporary problem. As an illustration, the student per computer ratio is one of the most used indicators concerning ICT equipment in higher education. In 1990, the students per computer ratios were approximately 30 in advanced institutions (UNESCO, 2003). Table 1 shows how market dynamics and public policies have significantly reduced this ratio and are working to bridge this divide. However, we must keep in mind that the rapid technological changes may create new, more qualitative divides (bandwidth, broadband, storage possibilities, etc.).

Table 1 - Average number of students per computer, 2000 and 2003 (OECD, 2005)

Country	2000	2003
Norway	7	6
United Kingdom	8	4
Sweden	12	6
Italy	16	8
Spain	24	12
Germany	24	12
Finland	10	6
Portugal	74	14
Greece	58	12

1.2. The second level of digital divide: usages

If the problem of equipment (the first level of digital divide) is being solved, the question of usage becomes more important. Many studies state that, "the potential of ICT in higher education is not fully used" (UNESCO, 2003). "The next challenge relates to the incentives for the teachers and the students to use the technological functionalities in an innovating and effective way (OECD, 2005: p. 14-15)".

Universities, students and teachers do not have the same intensity and objectives of usages. Time devoted on the Internet varies from one student to another, and students use these technologies for different goals. If we restrict ourselves only to pedagogical aims, one can stress the diversity of usages: communication with other students or teachers, finding information concerning their courses, collaborative learning and serious gaming. This diversity and the intensity of usages of EICT are generally considered in economic literature as having two basic sources. The first one relies on the educative strategies of the universities. They are exploring and exploiting a wide range of services in order to create competitive advantages and in order to have better returns of education. The second is due to differences in students' abilities and attitudes towards e-courses and more generally e-learning objects. Since these elements are quite different from one country to another one can expect differences in usages and in their intensity.

Determinants of usage of digital divides are mainly time allocation, user skills and autonomy of use.

Intensity of use refers to the time devoted to online activities. Since people are constrained by their available time, they allocate it for different goals: work, training, leisure, etc. The more students allocate their time to on-

line education activities the more they renounce on work (salaries), leisure or other usages. This allocation of time is a fundamental dimension in explaining differences in usage among students. The initial inequalities concerning revenue exert a huge effect here. Students who are working full-time or part-time may have less time available for online educative activities.

Using ICT efficiently in higher education is not straightforward. Basic computer skills and more advanced skills are needed for effective use. Differences are observed among students and teachers in these skills. In a recent publication, Ben Youssef *et al.* (2007) show clear digital divides in the ability of uses among higher education teachers in France.

Finally, equipment constraints may exert an effect on uses. The autonomy of use refers to the availability of computers and other technologies at home. This gives the user the ability to use the technology whenever he or she wants. If we accept that most higher education institutions nowadays offer access to the Internet and to computers at school, there is still a huge difference concerning access at home. This leads automatically to differences in the intensity of usage.

Two basic problems related to usage of EICT in European universities need specific answers. First, the ability to use these technologies varies from one student to another and from one teacher to another. Awareness of the potential of these technologies must be increased. Second, usage of EICT needs a basic learning process and training programmes nowadays do not seem to meet teachers' needs.

1.2.1. Exploration-exploitation process of the technology

Computers are powerful tools to mediate the learning process in higher education. Teachers use them in their relation with their students. The development of online courses has led many educators to re-examine their current approach, whereas others have simply adapted their current approach. Courses can thus vary from video lectures to student-centred constructivist approaches with less guidance from educators (Weller, 2003). This variety of approaches reflects the exploration-exploitation process induced by ICT. Any use of technology needs an adaptation by the teacher to its specific uses and teachers prefer their own tools to all other ready-to-use tools in the education setting. The ability and the preferences of teachers are fundamental concerning the intensity of usage. Nowadays a variety of under-utilised learning objects[2] exist on the web. For example, in a recent study, Sutherland (2004) points out that "the Oxford English Dictionary, online in English, and the graph-plotting software in mathematics are among the free powerful pedagogical tools which are under-utilised". The identification of these tools and the increasing awareness of their potential must be at the heart of future public policies. The whole process of learning must be changed such that teachers take the time to explore, with their students, the possibilities of ICT usages in education.

1.2.2. Effective usage needs intensive workplace training

Related to the above mentioned point, the digital divides in European and OECD countries are more linked, to some extent, to a lack of training activities for teachers and staff within universities. ICT calls for intensive training and the main problem is to understand how to implement these training programmes. "The changes in workplaces that were due to the introduction of new technologies and of new workplace practices have highlighted the necessity of acquiring new skills even after workers have completed their formal education. One of the most common places where workers acquire these new skills is in the workplace". (Black and Lynch, 2003). Increasing the intensity of uses needs specific policies for teachers, depending on their initial skills and usages. For some of them (laggards) hard and long training is needed in order to initiate them in the potentials of these technologies.

1.3. The third level of digital divides: performances

We may have a high level of ICT equipment without any economic or pedagogical impact on the higher education sector. The productivity paradox described by Solow[3] seems to be effective in the higher education sector. In other words, for two decades, the accumulation of ICT in the higher education sector in most European countries has been very im-

1. Related to SCORM (one of the organisations driving learning object standards), a learning object is defined as "a portion of a course packaged with sufficient information to be reusable, accessible, interoperable, and durable". WELLER (2003) suggests that a learning object is any piece of educational material that addresses one learning outcome.

2. For an extensive discussion of the Productivity Paradox see SHARPE (2004)

portant. Most of the teachers are connected in their workplace and even at home. Similarly, most of the students, even within the face-to-face learning process, are connected and use computers and the Internet. But is there any change in the learning process? Do we have better results or returns?

Table 2 shows that the productivity of higher education in most European countries is falling. Productivity is calculated by the standard input/output analysis.

Table 2 – Productivity growth in higher education in Europe (2005)

Country	2000
Norway	+4%
United Kingdom	+4%
Hungary	+8%
Austria	-9%
Denmark	-24%
France	-13%
Spain	-33%
Germany	-11%
Italy	-20%
Greece	-31%

Higher education may be evaluated for its performances in different ways. At least four outcomes may be distinguished: (i) student achievements, (ii) competencies and human capital, (iii) innovation and knowledge generation and (iv) other externalities such as security and less crime. We restrict ourselves in this paper to the two first outcomes.

From the perspective of student achievement, the debate shows contradictory results. While some literature shows a positive relationship between the use of ICT and student performance, other studies suggest little impact. For example, in recent research, specific to the United States, Sosin *et al.* (2004) constructed a database of 67 sections of 3,986 students enrolling for introductory economics, taught by 30 instructors in 15 institutions during the spring and fall terms of 2002. They found significant, but small, positive impact on student performance due to ICT use. But they show that some technologies seems to be positively correlated to the performance while others not. Brown & Liedholm (2002) have studied the performance of students in Microeconomics at the Michigan state University in three different modes (live, hybrid and virtual). They found that students in virtual classes, while having better characteristics, performed significantly worse in exams than students in face-to-face classes.

From the job market perspective, the debate seems clearer. Since with intensive usage of ICT e-competence is acquired, more advanced users among students may have two outcomes (e-competencies and their degrees). There is extensive literature on the effects of ICT on workers' skills (Acemoglu, 1998; Caroli E., Van Reenen, 2001; Autor *et al.* 2003; Hempel, 2004; Autor *et al.* 2005), with the ICT bonus apparently effective in the job market.

The European Union is building a strategy to cover the shortage of e-skilled workers that the European Union will face in the next decades, which means that the usage of ICT in higher education is becoming increasingly necessary, at the very least for acquiring these skills. The digital divide in performance will become a divide in future salaries. The link between the introduction of ICT in higher education and the Skill Biased Technological Change is then easy to understand from this perspective.

The "higher education productivity paradox" needs further research at the theoretical and empirical levels. Two explanations may be valid here; the first is that, while technological change is important in the higher education sector, there is a need for complementary innovations and organisational change in order to achieve better returns, the second one is that technological change needs to reconsider the incentives for teachers to use these technologies more intensively.

1.2.3. The lack of adoption of organisational change in the higher education sector

Economic literature has shown that technological change, alone, does not lead to any change in economic performance.[3] There is a need for rethinking the organisation[4] and use of organisational innovations. The uses of ICT need more flexible models of organisation. Few studies have tried to examine this dimension in the higher education sector.

3. Several studies present evidence on the link between ICT and new work practices (Bresnahan *et al.* 2002, Black and Lynch, 2001; Greenan and Mairesse, 2003 & 2004).

4. Organisation is defined as the way decision-making units are structured within an institution (firms, universities etc.), the way decision-making power and skills are distributed and the type of information and communication structures in place. Thus any change in the distribution of power, skills, and information, or in lines of communication constitutes an organisational change (Sah and Stiglitz, 1986). From an evolutionist perspective (Nelson and Winter, 1982) organisational change is a change in the routine that the universities operate.

In the European context, while students and teachers are using these technologies more and more intensively, the change in the organisational side seems to be very weak. This lack of organisational change may, as different studies have explained, lead to a negative productivity as shown in Table 2. It is better to use the old methods with the old technologies and new technologies with new organisational innovations.[5] The shift must follow two directions as the complementarities hypothesis suggests. Perhaps, the most important training topic is how to use new organisational designs in higher education. Several methods are available such as learning teams but few training programmes are implemented to show higher education teachers how to use them. E-education is more linked to new organisational designs than to new technology uses. This may explain the contradictory results obtained concerning the link between the use of ICT and performance.

1.2.4. Effective ICT use needs a change in incentives

The lack of change in the higher education sector may be explained by the relative lack of change in incentives and rewards. For example, the evaluation of higher education teachers is still based only upon "scientific" criteria such as how many articles and books, and in what journal, teachers have published. This does not give a teacher the incentive to invest in new pedagogical tools, in a learning process using ICT in teaching, etc. Certainly, the environmental pressure (students, colleague, and staff) can lead to some motivation to use the new technologies, but for better performance from the use of ICT, since it changes the allocation of the available time, one must reconsider the incentives and the rewards. All kinds of incentives must be revised, monetary and non-monetary incentives.

2. From digital divides to digital trajectories: explaining the differences

The main problem with the digital divides hypotheses is the fact that they assess the impacts of ICT as homogenous such that countries, regions, individuals and business can be benchmarked. But recent publications deal more with the concept of digital trajectories and less with digital divides. Information and communications technologies are widely accepted as general purposes technologies (GPTs) (Bresnahan and Trajtenberg, 1995). They need to be adapted to the local environment and to local constraints (Antonelli, 2003). Starting from this point of view higher education institutions may have different digital trajectories in using these technologies. Thus, understanding the diversity of usages and the models of usages is at the heart of research. Institutions and students may use these technologies differently but in the end achieve the same goals. There is no dominant strategy. All mixed strategies are available for HEI and each of them can develop a model with different level of usage intensity. Among different factors contributing to the diversity of usages, we restrict ourselves here to two main explanations.

Firstly, universities use ICT in order to create competitive advantages in worldwide competition. Secondly, students' abilities and innovations differ from one country to another and from one university to another. These elements may explain why we are observing a diversity of strategies.

2.1. Universities as a provider of e-services

The higher education sector is becoming more and more competitive. Universities seem to be in competition to attract talented students and lecturers. These dynamics have an impact on their proposed e-services. Quality of education and better returns on the diploma were the first elements to be considered. E-services provided by universities seek to create a "product differentiation" in a more competitive market (free entry market). At the same time, ICT help universities to give more personalised services and to take into account the differences between students. The quality of education is increasing with the use of these technologies.

2.1.1. Competition among universities and ICT uses

E-Learning services is an emerging and fast growing market and perhaps one of the most dynamic markets in the near future.

5. Greenan and Mairesse (2004) give more detailed explanation on this hypothesis.

> "There is a rush by universities, dotcoms, and corporations to develop online courses, virtual campuses, education portals, and courseware. The drive to develop a winning formula for commercial online education has fostered partnerships, as 'Internet entrepreneurs, textbook publishers, venture capitalists, corporate raiders, and junk-bond kings' look to education to drive the next wave of e-commerce" (Bianchi, 2000).

Universities are competing worldwide. They are trying to attract the best students and professors worldwide. By creating knowledge, by creating innovative patents, training the "knowledge workers", diffusion of culture, etc. they are considered the key actors in the knowledge based economy. Since they are in competition, the usage of ICT was viewed in the early 90s as a means of creating competitive advantages. They were engaged in hard policies for equipment and e-services production. In some ranking of universities, the equipment criteria are highly considered. As later adopters were equipped, creating competitive advantage within the university is more closely linked to efficient use of the technology rather than the equipment itself.

Two stages characterise this race by universities to deliver e-services. The first corresponds to the situation where the quick change of technologies allowed a major differentiation of the services proposed by universities. This stage corresponds to an earlier period of the Internet and its associated technologies. For example, e-learning was perceived as a tool of differentiation of universities aiming at reaching students worldwide. This strategy of offering these services to the students by the more competitive universities rapidly became a common strategy for the whole university sector. The usage of Internet becomes very common in European universities and most of them offer many standardised services. Many universities offer free online courses and access to many resources. To some extent, this standardisation process leads to a package of services offered freely by all universities.

Table 3: Standard usages of ICT in European countries

Basic e-services – Standard
Free access to computers
Free access to Internet
Free access to software
Online access to virtual library
Free access to virtual resources
Online e-administration of students

Table 4: Innovative usages of ICT

Advanced e-services – Innovative uses
Podcasting
Usage of collaborative platforms
E-Learning 2.0 (social capital and social interactions)
Web access to courses
Online exams
Serious Gaming as pedagogical tool
Network of universities sharing common best practices
E-resources
E-skills oriented programmes
E-governance of universities (E-vote for examp le)

This technological race for delivering e-services through innovative ICT generates a new concept of delivering education services through different channels: The multi-channels business model. Since the channels of delivering education services could not by themselves generate competitive advantages, universities reconsidered their strategies and tried to offer more advanced services based on these new technologies.

These dynamics were facilitated by the emergence of a wide range of new applications (Podcasts, Wiki, Blogs, Tagging, etc.) called Web 2.0. This process requires huge resources for universities and a change in their organisation and their business models. Here, the institutional diversity of European countries towards universities and the way of delivering diplomas led to a great diversity of usage of ICT.

This race was not observed in all European countries. Countries where the competition is intensive and where universities are seeking to compete for the worldwide market are more likely to adopt innovative usages and innovative services proposed by their universities.

2.1.2. From mass education to discrimination and personalised learning

A second element characterises the new forms of e-services and affects the innovative usages of ICT by universities. Universities seek to personalise their services for their students and offer courses in different formats. This was made possible thanks to the multiplicity of the channels of distribution and the tractability of the interactions among students and among students and teachers.

The supply of university services was verticalised and personalised. The Internet allows universities to offer high

value services, not linked to geographical proximity. These discrimination strategies seem to be satisfying for both the universities and the students. Students have exactly what they need and universities are catching more students by less means, and benefit from a scale economy. But these dynamics are not observed in all European countries. Many countries have a centralised governance system of universities that prevents changes from being made locally. A non-discriminatory argument among students is invoked to explain why universities, while they are aware of the values, do not use these possibilities fully.

The intensity of competition between universities is increasing and the contestability (free entry) of the markets was accelerated by the generalisation of new uses related to ICT. The diversification of services and the personalisation of the student-teacher relationships also allow universities to exploit the virtues of price discrimination. These dynamics are creating a variety of models in the European Union.

2.2. The role of students in the development of innovative usages

Collective preferences imply that the development of e-services must take into account the specific student's choices in each country. At least two elements characterise the diversity of these preferences. The first relates to the student's experience when it is a question of appreciating e-services that constitute experiment goods. The second, very close to the first one, relates to the innovation of students regarding the new education services.

2.2.1. Student preferences and digital trajectories

Life styles greatly influence the relation between universities and students. Indeed, since the students' and teachers' choices diverge from one country to another, they affect the uses in education. These differences are expressed in at least two ways.

Intensity of use depends on the first use experience, which is a crucial moment in the process. The main issue here is that the launch of a new usage or service must avoid the risks of dissatisfaction with technology (Meuter *et al.*, 2000; Joseph *et al.*, 1999). The confidence relationships and trust may be modified at this moment. It is important that students find the applications and technologies secure and satisfying from the first use, or they will not adopt them. This may explain the differences in the adoption process of new usages and services among countries. However, since many universities replicate the best practices from the first adopters they implement only stabilised e-services and so avoid the no-satisfaction risk.

The second element is related to the spatial interdependence between preferences. Students are subject to imitation and contagious effects regarding education, and even consumer goods. As experimental goods, these new services imply that the students agree to support costs of training associated with their use. It is only if the effects of imitation and interdependence between consumers prove to be sufficient in terms of positive externalities that these new services are adopted. The costs of training are assumed to be the switching costs. Students adopt the new services if the switching costs are low and the perceived value is high. This process of learning follows different patterns from one country to another. It depends on the collective learning by economic agents and the depth of the networks effects, clubs, and virtual communities, etc.

2.2.2. Innovations of students as determinant of the digital trajectory

Since the seminal work of Rogers (1995), people's innovation is considered as an important dimension concerning ICT in general. People are more or less receptive to new technologies and new ideas. Rogers states that earlier adopters play a key role in the development of these technologies and in the process of maturation of these technologies in a way that they respond to their needs. Rogers (1995) suggests a classification of five types of adopters: (1) innovators, (2) early adopters, (3) early majority, (2) late majority and (5) laggards.

Using this as a base, it is obvious that the composition of these sub groups is quite different from one country to another and from one university to another. Countries where innovator students are a large group develop the most technologically advanced applications and services compared with countries where late majority or laggards dominate. This is not a question of adoption of new technologies, it is more about adaptation of technologies to the innovativeness of students. Agarwal and Prasad, (1998) state that innovativeness of consumers, as "the willingness of an individual to try out any new information technology", is an important dimension of information technologies.

This innovation has found its tools by the development of what we call the collaborative Web or Web 2.0. On one hand, interactions among innovative students are growing

rapidly and this implies disparities concerning uses among countries and universities. On the other hand, the interaction between students as innovators and teachers is defining the new e-services. Since the intensity of interactions is quite different from one country to another, the e-services are expected to be different.

In the end, the impact of new technologies often depends on historical factors and the cumulative capabilities of students and teachers to support a learning process. These learning processes are very different from one country to another. This role of the students is becoming more and more important. Since the emergence of the participative web and the so-called e-Learning 2.0, students are becoming more and more active in the definition of the contents of the Internet.

Conclusion

In this paper we have tried to understand the basic dimensions of EICT digital divide and to explain their implications in European higher education institutions. Our main findings are that, after a decade of equipment strategy, there is a need nowadays to implement an efficient use strategy. As ICT has an impact on the whole learning process, we need a holistic approach to the changes. The productivity paradox implies that the learning process must take into account the organisational changes and the incentives problem to have better returns in terms of teacher quality, student achievement, and the quality of the labour force. At the same time, since the main changes are qualitative, we must understand these changes and quantify them before looking for any specific policies.

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