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Monograph "The Economics of E-learning"

ARTICLE

The Impact of ICT on Student Performance in Higher Education: Direct Effects, Indirect Effects and Organisational Change*

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Abstract

The purpose of the present paper is to examine the relationship between the use of information and communication technologies (ICT) and student performance in higher education. So far, economic research has failed to provide a clear consensus on the effect of ICT investments on student's achievement. Our paper aims to summarise the main findings of the literature and to give two complementary explanations.

The first explanation focuses on the indirect effects of ICT on standard explanatory factors. Since a student's performance is mainly explained by a student's characteristics, educational environment and teachers' characteristics, ICT may have an impact on these determinants and consequently the outcome of education. The differences observed in students' performance are thus more related to the differentiated impact of ICT on standard explanatory factors.

The second hypothesis advocates that ICT uses need a change in the organisation of higher education. While ICT equipment and use rates are growing very fast in the European Union, the adoption of complementary organisational designs is very slow and differs from one institution to another. This may explain the observed differences in students' achievement.

Keywords

ICT use, student performance, higher education institutions, organisational change

JEL codes: A20, A23, I20, I23, O38.

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El impacto de las TIC en el rendimiento de los estudiantes de educación superior: Efectos directos, indirectos y cambio organizativo

Resumen

El propósito de este estudio es examinar la relación entre el uso de las tecnologías de la información y de la comunicación (TIC) y el rendimiento de los estudiantes en la educación superior. Hasta ahora, la investigación económica no ha logrado alcanzar un consenso claro acerca del efecto de las inversiones en TIC sobre los resultados de los estudiantes. Nuestro estudio trata de resumir los principales resultados obtenidos en los trabajos publicados y ofrecer dos explicaciones complementarias.

La primera explicación se centra en los efectos indirectos de las TIC sobre factores explicativos estándar. Dado que los resultados de un estudiante vienen determinados principalmente por las características del propio estudiante, el entorno educativo y las características de los profesores, las TIC tienen un impacto sobre estos determinantes y, en consecuencia, sobre los resultados de la educación. Las diferencias observadas en los resultados de los estudiantes se hallan, por tanto, más relacionadas con el impacto diferenciado de las TIC sobre los factores explicativos estándar.

La segunda hipótesis argumenta que los usos de las TIC necesitan un cambio en la organización de la educación superior. Mientras los índices de uso y el equipamiento TIC siguen creciendo rápidamente en la Unión Europea, la implementación de diseños organizativos complementarios se lleva a cabo lentamente y varía de una institución a otra. Esto puede explicar las diferencias observadas en los resultados de los estudiantes.

Palabras clave

uso de las TIC, rendimiento de los estudiantes, instituciones de enseñanza superior, cambio organizativo

Introduction

During the last two decades higher education institutions have invested heavily in information and communication technologies (ICT). ICT has had a major impact in the university context, in organisation and in teaching and learning methods.

One puzzling question is the effective impact of these technologies on student achievement and on the returns of education. Many academic researchers have tried to answer this question at the theoretical and empirical levels. They have faced two main difficulties. On one hand, student performance is hard to observe and there is still confusion about its definition. On the other hand, ICT is evolving technologies and their effects are difficult to isolate from their environment.

There is no standard definition for student performance. The standard approach focuses on achievement and curricula, how students understand the courses and obtain their degrees or their marks. However, a more extensive definition deals with competencies, skills and attitudes learned through the education experience. The narrow definition allows the observation of the outcomes of any change in higher education, while the more extensive definition needs a more complex strategy of observation and a focus on the labour market. The outcomes of education are mainly validated in the labour market.

The relationship between the use of ICT and student performance in higher education is not clear, and there are contradictory results in the literature. Earlier economic research has failed to provide a clear consensus concerning the effect on students' achievement.

Starting from this point, the aims of this paper are two-fold: first, we summarise the main findings of this extensive literature and second, we give two complementary explanations on the contradictory results. Our first explanation is that most of the literature has focused on direct effects of ICT while it is more appropriate to look at the indirect effects through the traditional channels. Since student performance is mainly explained by a student's characteristics, educational environment and teachers' characteristics, ICT may have an impact on these determinants and consequently the outcome of education. The differences observed in the performances of students are thus more related to the differentiated impact of ICT on the standard determinants.

The second explanatory hypothesis is that ICT needs a shift in organisation. While ICT equipment and use rates are growing very fast in the European Union, the adoption of complementary organisational designs is very slow and

differs from one institution to another. This may explain the observed differences in students' achievement.

Our paper is structured as follows: section one surveys the literature on students' performance and the use of ICT, section two explains the impacts of ICT on the traditional determinants of students' performance and finally, section three underlines the role of organisational change in education on students' performance.

1. ICT and students' performance: no clear direct effects

The direct link between ICT use and students' performance has been the focus of extensive literature during the last two decades. Several studies have tried to explain the role and the added value of these technologies in classrooms and on student's performances. The first body of literature explored the impact of computer uses. Since the Internet revolution, there has been a shift in the literature that focuses more on the impact of online activities: use of Internet, use of educative online platforms, digital devices, use of blogs and wikis, etc.

This literature shows mixed results. On one hand, some research demonstrates that there is no evidence of a key role for ICT in higher education (Angrist and Lavy, 2002; Banerjee *et al.*, 2004; Goolsbee and Guryan, 2002; Kirkpatrick and Cuban, 1998). On the other hand, some studies show a real impact of ICT on students' achievement (Kulik, 1999; Sosin *et al.*, 2004; Fushs and Wossman, 2004; Talley, 2005; Coates *et al.*, 2004).

a) ICT does not play a role in students' achievement

Coates *et al.* (2004) surveyed three matched pairs of face-to-face and online principles of economics courses taught at three different institutions. The students' score in the Test of Understanding College Level Economics (TUCE) given at the end of the term is used as the measure of learning outcomes. After taking into account selection bias and differences in student characteristics, they report that the average TUCE scores are almost 15% higher for the face-to-face format than for the online format.

Anstine and Skidmore (2005) surveyed two matched pairs of on-campus and online courses, one in statistics, and the other in managerial economics. They report that after taking into account student characteristics and selection bias, students in the online format of the statistics class exam scored 14.1% less than in the traditional format, whereas, for the managerial economics class, the test scores within both formats were not significantly different.

Navarro and Shoemaker (1999) surveyed a matched pair of on-campus and online sections of a class on principles of macroeconomics. The students self-selected the instruction format, with each section having approximately 30 students, and there was no difference in the demographic composition of each section. They used a simple comparison of means of test scores and reported no significant difference in academic performance between the two formats.

Terry, Lewer and Macy (2003) surveyed 240 students in a programme offering courses in the three formats of online, on-campus, and hybrid. Using a standard regression model where final exam score is the dependent variable and student characteristics are the independent variables, they report that predicted exam scores for students in the online courses were significantly less than those of students in the on-campus and in the hybrid formats. However, with the comparison of exam scores between students in the hybrid and students in the on-campus classes there was no significant difference.

Brown and Liedholm (2002) surveyed students in a matched pair of online and face-to-face principles of economics course taught by the same teacher. They reported that exam scores, after taking into account differences in student characteristics, were approximately 6% higher for the on-campus format than for the online format. They attribute the relatively better performance in the on-campus classes to the benefit of in-person teacher-student interactions, and attribute the relatively poorer performance of the students in the online class to the lack of self-discipline necessary for successful independent learning in the online environment.

Leuven *et al.* (2004) concluded that there is no evidence for a relationship between increased educational use of ICT and students' performance. In fact, they find a consistently negative and marginally significant relationship between ICT use and some student achievement measures.

Students may use ICT to increase their leisure time and have less time to study. Online gaming and increased communications channels do not necessarily mean increased achievement. Many other explanations were presented.

b) ICT plays a role in students' achievement

Kulik's (1994) meta-analysis study revealed that, on average, students who used ICT-based instruction scored

higher than students without computers. The students also learned more in less time and liked their classes more when ICT-based instruction was included.

Sosin *et al.* (2004) constructed a database of 67 sections of introductory economics, enrolling 3,986 students, taught by 30 instructors in 15 institutions in the United States of America during the spring and autumn semesters of 2002. They found significant, but low, positive impact on student performance due to ICT use. But they showed that some ICT seems to be positively correlated to performance while others are not.

Fuchs and Woessman (2004) used international data from the Programme for International Student Assessment (PISA). They showed that while the bivariate correlation between the availability of ICT and students' performance is strongly and significantly positive, the correlation becomes small and insignificant when other student environment characteristics are taken into consideration.

The analysis of the effects of these methodological and technological innovations on the students' attitude towards the learning process and on students' performance seems to be evolving towards a consensus, according to which an appropriate use of digital technologies in higher education can have significant positive effects both on students' attitude and their achievement.

Attwell and Battle (1999) examined the relationship between having a home computer and school performance, for a sample of approximately 64,300 students in the United States. Their findings suggest that students who have access to a computer at home for educational purposes, have improved scores in reading and maths.

Coates *et al.* (2004) showed that students in on-campus courses usually score better than their online counterparts, but this difference is not significant here.

Li *et al.* (2003) pointed out: "First, web-based instruction presents information in a non-linear style, allowing students to explore new information via browsing and cross-referencing activities. Second, web-based teaching supports active learning processes emphasized by constructivist theory. Third, web-based education is enhanced understanding through improved visualization and finally, the convenience, it could be used any time, at any place".

c) A need for clarification and for more appropriate explanations

Fuchs and Woessman (2004) present two hypotheses explaining the mixed results shown in the literature. The first one states that, with all else being equal, ICT constitutes an input in the student learning process that should help produce better learning output. ICT use can enhance learning by making education less dependent on differing teacher quality and by making education available at home throughout the day. Authors argue that the use of ICT can positively transmit knowledge to students. Furthermore, ICT use can help students exploit enormous possibilities for acquiring information for schooling purposes and can increase learning through communication.

The second hypothesis combines the arguments that:

In fact, all else is not equal. ICT based instruction induces reallocations, substituting alternative, possibly more effective, forms of instruction. Given a constant overall instruction time, this may decrease student performance. Also, given that budgets are not perfectly elastic, the introduction of ICT based instruction can result in a reallocation of funds in favour of ICT, possibly substituting more effective instructional materials.

ICT can distract learning. This may be particularly salient at home, where Internet access could be a source of distraction because of chat rooms or online games, reducing the time spent in doing homework or learning. Thus, the impact of the availability of ICT on student learning will strongly depend on their specific uses.

ICT-based instruction could restrict the creativity of the learner. ICT tends to allow acting only in a predefined way with limited interactive possibilities. This might reduce the students' abilities in terms of problem solving and creative thinking in predetermined schemes but not their ability to come up with independent creative solutions on their own"

For a better understanding of the link between student performance and ICT usage, we suggest two alternative research strategies in the next sections. The first one consists of examining the impact of ICT on traditional explanatory variables of student's achievement. The students' performance depends on other explanatory factors and ICT may have a profound impact on these factors. Thus, differences in the observed performance depend on the nature and the intensity of these changes. The second explanation is given by the economic literature concerning ICT performance in economic sectors. Education is a specific sector but can be considered as an economic sector and the literature on the "productivity paradox" suggests that organisational change is the key explanation of ICT performance (Sharpe, 2004).

2. Student performance: indirect effects

Students' performance is a puzzling question in education science and economics. The general approach followed by economics is to use a model of added value based on the educational production function. This methodology consists in evaluating the effect of the educational inputs (characteristics and attitudes of the teachers, physical resources committed in the universities, the teaching organisation, the rate of students framing, etc.) on the students' performance by taking into account other inputs (socio-economic origin, characteristics and attitudes of the students) (see e.g. Hanusek, 1996, Jaag, 2006; Lazear, 2001; Krueger, 1999). A large body of literature is dedicated to this subject and here we are not aiming to survey this research. However, the findings indicate consistent trends and provide evidence on the relationship between educational environment, students' characteristics, teachers' characteristics and performance of students and we propose to discuss them.

2.1. Students' characteristics

The first body examines the effect of the students' socio-economic characteristics on their educational performance. Initial socio-economic differences are determinant of their achievement (age, gender, family structure, level of parents' education, geographical area, etc.). A large body of literature focuses on the relationship between the students' school results and the students' socio-economic characteristics.

Pozo and Stull (2006) highlighted the importance of the initial provisions (secondary studies and competence in mathematics) in success at university. The secondary performance also depends on socio-economic variables. The students who come from underprivileged socio-economic environments have worse school performances than the less underprivileged students (Conger *et al.*, 1997; Haveman and Wolfe, 1995; Wilson, 1987). Bratti *et al.* (2007) show that the differences in student performance can be explained by the differences between the areas in economic terms of structures, regional leisure, type of institutions and the individual characteristics of the students (family and social characteristics).

Didia and Hasnat (1998) examined the determinants of student performance on an introductory finance course. They found that age, as a measure of maturity, had a significant influence on performance. Reid (1983) focused his study on an introductory university economics course and also found that age was a significant variable, with older students performing better than younger ones.

Jaggia and Kelly-Hawke (1999) included variables concerning school inputs and student's family background in order to test whether these two variables influence student performance. They found that higher levels of spending did not have any consistent relationship with student performance. However, family background was clearly very important in explaining differences in achievement.

There seems to be a very close link between the ICT revolution and the socio-economic variables. Family structure, social environment and related variables are not sensitive to ICT, yet ICT may act on secondary education and contribute to better achievement. However, ICT may have an impact on students' motivation. Becker (2000) found that ICT increases student engagement, which leads to an increased amount of time students spend working outside class.

2.2. Educational environment

The second body of economic literature aims to evaluate the impact of the educational inputs on the students' performance, based on educational production functions (Hanusek, 2003; Glen, 2006; Glewwe *et al.*, 2004, Glewwee and Kremer, 2006; Todd and Wolpin, 2003). The starting point was that the more students benefit from the physical environment of education the better is their achievement. Thus, increasing physical investment in education must lead to better results and performance.

One prominent variable in the environment and physical investment is class size. A better higher education environment is correlated with small classrooms. While the theoretical hypothesis seems evident, empirical research is more controversial. On one hand, Krueger (1999) and Angrist and Lavy (2004) provide evidence in favour of the positive and significant effect of small classes. Arias and Walker (2004) conducted an experiment to test the relationship between class size and student performance. They controlled variation in instruction, lecture material, and topic coverage by using the same instructors. Their results were statistically significant showing that small class size had a positive impact on student performance. On the other hand, Hanusek (2003) had already shown that one cannot conclude, without some doubt, that the reduction of class size improves student performance. Hoxby (2000), using data on the United States, did not succeed in finding an effect of class size on student performance. This result

was confirmed by other studies conducted by Dustmann (2003), Mosteller (1995) and Jaag (2006), showing the existence of a significant and single effect of class size on student performance.

The effect of the rate of students framing is also a subject of controversy. In certain studies, one finds that, when it is weak, it can have a positive effect on the students' performance. Starting from the results in mathematics in 148 school institutions in England, Raudenbush and Willms (1995) showed that a reduction in this ratio from 25 to 16 would increase the students' performance. On the other hand, using data collected in England between 1992 and 1996, Bradley and Taylor (1998) found that the number of students per teacher does not have an effect on the students' performance. However, they showed a significant, but weak, impact when they studied the relationship between the variation of this number between 1992 and 1998 and the variation of performance in the exams during the same period.

Investing in ICT can be considered as physical investment that improves the educational environment. ICT may act as a means by which higher education institutions implement interactive learning based on reduced class-size approach. Firstly, the use of ICT in higher education is allowing a shift from a teacher-based approach to a student-based approach (Becker, 1997).

Secondly, since the usage of ICT leads to asynchronous learning the class size does not matter. Using computers and the Internet, students have more time to interact with the course. They are not constrained by the available face-to-face time where their understanding and participation depend on the number of students. Thirdly, concerning network economics, the value of the network depends on the number of users. Therefore, the number of students may have a positive effect on online courses. This result depends on the teacher's motivation and student characteristics.

2.3. Teachers' characteristics

The third body highlighted the effects of teachers' characteristics on student performance. The influence of the teacher had already been shown in the seventies by research of the process-product type of Rosenshine (1971) and that of Bloom (1979). These studies connected the behaviour of the teacher (process) with the training of the student (produced).

In recent empirical studies conducted in the United States, Rivkin *et al.* (2005) found that teachers in their first or second year of teaching are associated with lower student performance in Texas, but teacher education and qualification have no systematic relationship with performance. Jepsen and Rivkin (2002) obtained similar results using grade-level data from California. Preliminary results from Clotfelter *et al.* (2003) suggest positive impacts of teacher experience and teacher license test scores on student achievement in North Carolina. Betts *et al.* (2003) obtained mixed results for teacher characteristics using detailed individual-level data in the San Diego Unified School District.

The lack of significant effects for these teacher characteristics should not be interpreted as evidence that teachers have no impact on student performance. Teacher quality, measured by teacher fixed effects, has an important impact on student achievement, according to Rockoff (2004). In addition, Hanushek (1971) and Murnane (1975) found significant impact of classroom fixed effects (i.e. combined impact of teachers and peers). Rivkin *et al.* (2005) found a major effect of overall teacher effects measured at the grade level. In other words, teacher quality may be important, but it is not well captured by levels of teacher experience, certification, and education.

Recent research has pointed out the importance of transforming teaching in order to integrate ICT effectively. ICT is seen as a catalyst of system, community, school and classroom reform because it provides opportunities to shift from teacher centred to student centred learning. In turn, ICT could also increase the pedagogical repertoire of teachers. This teacher effect is most likely to improve the outcomes of disadvantaged students because it attends to individual need and provides a variety of curriculum and assessment strategies to promote student capabilities across a range of learning outcomes. In this sense, good pedagogical practice in the use of ICT to enhance the learning of students who are disadvantaged is good pedagogical practice for all students. ICT may have an impact on teacher quality and characteristics, and so student performance and achievement.

Three complementary effects may be observed. First, teachers' actions may be complemented by the use of learning from the Internet. The process of learning is not only based on teachers' materials. Second, teachers are acting as learners in the new setting of education. Teachers learn from peers and also from students. They are co-constructing the courses and are more sensitive to student participation. ICT is transforming the classrooms and focusing learning more on the process. Third and related to the two first points, while initial competence and degrees of teachers remain important, new skills are needed and students' performance seems dependent on the ability of teachers to develop these new competencies and skills. Extended training is needed in this subject in the European Union.

Basic effects of ICT on the teaching process

- Has an edit effect in terms of quality of student work and practical examples through visualisation;
- Improves poor handwriting and languages skills through word processing;
- Equalises individual differences and has particularly dramatic effects for students with special needs;
- Facilitates self-pacing with increased capacities to deal with individual learning styles as students can work at the pace and intensity suitable to their needs;
- Enables collaborative learning with little indication of the isolated learner;
- Encourages use of peer coaching and peer reviews;
- Develops communication skills and awareness of different audiences;
- Has impact on resource–based learning and access to real world information through the Web;
- Increases information reliability and accuracy adding to authenticity of learning tasks, with realistic and up-to-date information;
- Increases student motivation through hands-on activity, visual representations and improved modes of presentation;
- Encourages independent learning and individual preferences for process, layout, style and format;
- Gives students more control;
- Allows students to produce high quality multimedia products;
- Changes teacher practices, planning tools and assessment rubrics;
- Increases opportunities for classes to evolve and for student experiences to shape outcomes;
- Has motivated students to commit to learn and to participate in learning activities;
- Has improved students' quality of work and has given them the confidence to perform enhanced learning tasks;
- Has allowed students to learn independently, which has enabled more work to be completed, and
- Has enhanced achievement due to the reinforcement and practice that ICT has afforded.

3. ICT and student performance: an enormous lack of organisational change

Looking at the link between ICT and student performance seems nowadays a misunderstanding of the role and nature of these technologies. In fact, since ICT is general purpose technology (GPT), it needs to be specified in order to meet the needs expressed by students and to be adapted to the local context and constraints (Antonelli, 2003; Ben Youssef, 2008). A variety of models of usages can be identified leading to the same outcome. ICT brings widened possibilities for the learning processes that are independent from place and space. ICT also allows more flexible (asynchronous) and more personalised learning. It offers new methods of delivering higher education. Taking advantage of these opportunities needs a profound change in the organisation of the higher education system.

Economic literature in the last decade has shown that technological change, on its own, does not lead to any change in economic performance. Among the most popular explanations of this paradox – huge investment in ICT without any economic performance – the complementarity thesis seems to be the most accepted nowadays (Greenan and Mairesse, 2004). Old methods need old educative technologies and new technologies need new organisational innovations. There is an agreement between researchers that the usage of ICT requires the usage of new organisational designs and a shift in organisation. Higher education is not an exception and needs a huge organisational change.

Organisation is defined as the way decision-making units are structured within an institution (here universities or higher education institutions), the way the 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 the 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 routines of the universities. The potential benefits, implications and challenges of introducing ICT into schools can be very different depending on the vision and the understanding of the nature of this change, as well as strategies for its management adopted by the leadership at the school level and beyond (UNESCO, 2003).

Hargreaves (1997) and Meighan (1997) argue that merging ICT and education requires organisational chan-

ges at the level of the whole system: in the direction of allowing more distance-learning or even virtual schooling, thus changing the attitude towards time, place, curriculum and other connected attributes of the system.

ICT has a profound impact in classrooms. It adds complexity to a non-linear system. This complexity needs a major change in organisation. Downes (2001) differentiates four levels of use of ICT in the classroom:

Level 1: ICT skills are added into the school programme through a separate ICT subject, while teacher practices in other subjects remain unchanged;

Level 2: ICT skills are integrated into teachers' daily work with some teachers' pedagogical practices and classroom behaviour remaining the same, while the practices of others change more radically;

Level 3: ICT is transformative at the classroom level as it changes content as well as pedagogy (what students learn as well as how they learn it);

Level 4: ICT is transformative at the system level leading to changes in the organisational and structural features of schooling.

Performance is then observed when the institutions reach the third or fourth levels. Most universities are currently working at level one and two, especially universities with scarce or few resources. The usage of computers in classrooms is more often based on the vision of the teacher and his or her beliefs about ICT. In some cases, when ICT is introduced without changes in organisation this may lead to a decrease in student performance and the outcomes of the education.

From our perspective, organisational change related to ICT and its link to students' performance need to focus on at least four basic principles. First, ICT is collaborative technology and needs to be used as such. Second, ICT allows the personalisation of education and personal services are a key element of ICT in education. Third, universities must be viewed as learning organisations. Fourth, the outcomes of education are changing through ICT and we need to focus more on competencies rather than curricula.

i. A shift to a more collaborative and less individualist model of learning

Few economic studies have tried to examine this dimension in the higher education sector. Fullan (1999) mentions that reforms failed due to the problem of changes in collaborative culture among students and between students and teachers. ICT is mainly collaborative and interactive. Improving the outcomes of the learning process needs a change in the way students interact. This is not a trivial dimension. Nowadays, several technologies allow co-writing and sharing resources (Wikis, blogs, etc.). The collaborative and co-operative dimensions of the learning process are fundamental and an organisational change is needed in order to explore this dimension. Collaboration is also one of the most highly-searched for skills in the job market. By enhancing the learning of this kind of skill, higher education provides the job market with better workers.

ii. ICT allows personalised learning and organisation must follow this trend

ICT is based on individual access, personal mobile phones, personal computers etc. as well as the new trend for personalisation of the Web. This implies that the needs and the competencies of students are quiet different, and since ICT allows one-to-one learning, a more personalised learning may constitute the future trend of higher education. Better achievement of students is easier to obtain since the learning is personalised and customised. However, this implies a huge change in the format, in the organisation of the classrooms and in the competencies and availability of teachers. This may explain the differences observed in the impact of ICT on the performance of students. Wherever the introduction of ICT is associated with a personalised service for students, performance increases.

iii. Universities as a learning organisation

Hargreaves (1997) and Meighan (1997) argue that the potential impact of the implementation of ICT in higher education will not be observable without organisational changes at the level of the whole system. Universities must act as a learning organisation. ICT implies more interactions among all the actors. The institution is then developing collective learning by changing its rules and routines. But the main change is that innovation becomes the heart of the learning process. Teachers and students are exploring the new possibilities given by these technologies and construc-

ting capabilities concerning learning through ICT. Building capabilities concerning ICT usage in education becomes a discriminatory element among universities. The attitudes toward time, place, curriculum and other connected attributes of the system on a systemic level are changing.

iv. The outcomes of higher education are changing

The impact of ICT on the learning process seems to be more important and requires more than looking only to curricula. Improved student outcomes are observed, with regard to: motivation, enjoying learning; self-esteem; ICT skills; collaborative skills; subject knowledge; information handling skills; meta-cognitive skills, etc.

In European higher education institutions, while students and teachers seem to be using the new available technologies more and more intensively, organisational designs are changing slowly. The lack of a strategy regarding organisational change, as several studies have shown, leads to a weak impact of the use of ICT on student performance.

Flexibility of training

ICT is considered to exploit the flexibility of training. The rhythm of study, the allocation of time and the availability of teachers can allow better articulation between private life/professional life (studies) as well as a better allocation of time between the various uses. This allows better student performance in pecuniary terms of profits and achievement. There is also the quality of the training. The teaching support, the availability of resources and the variety of training channels may change following the introduction of the ICT. This would make it possible for students to acquire e-skills and to develop them in the labour market (OECD, 2006). Some go as far as claiming that the use of innovative models of training permitted by the introduction of ICT could make it possible for the students to "carry out team work, to share knowledge and to decrease individualism in order to promote the authorized capital" (Lundin and Magnusson, 2003).

Conclusion

In this article, we have tried to summarise the main findings in economic literature concerning ICT usage and student achievement. ICT seems to have a profound impact on the process of learning in higher education by offering new possibilities for learners and teachers. These possibilities can have an impact on student performance and achievement. There are contradictory results in the empirical literature in this field. Three different arguments can be given in order to explain this lack of empirical evidence. First, since ICT is a form of GPT and immature by nature, a long process of appropriation and exploration of their possibilities by higher education institutions is needed before observing any significant change. This has been the case in other economic sectors and it is also true in higher education. Second, we consider the lack of organisational change in higher education the main explanation. While universities have invested heavily in equipment, and at the same time students and teachers are using these technologies more and more, there has been little change on the organisational side. The adoption of complementary organisational innovations is a major factor in student performances and achievement. Third, returns of education using ICT are changing. Students are acquiring new skills and new competencies – more collaboration, team building, project management – closer to the needs in the job market and perhaps less performance on curricula. Observing the performance of students needs to deal more with these topics and less with knowledge of specific topic and curricula.

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