Information and Communication Technologies, E-competences and Innovation: The Role of Higher Education Teachers in the innovation process (A case study of Tunisia)[1]

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October 21th 2010

Abstract

The aim of this article is to characterize the pattern of adoption and usage of ICT by Higher Education Teachers (HET) in Tunisia and to understand how innovative this process is. A Web questionnaire was designed in order to examine the e-competencies and the daily practices of vocational high-school teachers in Tunisia. The results and findings are based upon 288 HET respondents. A structural Equation model was developed in order to understand the main determinants of innovative pedagogical uses of ICT by HET. Two unexpected results were found. First, gender differences in matter of innovative uses are not found in Tunisia. Female HET seem to use more innovatively ICT than male ones. Secondly, we did not find a relationship between tenure or research activities of HET and their pedagogical innovative uses. However our model shows that Computer and Internet Skills, Effective use of ICT and Facilitations conditions play a prominent role in the innovative pedagogical use of ICT by HET in Tunisia. Findings imply that the e-learning competencies of teachers in Tunisia must be strengthened in order to reach optimal use.

Key words: Internet Usage, E-competences, Structural Equation Model, ICT attitude, Use pattern, Tunisia, PLS path modelling.

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Introduction

Innovation is the main engine of economic and social development (Schumpeter, 1954). It foster economic growth, improves human well-being and impacts social interactions. Information and Communication Technologies (ICT) considered as General Purposes' Technologies (Bresnahan and Trajtenberg, 1995; Helpman, 1998) are facilitator of innovation. They are allowing firms to improve substantially their products and the linked services. At the same time ICT are allowing users to acquire better information, better learning and finally to innovate (Von Hippel, 2010). The new opportunities offered by these technologies lead some countries to invest hugely in order to improve the equipment and the use of these technologies within economic sector. Some developing countries like India are benefiting from these new opportunities.

The picture is different when we look at the Southern Mediterranean Countries. They are characterized by a low rate of innovation and weak economic growth compared to the desired rate (Aubert and Reiffers, 2004, FEMISE 2009). One possible way to improve the situation is to use fully the possibilities of these new technologies (Bellon and al. 2007). ICT may bridge the economic and social gaps with more developed countries (Especially European Union) and improve civil society to participate more on economic development. While the focus was on the equipment and usage questions (first and second order digital divides), several authors mentioned that the learning process associated to those technologies is as important as the question of equipment and usage (Hargittai, 2004; A. Ben Youssef, 2004). It's common to consider that the use of these technologies needs E-competences (i.e) "E-competence is the development of personal competences in the creative use of ICT" (Schneckberg and Wildt, 2006). Acquiring those competencies is neither evident nor easy and has a significant impact on the innovation process.

Universities play a prominent role in the diffusion of technological change and especially in the diffusion process of ICT (Goldfarb, 2005). Higher Education Teachers (HET) are supposed to be the key actor in education innovation and in the process of change. From their effective and innovative use depends the full exploitation of the potentials of these technologies.

Three complementary channels are considered for the role of HET. First, thanks to these technologies they may foster their research, scientific production and innovation. Innovation may be faster than in the past and may impact deeply on growth and productivity. Secondly, their ideas and knowledge creation may be shared more rapidly on society. Their externalities may be more important than in the past since they have powerful tools to publish and share their ideas, views and innovation. Thirdly, by using these technologies they impact on the achievement of their students. Students can benefit from the innovative use of ICT by acquiring e-competences and more appropriate learning. These channels seem to be active in most of OECD countries where learning processes in universities incorporate ICT and their innovative potential more and more. However, contrasting evidence is shown in the context of developing countries like South Mediterranean Countries where ICT are used as basic pedagogical tools without innovative power.

According to Drent (2005) the use of ICT can be regarded as "innovative" if it has the following two characteristics: firstly, the application of ICT facilitates student-centred learning: students can, to a large extent, influence their own learning by adapting the learning process to their own needs and interests. Secondly, there is a variation in the usage of ICT: different ICT applications are combined. When only one application is used, it is less likely that the HET had integrated the use of ICT in support of a student-oriented arrangement of education. Thanks to this process ICT helps the development of a critical spirit, to transform the traditional education vision of professor-expert and student-disciple by redefining the roles of each of these actors.

Starting from these observations, the aim of this article is to characterize the pattern of adoption and use of the main ICT by Higher Education Teachers (HET) in Tunisia and to understand how innovative this process is? We want to contribute to this debate by examining if the integration of this process is effective. We would like to know the kinds of interactions between Students and HET are induced by these technologies. And finally if the HET are using these technologies in order to innovate or not and what are the expected returns on the whole society.

Our article is structured as follows. Section two examines the theoretical background and surveys the literature about the role and the impacts of Academic staff on innovation. Section three presents the research methods and hypothesis. Section four presents the model. Section five discusses the main findings and results. Section six concludes.

2. E-competences in Higher Education and the Innovation Process

The concept of e-competence is widely used nowadays across many disciplines (economics, sociology, psychology, management sciences, education science) and in various contexts with several meanings and signification. Our purpose in this paper is not to discuss the foundation of the concept[2] but to discuss its importance in the process of innovation. We are going to restrict our selves to European Commission (2006) definition that refers to the ability to use fully and critically ICT. This process leads the development of personal competences in the creative use of ICT (Schneckenberg and Wildt (2006).

According to Steyaert and De Haan (2001) we can distinguish three levels of e-competences: instrumental competences, informational competences and strategic competences. Instrumental competences are the basic skills in order to use ICT like…Informational competences are the skills of acquiring information…Strategic skills refers to the ability of using the in a proactive way.

It's important to mention that our focus is at the individual level and not organizational level. First, Higher education Teacher E-competences are embedded within a social and educational context. We refer to this as E-context. In fact, the equipment, the learning strategy of the higher institution…impacts the use of HET of ICT. There's a reciprocal link between E-comptences of HET and their E-context. Within their E-context they develop

[2] For a deep discussion of the concept in Higher Education see Schneckenberg and Wildt (2006).

Organizational E-competences (i.e) collective competences in matter of effective and innovative use of ICT. At the same time they strengthen their E-competences. In the present research we look only at the Individual e-competences.

The accumulation of E-competences is fundamental for the innovation process within a country. As we mentioned before at least three alternative channels may be used for this task.

We are going to present in this section the method and research design adopted in order to investigate the relationship between innovation and ICT uses by HET in Tunisian universities. Basically, two types of variables were discussed in the literature as regards innovative pedagogical use of ICT. The first set deals with socio-demographic characteristics as the main determinants in differences of innovative usage. However, the second set of variables discusses more sophisticated variables as ICT e-skills.

2.1. Socio-demographic characteristics

Gender

With regard to gender issues, some prior studies (Dahmani and Ragni, 2009; Gefen and Straub, 1997; Ono and Zavodny, 2005; Kay 2006) revealed that there is a difference between the males and females in using various types of technologies. Liaw (2002) investigated gender differences in individual adoption and sustained pedagogical usage of technology. His findings indicate that males have more positive perceptions toward computer and Web technologies than females. This is also consistent with the findings of Durndell and Thomson (1997) as they obtained that males have significantly better basic computer experience and are more positive about the computers than do females. Research has also found that males use computers more often than their female counterparts. Furthermore, according to Van Braak et al. (2004), male teachers reported that they integrate computers in their classrooms more often than female teachers. In addition, a study conducted by Thomas (2005) reveals that males are more conscious of the new pedagogical technologies than do females.

Age

Previous studies relating age and ICT use suggest that there is a strong relationship between age and the acceptance of innovation. The older the consumers are the more they develop negative attitudes towards new technologies (Harrison and Rainer, 1992). Moreover, in the case of the higher education sector, Russell et al. (2003) noted that, although New Qualified Teachers had higher technology skills than older teachers, they did not display higher levels of pedagogical technology use. The researchers provided two reasons. First, new teachers could focus on learning about how to use technology rather than on how to integrate technology in the content areas. Second, the first few years of teaching are challenging, and new teachers typically spend most of their time and energy in getting acquainted with curriculum and classroom management instead of technology integration. These findings were consistent with those obtained by Jennings and Onwuegbuzie (2001), who showed that younger teachers were found to be associated with more positive attitudes towards ICT use.

Position and Research activities

According to Osterlunda and Robson (2009), non-tenured teachers use less pedagogical ICT in their teaching than tenured ones. The authors explained this difference by their relative lack of experience compared to tenured-teachers. Research activities also play a significant role with regards to attitude toward pedagogical ICT use. Teacher who are pursuing their research activities are more comfortable with using technology. A reason for this is that teachers who used ICT in their research activities have more experience with these technologies and are more comfortable to use in their teaching. When we exclude demographic and socio-economic characteristics three main variables may influence the behaviour of teachers for innovative pedagogical uses of ICT: facilitating conditions, e-skills and, effective use of ICT.

2.2. Facilitating conditions, E-skills and Effective use as drivers of innovative pedagogical use of ICT

Facilitating conditions

Triandis (1980) defines facilitating conditions as "*factors that enhance or impede behaviour, such as perceived compatibility of the behaviour with the lifestyle, and the availability of resources necessary to perform behaviour*". In the particular case of the use of instructional technologies in teaching, this pertains to the availability and accessibility to the teacher of the necessary infrastructure (e.g. access to computers, adequate technical support given teachers). Recently, Lim and Khine (2006) revealed that teachers in their study had cited poor facilitating conditions as barriers to ICT integration in the classroom. Similarly, Ngai et al., (2007) and Teo, (2009) showed that facilitating conditions have a positive effect on attitude towards computer use. Among the types of support given to teachers, technical support was ranked highly on the list of factors that affect teachers' the implementation of technology (Williams, 2002). In related studies, Ben Youssef and Dahmani, 2008; Ben Youssef and Hadhri, 2009, reveal that appropriate organisational change in higher education is another key factor in the effective technology integration process. The study reveals substantive correlation between organisational change, technology access and use.

ICT skills

Competence can be defined in various ways. Basically, computer competences are "*being able to handle a wide range of varying computer applications for various purposes*" (Van Braak et al., 2004). Similarly, for Albirini (2006), computer competences refer to teachers' beliefs about their computer knowledge and skills. Moreover, several studies report that teachers' computer competence is a major factor for integrating ICT in teaching. Mooij and Smeets (2001) explain "*if teachers are not confident in their ability or competence to handle computers this may hamper their willingness to introduce technology in their classroom*". In an international study (Smeets et al., 1999 cited in Mooij and Smeets, 2001) it is also reported that the most important reason teachers give for not using ICT is that they are not familiar with ICT.

Effective use of ICT in teaching

The available research evidence clearly illustrates that the question of pedagogical ICT use cannot only be explained by referring to teachers' characteristics or ICT skills. Rather, it seems to be valid to shift the focus towards a broader debate about the effective use of ICT in teaching. Atan et al. (2002) found that teachers use pedagogical ICT innovatively when they have made frequent use of it. Hence, it was predicted that teachers who effectively use ICT are more competent in ICT compared to those with a lower rate of usage.

From the previous discussion we consider the following hypothesis in our model (see Box 1).

H 1a: Facilitating conditions have a significant impact on teachers' computer competences.

H 1b: Facilitating conditions have a significant impact on teachers' Internet skills.

H 2a: The computer competences of higher education teachers will positively influence their Internet skills.

H 2b: Computer competences have a significant impact on teachers' Web surfing.

H 2c: Computer competences have a significant impact on teachers' innovative pedagogical use of ICT. Teachers with high computer competences are more likely to use innovatively educational ICT.

H 3a: Internet skills have a significant impact on teachers' Web surfing.

H 3b: Internet skills have a significant impact on teachers' effective use of ICT. Permanent teachers are more likely to use effectively educational ICT.

H 3c: Internet skills have a significant impact on teachers' pedagogical innovative use of ICT. Teachers with high Internet skills are more likely to use educational ICT innovatively.

H 4a: Position has a significant impact on teachers' effective use of ICT.

H 4b: Position has a significant impact on teachers' innovative pedagogical use of ICT. Teacher who spent more time surfing the Web for non-pedagogical purposes are less likely to use educational ICT innovatively.

H5: Effective use of ICT and innovative pedagogical use of ICT are positively related to teachers' Internet skills.

H 6: Gender has a significant impact on teachers' innovative pedagogical use of ICT. Males are more likely to use innovatively educational ICT.

H 7: Age has a significant impact on teachers' innovative pedagogical use of ICT. Young teachers are more likely to use innovatively educational ICT.

H 8: Position has a significant impact on teachers' innovative pedagogical use of ICT. Tenured teachers are more likely to use educational ICT innovatively.

H 9: Research activities have a significant impact on teachers' innovative pedagogical use of ICT. Teacher-researchers are more likely to use educational ICT innovatively.

3. Hypothetical model and research methodology

Drawing on the previous discussion and hypothesis a research model is developed in order to help investigate the question that underpins this research. Figure 1 represents the structure of the hypothesised model of the research.

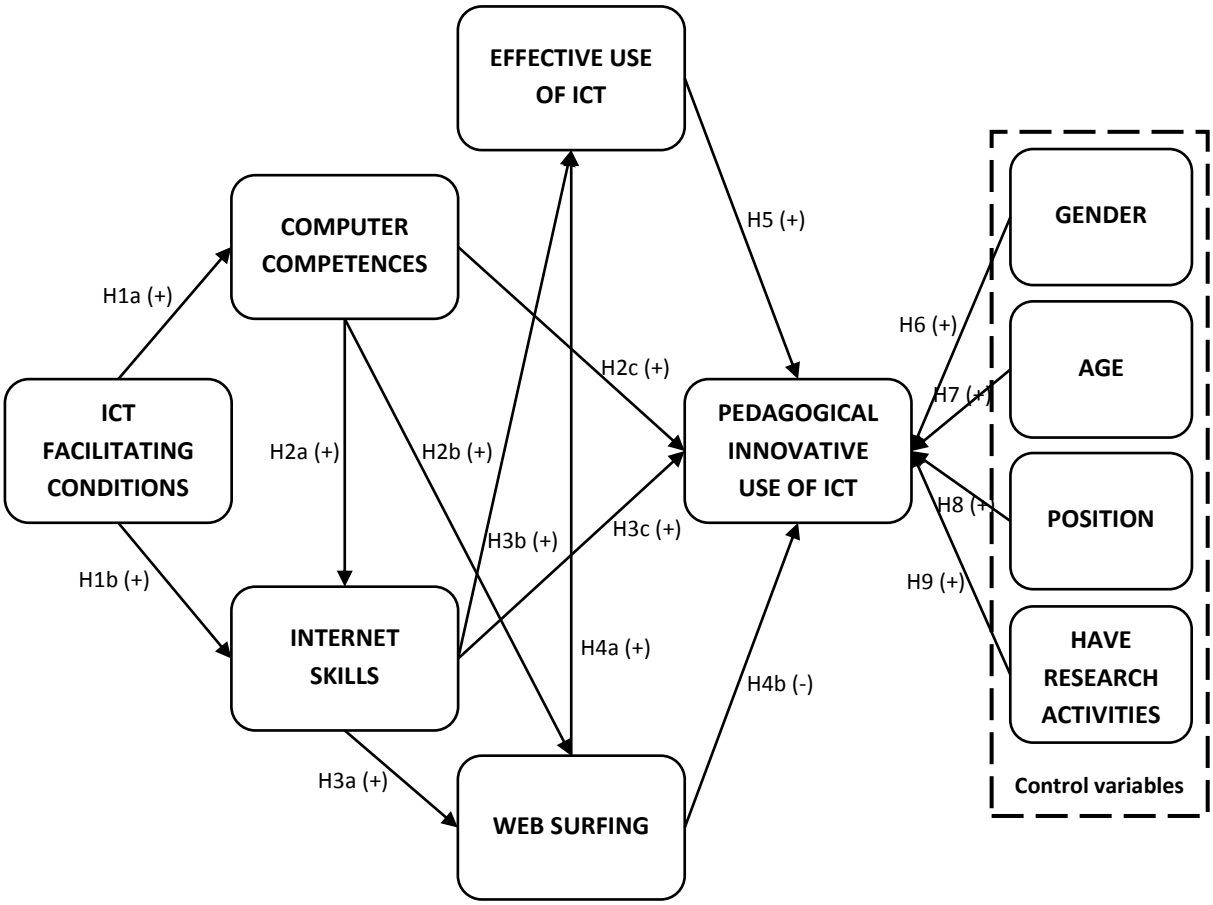

Figure 1 - The proposed theoretical model

3.1. Research design

This research employs a Partial Least Squares Path Modelling (PLSPM) approach to develop a model that represents the relationships among the ten latent variables in this research: position, gender, age, research activities, facilitating conditions, computer competences, Internet skills, Web surfing, effective use of ICT, and pedagogical innovative use of ICT. Model testing was conducted using XLSTAT 2010 and SPSS 18.

PLSPM technique was used here as it is particularly appropriate where there are many manifest and latent variables, when the need arises to link multiple correlated variables

through a limited number of observations, where some of the manifest variables are categorical, where distributions are non-normal and under conditions of heteroscedasticity (i.e. where the residuals on manifest and latent variables are correlated) and high degree of correlation between variables (i.e., multicollinearity) as it may happen with any survey dataset (Falk, 1987). This technique is especially developed for research that requires exploratory analyses. The strength of the PLS technique is that better predictions can be made about the interrelationships between factors in the real world, when no theoretical model is available. When research is aimed at confirmatory tests of a theoretically well-established path model, other methods like Amos or LISREL are more appropriate.

In this research preference was given to PLSPM over the other better-known structural equation modelling techniques due to two reasons. Fist, we have used in our survey numerous of dichotomous and ordinal variables. PLSPM employs the least squares method to obtain parameter estimates and, as a consequence, only minimal demands in measurement scales and residual distributions are required. Second, this research was conducted and the hypothetical model was developed *post hoc*. Thus many considerations and the nature of the analysis prompted to apply exploratory (prediction-oriented) rather than confirmatory (theory testing) methods of structural equation modelling (Chin, 1998).

3.2. Data collection and research participants

Data was collected by using a questionnaire comprising of questions on socio-economic characteristics and multiple items for each variable in the research. We used the survey approach, conducted via a Web-based questionnaire data-gathering technique. An electronic mail message, which explains the aims of the research and contains the link to the online questionnaire, was sent to respondents. The items of the survey were drawn from the literature. A pilot study of a group of 20 teachers was undertaken to ensure the items 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.

The research involved 288 higher education teachers of Tunisian universities (see table 1). Among the respondents in the research 51.74% (149 people) are female, and 48.26% (139 people) are male. A majority of respondents are in 26-45 age group. The most populated one is the 26-30 age group with 91 respondents (32.6%), followed by the 31-35 age group (25.69%) then the 35-40 age group (18.06%). The least represented one is the 55-60 age group with 7 respondents.

The distribution of respondents according to position and research activities is as follows: tenured (67.01%), non-tenured (32.99%), non-researchers (10.07%), junior researchers (47.22%), young researchers (22.57%), senior researchers (18.75%) and international experts (1.39%).

Table - Summary of teachers' characteristics

	Frequency	**Percent**	**Cumulative**

				Percent
Gender	Male	139	48.3	48.3
	Female	149	51.7	100.0
Age	20-25 years	3	1.0	1.0
	26-30 years	91	31.6	32.6
	31-35 years	74	25.7	58.3
	36-40 years	52	18.1	76.4
	41-45 years	33	11.5	87.8
	46-50 years	17	5.9	93.8
	51-55 years	11	3.8	97.6
	56-60 years	7	2.4	100.0
Position	Permanent	193	67.0	67.0
	Under contract	94	33	100.0
Have research activities	Non-researchers	29	10.1	10.1
	Junior researchers	136	47.2	57.3
	Young researchers	65	22.6	79.9
	Senior researchers	54	18.8	98.6
	International experts	4	1.4	100.0

3.3. Variables

Six variables were used in the model (see Table 2 for a full description of these variables). Manifest variables or items for the latent variables were chosen on a theoretical basis. The order of the variables in the hypothetical model was determined by our previous research in the area and a review of the literature.

Table 2 - Summary of the structure of latent and manifest variables

Latent variables (constructs)		**Manifest variables**	**Mean**	**Standard deviation**
Facilitating Conditions (FC)	FC1	Computer at university	0.552	0.497
	FC2	Computer at home	0.885	0.319
	FC3	Teacher laptop own	0.910	0.287
	FC4	Internet connection at home	0.934	0.248
	FC5	Internet connection at university	0.951	0.215
	FC6	Teacher ICT training	0.330	0.470
	FC7	Availability of ICT training	0.503	0.500
Computer Competences (CC)	CC1	Word-processing	4.424	0.830
	CC2	Reports production	3.066	1.382
	CC3	Spreadsheets applications	2.757	1.388
	CC4	Statistical and specific soft	3.198	1.230
	CC5	Data and multimedia soft	2.361	1.025

Internet Skills (IS)	IS1	Information and documentation	2.587	1.010
	IS2	Pedagogy and collaboration	1.781	0.926
	IS3	Communication	3.767	0.978
	IS4	Social networks	2.698	0.955
	IS5	Administration	2.497	1.127
Effective Use of ICT (EUI)	EUI1	Use of ICT in classrooms'	0.198	0.398
	EUI2	Use of ICT out of the classrooms	0.538	0.499
Web Surfing (WS)	WS1	Internet surfing	3.771	1.223
	WS2	Internet surfing for pedagogical purposes	2.635	1.135
Pedagogical Innovative Use of ICT (PIUI)	PIUI 1	Innovative use of ICT	18.20 5	5.937

Four control variables illustrating teacher profile (gender, age, teacher position and the fact that the teacher has research activities or not) were included as likely to directly impact on pedagogical innovative use of ICT (see table 1).

In the context of our study, building on the earlier discussion about the relationship between facilitating conditions and teachers' educational use of ICT, the facilitating conditions include the provision of computer and Internet connection at home and at university, ICT training given to teachers, etc.

Because of the exploratory nature of this research, the collected survey data were subsequently analysed on the basis of the Exploratory Factor Analysis (EFA) method. Two exploratory factor analysis using principal components factor extraction and Varimax rotation was conducted to identify items representing the two latent variables: computer competences and Internet skills.

The first principal component analysis (PCA) of the computer applications resulted in five factors with an eigenvalue larger than 1. The total variance explained by these factors is 65.71%, which in social sciences is generally regarded as satisfactory (Hair et al., 2006). The second PCA of the Internet applications resulted in five dimensions. The total variance explained by these factors is 62.43%.

For each of the ten dimensions resulted from the two PCA, a summated scale was created by combining all of the variables with high factor loading on the dimension, and the average score for the variables was used as to create manifest variables for computer competences and Internet skills variables. In order 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 0.7 or less generally indicates unsatisfactory internal consistency reliability (Malhotra, 1999). 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 collaboration dimension (0.56).

Table 3 - Results of principal component analysis

Factor	Eigenvalue	Percent of variance	Cumulative percent of variance	Cronbach's alpha
First PCA : Computer competences				
F1: Data and multimedia soft	5.699	31.661	31.661	0.821
F2: Statistical and specific soft	2.149	11.937	43.598	0.743
F3: Word-processing	1.539	8.550	52.148	0.701
F4: Spreadsheets applications	1.363	7.572	59.720	0.855
F5: Reports production	1.079	5.995	65.716	0.829
Second PCA : Internet skills				
F1: Communication	5.697	29.987	29.987	0.728
F2: Administration	1.843	9.701	39.687	0.782
F3: Social networks	1.774	9.335	49.022	0.777
F4: Information and documentation	1.531	8.060	57.082	0.732
F5: Pedagogy and collaboration	1.017	5.354	62.436	0.560

A variable, “effective use of ICT”, was created regarding to regular use and experience of ICT from inside and outside the classroom.

The variable, “Web surfing”, was measured on five-point scales by two distinct activities:

(1) Number of hours spent surfing the web for all purposes (Internet surfing); and

(2) Number of hours spent surfing the web for pedagogical purposes (Internet surfing for pedagogical purposes).

The two activities were measured by asking respondents to indicate the number of hours they spent in all online activities and in pedagogical activities each week. The scale for “Internet surfing” and “Internet surfing for pedagogical purposes” had five items: less than 1 hour per week; from 1 to 5 hours per week; from 6 to 9 hours per week; from 10 to 14 hours per week and more than 15 hours per week. Eight ICT applications, which are expected to support student-centred learning were identified in the teacher’s questionnaire (see Table 4). The variable “Pedagogical innovative use of ICT” consists of the sum score of these items.

Table 4: Applications underlying the latent variable "Pedagogical innovative use of ICT"

Items	Minimum	Maximum	Mean	Standard deviation
Webographie	1	5	3.55	1.243
InternetEvaluations	1	5	2.05	1.251
EducObjects	1	5	3.05	1.417
EducPlatforms	1	5	1.66	1.067
SeriousGaming	1	5	1.45	0.790
CollabAssign	1	5	2.35	1.277
OnlineStudyAid	1	5	2.20	1.222
Visioconferences	1	5	1.90	1.111
	Cronbach's alpha= 0.78			

4. Results

In this section we discuss the results of model testing, including scale validity and reliability and the results of our Partial Least Squares Path Modelling analysis.

4.1. Measurement model results

In order to check the properties of our measurement scales, confirmatory factor analysis (CFA) was conducted. The test of the measurement model includes the estimation of internal consistency reliability and the convergent and discriminate validity of the instrument items. All reliability measures (composite reliability and Cronbach's alpha) were well greater than the recommended level of 0.70 as an indicator for adequate internal consistency (Hair et al, 2006; Nunnally, 1978). The constructs also illustrated satisfactory convergent and discriminate validity. As suggested by Fornell and Larcker (1981) and Hair et al. (2006), convergent validity is adequate when constructs have an average variance extracted (AVE) of at least 0.5. Also, convergent validity can be examined when items loading are well above 0.5 on their associated factors as an indicator of adequate reliability (Hair et al., 2006). Table 5 provides a summary of the reliability and convergent validity of the final scales used in the research.

Table 5 - Summary of measurement scales

Constructs	Items	Loading	Composite reliability	Cronbach's alpha (α)	Average variance extracted (AVE)
Facilitating Conditions (FC)	FC1	0.92	0.95	0.79	0.89
	FC2	0.83			
	FC3	0.79			
	FC4	0.97			
	FC5	0.79			
	FC6	0.83			
	FC7	0.75			
	FC8	0.77			

Computer Competences (CC)	CC1	0.71	0.92	0.73	0.72
	CC2	0.96			
	CC3	0.97			
	CC4	0.88			
	CC5	0.90			
Internet Skills (IS)	IS1	0.96	0.83	0.74	0.96
	IS2	0.79			
	IS3	0.95			
	IS4	0.86			
	IS5	0.92			
Web Surfing (WS)	WS1	0.90	0.87	0.72	0.92
	WS2	0.87			
Effective Use of ICT (EUI)	EUI1	0.81	0.81	0.84	0.93
	EUI2	0.85			
Pedagogical Innovative Use of ICT (PIUI)	PIUI1	NA[a]	NA[a]	NA[a]	NA[a]

[a] Single item measure.

Table 6 provides the discriminant validity of constructs, with correlation among constructs and the square root of average variance extracted (AVE) on the diagonal (in bold). All indicators load more highly on their own constructs than on other constructs. All these results point to the convergent and discriminate validity of our instrument items (Chin, 1998).

Table 6 - Discriminant validity of constructs

Constructs	**FC**	**CC**	**IS**	**WS**	**EUI**	**PIUI**
Facilitating Conditions (FC)	**0.943**					
Computer Competences (CC)	0.433	**0.849**				
Internet Skills (IS)	0.829	0.619	**0.980**			
Web Surfing (WS)	0.201	0.242	0.240	**0.959**		
Effective Use of ICT (EUI)	0.476	0.375	0.594	0.343	**0.964**	
Pedagogical Innovative Use of ICT (PIUI)	0.577	0.531	0.755	0.157	0.639	NA[a]

[a] Single item measure.

4.2. Structural model results

The R^2 and the path coefficients indicate how well the model is performing. R^2 shows the predictive power of the model, and the values should be interpreted in the same way as R^2 in a regression analysis. The path coefficients should be significant and consistent with expectations (Chau and Hui, 2001). The PLSPM results are illustrated in figure 2 and summarised results for the hypothesis tests are shown in table 7.

Table 7 - Summarized results for the research path tests

Research path	**R^2**	**Standardized path loading (β)**	***t*-value**	**Hypothesis (supported?)**
Computer competences	0.189			
FC → CC		0.435***	8.176	H1a (yes)
Internet skills	0.759			
FC → IS		0.671***	20.779	H1b (yes)
CC → IS		0.337***	10.432	H2a (yes)
Web surfing	0.068			
CC → WS		0.142**	1.932	H2b (yes)
IS → WS		0.147**	1.998	H3a (yes)
Effective Use of ICT	0.393			
IS → EUI		0.539***	11.346	H3b (yes)
WS → EUI		0.218***	4.599	H4a (yes)
Pedagogical Innovative Use of ICT	0.653			
CC → PIUI		0.109***	2.351	H2c (yes)
IS → PIUI		0.533***	10.089	H3c (yes)
WS → PIUI		-0.110***	-2.789	H4b (yes)
EUI → PIUI		0.322***	7.059	H5 (yes)
GENDER → PIUI		-0.061*	-1.647	H6 (no)
AGE → PIUI		0.105**	2.391	H7 (yes)
POSITION → PIUI		0.045 n.s	1.038	H8 (no)
RA → PIUI		0.016 n.s	0.431	H9 (no)

* Path coefficient significant at the 0.1 level.

** Path coefficient significant at the 0.05 level.

*** Path coefficient significant at the 0.001 level.

n.s Path coefficient non-significant.

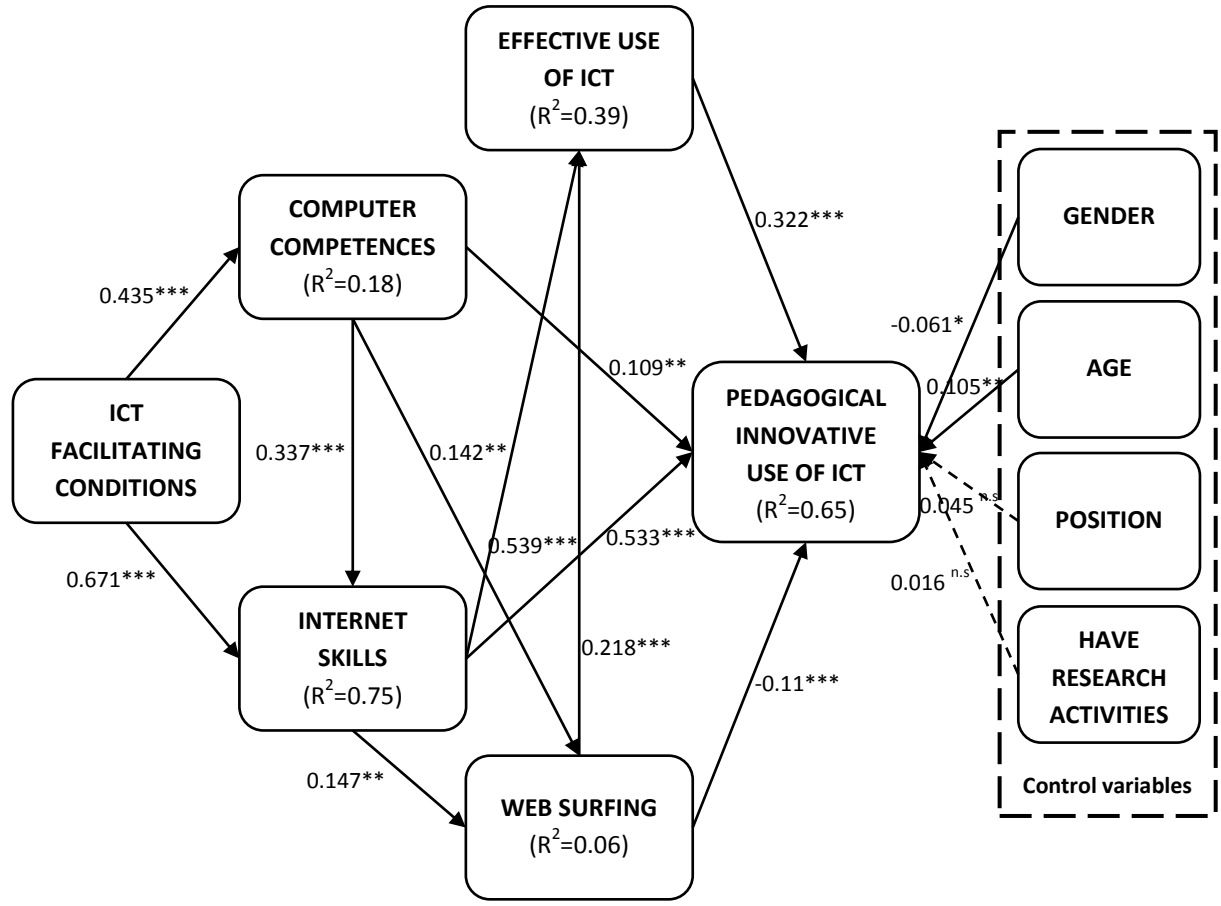

Figure 2 - Results of the structural model

The overall variance explained (R^2) by the research model was 0.643 which implied a satisfactory and substantial model. It was found that ICT facilitating conditions explain 18% of the variance in computer competences (CC). The path had positive effect, with path coefficient of 0.435. Meaning, hypotheses H1a was supported. ICT facilitating conditions and computer competences did have significant effects on Internet skills (IS) and together explain 75% of the variance. Computer competences and Internet skills influenced teacher attitudes towards Web surfing (WS), Internet skills and Web surfing explain 39% of effective use of ICT in teaching (EUI) with path coefficients of 0.539 and 0.218. As a result, hypotheses H2b and H4a were also supported.

5. Discussion of findings

Most of our theoretical expected hypotheses are supported by our findings. We are going to restrict ourselves to five main findings in matter of pedagogical innovative uses in HE

institutions in Tunisia explaining the trends and the key points that need to be considered in the future.

Gender Differences in matter of innovative use

Contrary to our expectation, the effect of gender on teachers' pedagogical innovative use of ICT is not confirmed. Although the path coefficient is statistically significant, the negative sign of the path implies that females are more likely to use innovatively educational ICT and not males. As a result hypothesis H6 was not supported and validated. Two alternative explanations of our findings may be given. First, most of HET in Tunisia are women. They carry more about the pedagogical value of ICT usage. They are more sensitive about the innovative power of ICT. Secondly and complementary to the first explanation, there are gender differences in matter of administration activities between women and wen in HET institutions in Tunisia. This led to less time dedication for the exploration and exploitation of the power of innovative ICT and their pedagogical values by men.

Tenure and Teacher Position

Surprisingly, teacher position and the fact that the teacher has research activities had no effect on teacher pedagogical innovative use of ICT, as shown by the two non-significant paths. As a result, hypotheses H8 and H9 were not supported. This is also a new result since most of the literature showed that teacher position and research activity matter. Ben Youssef and Hadhri, (2009) showed that in the context of French universities, the position of the teachers matter. The main explanation given is linked to the availability of ICT capital and dedicated computers in workplace. Most teachers who have tenure are well equipped and can utilize the technologies in classroom more efficiently. They have more dedicated learning sessions and are more implicated in e-learning classrooms. From their findings one can conclude that the equipment constraints in 2005 are not valid in the context of Tunisia in 2009. Moreover, innovative usage does not depend on the research activity. Usage of ICT in research activities did not seem to have any additional value for pedagogical activities. This suggests that the natures of usage are different and Teachers need to have more oriented usage in order to innovate in matter of teaching activities.

ICT Facilitations and Pedagogical Innovative Uses of ICT

In our model we found that ICT facilitating conditions explain 18% of the variance in computer competences (CC). The path had a positive effect, with a path coefficient of 0.435. This means that hypotheses H1a was supported and validated. ICT facilitating conditions and computer competences have significant effects on Internet skills (IS) and together explain 75% of the variance. These two factors had positive path coefficients of 0.671 and 0.337. From this result we can also support hypotheses H1b and H2a and we show that they are still valid. ICT Facilitations like organizational changes are necessary in order to encourage teachers to explore more efficiently the potential of ICT with confidence.

E-skills and innovative Pedagogical Uses of ICT

Basic Internet and Computer Skills are needed in order to efficiently use ICT. In order to reach innovative uses more skills are required. We found also that computer competences (CC) and Internet skills influence the teachers' attitudes towards Web surfing (WS). From this finding we can support hypotheses H2b and H3a. These factors had positive path coefficients 0.142 and 0.147 respectively and along with effective use of ICT, age and gender, explained 65% of the variance for the pedagogical innovative use of ICT. As suggested by hypotheses H2c, H3c, H4b, H5, and H7 computer competences, Internet skills, Web surfing, effective use of ICT and age influence HET pedagogical innovative use of ICT, with respectively the following path coefficients 0.109, 0.533, -0.11, 0.322 and 0.105. Internet skills and Web surfing explain 39% of effective use of ICT in teaching (EUI) with path coefficients of 0.539 and 0.218. As a result, hypotheses H2b and H4a were also supported. The relationship between e-skills and innovative usage of ICT suggests that an investment in acquisition of e-skills through more learning or more interaction between teachers and between teachers and students improve innovative usages. Here one can mention that most of training session for teacher is oriented for beginners and less for confirmed users in order to improve their innovative skills.

Effective Usage and Innovative Usage

Effective Usage of ICT may be interpreted as the intensity of usage of ICT. Internet Skills have a positive impact on effective use and effective uses have a positive impact on innovative pedagogical use. The link between Internet Skills and Effective usage of ICT also needs to be mentioned. In fact Internet Skills explains 53.9% of effective usage of ICT. The more a teacher has Internet-related skills, the more he uses them effectively. This effective usage induces innovative use.

7. Conclusion

Innovative pedagogical usage of ICT can be considered as a proxy of the full exploitation of the possibilities of ICT in Higher Education. Given the learning role of universities in matter of usage of technologies, in this article, we have tried to understand the level of innovation of ICT usage in Tunisia by considering a small group of HET.

Two unexpected results were found. First, a gender difference regarding the matter of innovative uses is not found in Tunisia. Female HET seem to more innovatively use ICT than males. Second, we did not find a relationship between tenure and innovative uses. This needs to be clarified because it may impact the incentives of Newly qualified Teachers to not invest in innovative pedagogical uses of ICT. At the same time, we found that age plays a marginal role in matter of innovative uses.

Our results show that e-competencies (Computer and Internet Skills) and ICT facilitations like organizational changes are necessary in order to innovate in matter of pedagogical uses. Any public strategy aiming at fostering these uses needs to take into account the role of training and especially training for innovative purposes. At the same time

Universities need to develop clear strategies in matter of ICT facilitations in order to improve innovative usage by allowing innovative HET to fully exploit their skills. It is important to note that HE Institutions should fully incorporate ICT in their own learning process by making processes more flexible, modifying attitudes and habits, and clarifying values.

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