

UNIVERSIDADE DE LISBOA

Instituto de Educação



Strategies for teachers' professional development: Fostering ICT  
proficient use

Pedro Manuel Ferreira Raposo Torres Brás

Orientadora: Professora Doutora Guilhermina Maria Lobato Ferreira de Miranda

Tese especialmente elaborada para obtenção do grau de Doutor em Educação  
(*Especialidade: Tecnologias de Informação e Comunicação em Educação*)

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## **Dedication**

To my father, Manuel, who I have lost along this journey.

To my mother, Nia, always there for me, my entire life.

To my wife, Nelia, my love, companion and support for almost a lifetime.

### **Acknowledgements**

I would like to acknowledge (without any order in particular) Escola Profissional Gustave Eiffel (Gustave Eiffel Professional School) that has always provided the conditions to develop my research projects.

Special thanks also to my advisor, Guilhermina Lobato Miranda (PhD), who became a friend, always available to provide advice and sometimes the little push towards the conclusion of this stage in my life.

A special acknowledgement to all the teachers that participated in the surveys and helped me to collect empirical data to my investigation.

Last but not the least, to my wife Nélia Nunes, for having the patience of maintaining our family lives partially “on hold” for so many years.

#### Notes:

1. This thesis was written in British English. However, some citations and/or references respect the original publication and, because of that, it may appear in American English.
2. All translations from non-English sources and references were made by the author.
3. All images or tables without a reference to a source were produced by the author.

### **Abstract**

Almost in third decade of the 21<sup>st</sup> century, with so many affordable or free technologies available, most teachers still don't use digital technologies in their scholar activities.

That was the focus of this entire research.

The problem and the questions we aimed to answer with the present research are related to the variables that revealed the strongest predictive weight in the most credible scientific models that try to understand the technology acceptance by teachers. To answer those questions, we carried on two separate studies: i) A first study, with a methodology similar to a "survey research" where we propose a new development in the Technology Acceptance Models; ii) A second study, with a methodology close to "design-based research", which proposes a model for the development of teachers' digital skills (in a quest for "Digital Proficiency").

The present research may be included in the scientific domain of technology acceptance and adoption theories and methodologies and the most credible scientific models look to identify the factors that foster the use of ICT in education (TRA, TPB, TAM, UTAUT). However, the variable "ICT skills" is not present in any of these models... Is that a neglectable factor? We believe that "ICT skills" is far from neglectable and we tried to develop a model that integrates this dimension, along with some other factors already present in the models from the available literature.

In the first study (the we have called "A new development in the Technology Acceptance Models") we searched the literature for the instruments already validated for the Portuguese reality, and we developed a new instrument, built over the reunion of 4 questionnaires, that was applied to teachers from all Professional Schools in Portugal (N=7293) and we received 444 complete answers, from 67 different professional schools.

We have named the model that emerged from this process, developed using the Structural Equation Modelling technique, “ISTTU model” (ICT Skills Towards Technology Use). We discovered that “ICT Skills” have a strong influence over “ICT Intention to Use” (the strongest predictor of “ICT use”). The structural model revealed that “ICT knowledge” was the factor that revealed the strongest effect ( $\beta=.63$ ;  $p<.001$ ) over the “Intention to use ICT”. The trajectory “Learning through ICT”  $\rightarrow$  “Intention to use ICT” was not significant ( $\beta=.10$ ;  $p=.037$ ).

Nevertheless, this model explained 45% of the variance, which means that other variables explain the remaining 55% and further field experience research is necessary to identify the other variables that may increase the variance explained by the ISTTU model: Effort Expectancy, Computer Anxiety, Perceived Usefulness, and Perceived Ease-of-Use. We believe, however, that first we need to provide teachers with adequate training, if we want them to be more willing to use the digital technologies in pedagogical contexts. The question is: how may we help them to develop these skills? Given the results and the conclusions of the first study, some questions have emerged: 1) Are online models suited to acquire digital skills? 2) Is online education (where digital skills are required) adequate to acquire “digital skills”? 3) Are online courses adequate to empower teachers to overcome their barriers to the use of digital technologies? 4) Will the use of Virtual Learning Environments (VLE) increase the will to use digital technologies in the classroom?

The second study (“A quest for “Digital Proficiency”) was developed to look for the answers to the questions that emerged from the first study, trying to mitigate (or eliminate) the barriers to the usage of digital technologies and empower the “average teacher” to proficiently use the common productivity applications and produce and share their own digital educational resources.

For the second study, we have chosen a more pragmatic approach and we developed: a) online courses that aimed to provide teachers with the skills to proficiently use some of the productivity Office programs (Excel, Word, PowerPoint) and resource production software (image editing, audio recording and editing, video recording); b) face-to-face workshops that targeted the same goals, but in a warmer and more informal environment, where fellow teachers and trainers (himself a teacher) were present and all doubts and questions could be immediately answered.

From the results of both studies, we discovered that teachers are able and willing to shift from “technophobic” to “consumers” and from “consumers” to “producers”, as long as we provide them with the adequate scaffolded training. We also concluded that: i) “ICT skills” is a non-neglectable predictor of “Intention to use ICT”; ii) The online models are not suited when ICT skills are the subject to learn; iii) A series of workshops is much more profitable in the first stage to overcome barriers and anxiety. After these workshops, online courses may be suited to learn specific technologies; iv) There are no significant gender differences regarding the use of digital technologies; v) Considering the “Teaching Area”, teachers from the technical areas are more predisposed to use digital technologies, but the good response from those of “social and cultural” areas when compared with the “scientific” area teachers was surprisingly positive; vi) The use of Virtual Learning Environments do increase the use of Digital Technologies, indeed. After this research we have proved to be possible to change the landscape of “ICT use” in a microscale. The question now is: “will it be possible for this model to disseminate, and how much time will it take to reach a widespread use of Digital Technologies in today's schools”?

Keywords: Digital Technologies, Technology Acceptance Models, Survey Research, Design Research, Structural Equation Modelling, ICT Skills, Multimedia Learning.





## Resumo

“Porque é que, no final da segunda década do Século XXI, e com tantas tecnologias disponíveis, de forma gratuita ou de baixo custo, os professores continuam a não utilizar as tecnologias digitais nas suas atividades diárias”? Esta foi a primeira questão que emergiu numa das conversas com a minha orientadora, e resume o tema central desta investigação.

O problema e as questões às quais tentámos responder ao longo do percurso investigativo relacionam-se com as variáveis que demonstram maior poder preditivo para explicar o que leva os professores a desejarem integrar as tecnologias na sua atividade docente.

Para dar resposta a esta temática foram desenvolvidos dois estudos: um primeiro estudo cuja metodologia se assemelha a uma investigação por questionário (que intitulámos “Um novo desenvolvimento para os modelos de aceitação da tecnologia”) e um segundo estudo cuja metodologia se assemelha a uma “Design-Based Research” (que intitulámos “Na procura da Proficiência Digital”).

Num primeiro estudo, no âmbito dos modelos de aceitação das tecnologias, aplicámos um questionário que foi disponibilizado a todos os professores de todas as escolas profissionais de Portugal (N=7293), tendo sido recebidas e validadas 444 respostas completas (depois de eliminadas as respostas incompletas e os “outliers”) oriundas de um total de 67 escolas profissionais.

Todos os modelos da literatura, relacionados com o uso das tecnologias na educação, procuram identificar os fatores que inibem ou fomentam o uso das Tecnologias Digitais na Educação: São os casos da “Teoria da Ação Racional”, Teoria do Comportamento Planeado, Modelo de Aceitação da Tecnologia (três versões), Teoria Unificada de Aceitação e Uso da Tecnologia. No entanto, as “Competências Digitais” não estão

presentes em nenhum destes modelos. Será que este fator não é importante ou é negligenciável?

Para estudar estas questões procurámos na literatura os modelos e instrumentos existentes, validados para a realidade Portuguesa e já utilizados em Portugal. Em nenhum destes instrumentos, no entanto, a componente “Competências Digitais” estava presente. Assim, optámos por isolar e traduzir a secção “Conhecimento Tecnológico” do questionário relativo ao modelo TPACK (que é composto pelas componentes Pedagógica, Tecnológica e de Conteúdo), daí resultando um instrumento que inclui: i) O questionário sobre as atitudes e “Perceções de Computadores e da Internet” (Liaw, 2002); ii) O questionário de Implementação de Tecnologias (Wozney, Venkatesh & Abrami, 2006); iii) A secção “Conhecimento Técnico” do questionário do modelo TPACK (Mishra & Koehler, 2006); e iv) O questionário de “Uso da Tecnologia” (Luzio, 2006).

O instrumento que resultou da integração dos questionários anteriormente referidos foi sujeito aos procedimentos de validação, daí resultando um modelo (denominado ISTTU - Competências Digitais para o Uso da Tecnologia), desenvolvido através da técnica das equações estruturais, tendo o modelo fatorial resultante revelado índices de ajustamento com valores considerados “muito bons”. Este modelo foi refinado através dos índices de modificação e o seu ajustamento foi assegurado pela fiabilidade individual. O modelo foi então validado, tendo sido assegurada a sensibilidade, validade e fiabilidade de cada um dos fatores.

Os resultados deste modelo revelam que as “Competências Digitais” são um forte preditor da “intenção de uso das TIC”, constituindo esta (e isso já sabemos da literatura) o mais forte preditor do “Uso das TIC”.

De facto, o modelo de medida para as variáveis latentes revelou uma excelente

qualidade de ajustamento, tendo o modelo estrutural explicado 45% da variância total da “intenção de uso das TIC” e que a variável “Competências Digitais” foi a que revelou maior peso fatorial no modelo ( $\beta=.63$ ;  $p<.001$ ). Já a trajetória “Aprendizagem através das Tecnologias” sobre a “Intenção de Uso das Tecnologias” não é estatisticamente significativa, e com baixo peso fatorial ( $\beta=.10$ ;  $p=.037$ ) o que revela que as pessoas declaram ser indiferente a forma como desejam aprender a utilizar as tecnologias digitais (modelos pedagógicos online ou presenciais).

No entanto, tal como referido anteriormente este modelo ISSTU explica apenas 45% da variância da “Intenção de Uso das Tecnologias”, o que significa que existem outras variáveis que explicam 55% dessa variância. A descoberta dessas variáveis e a sua integração neste modelo, será necessária para a continuação do seu desenvolvimento, podendo nele ser incluídas variáveis como a “expectativa de esforço”, “ansiedade computacional”, “perceção de utilidade”, “perceção de simplicidade de uso”, entre outras.

Percebemos ainda que: i) nos dias de hoje, o género não tem qualquer influência nos modelos que desenvolvemos, revelando não existirem diferenças significativas entre homens e mulheres no que toca ao uso das tecnologias; ii) os professores das áreas técnicas (como seria expectável) estão mais predispostos em termos de “intenção de uso da tecnologia”; iii) No entanto, foi algo surpreendente a resposta positiva dos professores da componente sociocultural, tradicionalmente menos predispostos ao uso da tecnologia, especialmente em comparação com os docentes da área científica; Este é o motivo pelo qual concluímos que devemos, primeiramente, proporcionar a formação adequada para a aquisição das “competências digitais” e, então, esperar que os professores usem as tecnologias digitais de forma proficiente.

Deste primeiro estudo, e das conclusões que retirámos, ponderámos ainda duas

questões, mais laterais, mas que podem ser igualmente importantes: 1) Será que os modelos online serão adequados para que os professores incrementem as suas competências digitais de que possam necessitar? 2) Independentemente da dispersão geográfica (em que os modelos “a distância” são os mais adequados) será apropriado utilizar mecanismos TIC (que evocam o uso de competências digitais) para proporcionar competências digitais? 3) Serão os cursos “a distância” suficientes e adequados para que os professores superem as barreiras à utilização das tecnologias digitais e se sintam capacitados para produzir os seus próprios Recursos Educativos Digitais? 4) Fomentar o uso de Ambientes Virtuais de Aprendizagem poderá aumentar o uso das tecnologias digitais nas práticas docentes, em sala de aula?

O segundo estudo, que adota uma metodologia próxima da Design-Based Research, foi desenvolvido para tentar dar resposta aos resultados e às questões que emergiram no primeiro estudo, procurando contribuir para mitigar ou eliminar as barreiras à utilização das tecnologias digitais, e encorajar o “professor comum” a utilizar proficientemente as aplicações de produtividade mais comuns e capacitá-los para produzir e partilhar os seus Recursos Educativos Digitais.

O passo seguinte consistiu em determinar qual a forma mais adequada para proporcionar essas competências aos professores, em termos de modelo de formação? Realizar “cursos online” ou “formação presencial”? A opção não era simples e, desse modo, optámos pelas duas vias.

Assim, foram desenvolvidos vários cursos online que tinham com intenção proporcionar uma utilização proficiente das tecnologias digitais, tanto em aplicações do tipo “office” (Excel, Word, PowerPoint) como aplicações para produção de recursos (edição de imagem, gravação e edição de áudio, gravação e edição de vídeo).

Por outro lado, foram concebidos e implementados workshops que visavam as mesmas

competências, mas num ambiente “mais informal e acolhedor” onde colegas e formador (que era igualmente um colega) estavam presentes fisicamente e onde as questões e dúvidas podiam ser resolvidas no imediato.

Os resultados desta fase de implementação permitem-nos concluir que, no que respeita às tecnologias digitais, é possível os professores passarem de “tecnófobos” a “consumidores” e, depois, de “consumidores” a “produtores” de recursos educativos digitais. Para isso, será necessário proporcionar-lhes a formação e o suporte adequados, numa progressão suficientemente “andaimada” e sustentada no tempo.

Desta fase conclui-se igualmente, que os modelos “a distância”, pelo menos em ambientes totalmente em e-Learning, não são adequados quando o que se pretende adquirir são precisamente “Competências Digitais”. Neste aspeto, as séries de workshops revelaram melhores resultados, pelo menos numa primeira fase.

Curiosamente, numa segunda fase, concluímos que os cursos em “b-Learning” ou em “e-Learning” podem ser adequados para a aquisição de competências em aplicações informáticas específicas.

Concluímos ainda que o uso dos Ambientes Virtuais de Aprendizagem incrementou o uso das tecnologias digitais. O objetivo final da fase de workshops era a produção de recursos e a sua partilha com os alunos. O “incentivo extra” que resultou da publicação dos recursos na plataforma virtual e a partilha com os alunos (objetivamente verificável através do acesso às disciplinas dos professores, na plataforma, com direitos de administrador) provou ser um elemento determinante para o sucesso das ações.

No final desta investigação temos que concluir que a variável “Competências Digitais” não negligenciável, e pode ser a peça que faltava para despoletar o “uso das tecnologias”.

Com este trabalho provámos que é possível alterar o panorama da utilização das

tecnologias digitais numa escala “micro”. A questão que emerge, agora, é: será este modelo passível de ser replicado e amplamente disseminado e quanto tempo vamos ter que esperar até atingir uma utilização alargada das tecnologias digitais na escola contemporânea?

Palavras-Chave: Tecnologias Digitais, Modelos de Aceitação de Tecnologia, Investigação por Questionário, Modelação por Equações Estruturais, Design Research, Competências Digitais, Aprendizagem Multimédia.

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## **Introduction**

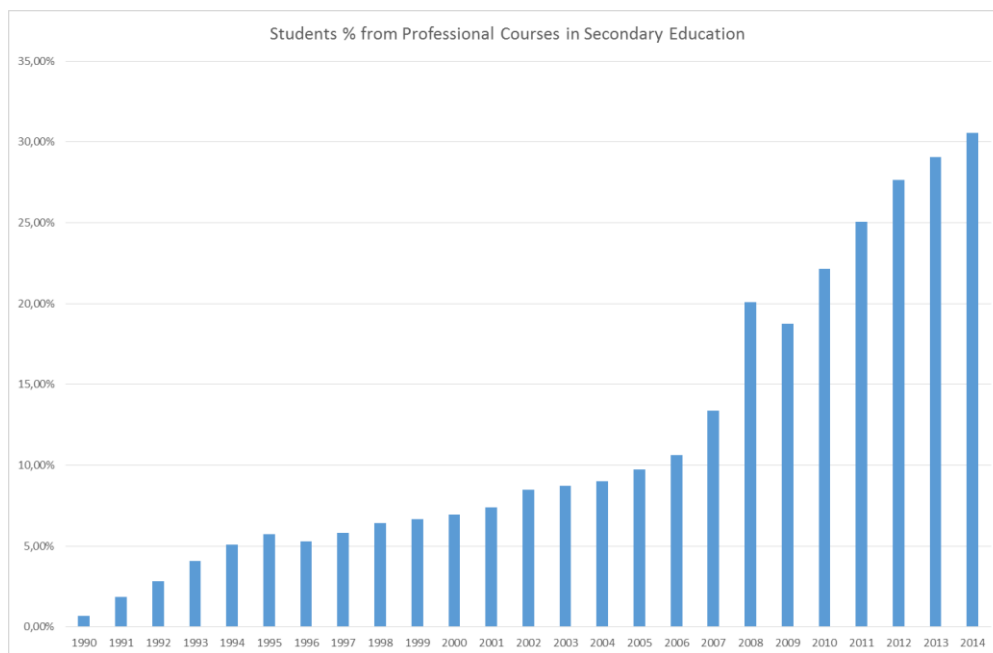
### **Theme and relevance**

#### **General framework.**

The vocational stream of secondary education (called “professional education”) was created in Portugal in 1989 (decree-law 26/89, published on January, 21<sup>st</sup>), following the general policies published in the Portuguese Education Act (Lei de Bases do Sistema Educativo - Law 46/86, published on October 14<sup>th</sup>). After several studies were published it became very clear that Portugal lacked the intermediate qualified workforce that disappeared after the elimination of technical education that occurred in the aftermath of the revolution that implemented a democratic regime in Portugal, in 1974. Such need was clear both to the government and to the enterprises that operated in Portugal and was first expressed at the economic and social framework document in the context of Portugal’s admission to the European Economic Community, in 1992, after a five-year period that prepared that integration. With that goal in mind, the Portuguese government created GETAP (the Governmental Cabinet responsible for the “Professional, Artistic and Technological Education” as a vocational stream of secondary education), through the Decree-Law 397/88, of November 11<sup>th</sup>. The professional courses should allow students to obtain a professional qualification, recognised across Europe, that would facilitate the transition to the labour market and simultaneously grant an academic secondary degree that allow them to proceed to Higher Education (DGEEC-MEC, 2016, p.24).

The first structural action from GETAP was to publish the legal framework (decree-law 26/89, published on January, 21<sup>st</sup>) for the creation of the “Professional Schools” in which this new stream of secondary education was tested and implemented in Portugal. In October of 1989, about 50 “Professional Schools” were created, resulting from local initiatives, both public and private, with some 2,088 students, a mere 0.67% of

all students in secondary education in that year. Nowadays (and the most recent data available is from 2014), “professional education” has a much more significant number of students (117,699), which is about 31% of all the students in secondary education. This is due mostly to the fact that secondary public schools accepted and integrated this type of courses and may can observe its sustained growth, which is more significant after 2008 (Figure 1).



*Figure 1. Evolution of % of students in Professional Secondary Education.*

Source: PORDATA, the Portuguese contemporary database.

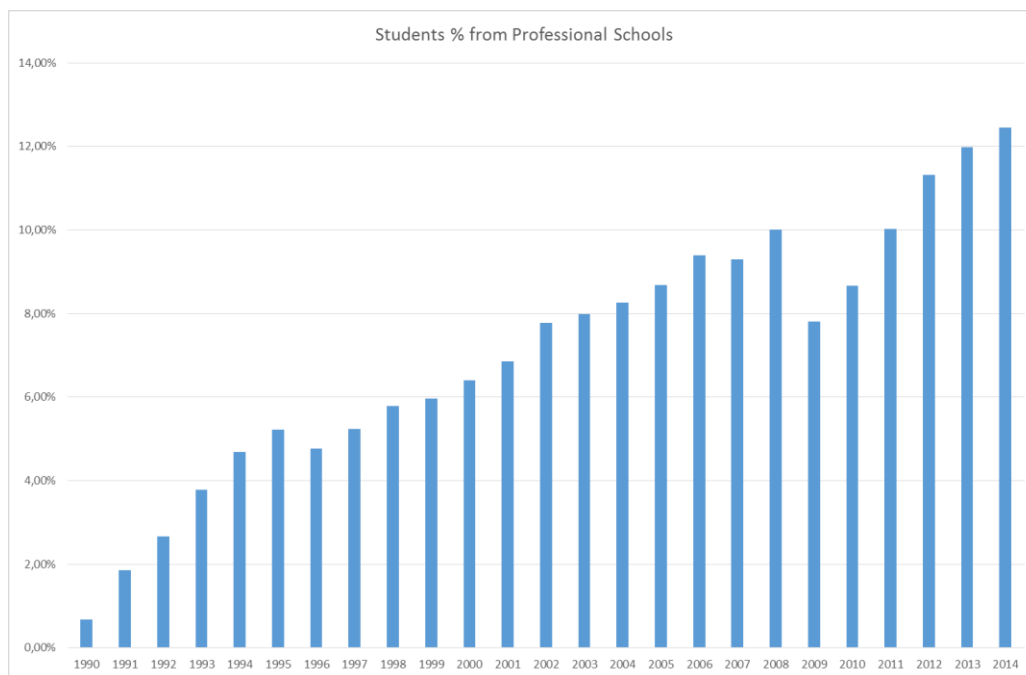
### **Professional Education and Professional Schools.**

A brief introduction is needed to help to point out the difference between “professional education” and “professional schools”. From 1989 to 2004 these two concepts were not distinguishable, as professional courses were exclusively carried out at “professional schools”, that is, the schools created according to the original GETAP model, from 1989.

In 2004, however, following some international commitments assumed by the

Portuguese government, it was necessary to significantly increase the number of students in that stream, and the “professional courses” model was extended to the secondary public schools. The result of that decision is reflected in Figure 1 and we can perceive that, from 2007 to 2014, the number of students in “professional courses” increased about 2.5 times (we will call it “professional education” and includes both public and private schools).

The “professional schools” had, obviously, a longer history and differentiated practices and results. In 2014, a total of 225 “professional schools” were still active (204 in continental Portugal, 17 in Azores and 4 in Madeira) with some 47,969 students, that represent 12.5% from all secondary education (Figure 2).



*Figure 2. Evolution of students' share of Secondary Education, in Professional Schools.*

Source DGEEC-MEC (2016).

The evolution of the student's ratio in “professional schools” compared to all secondary education in general, shows it sustained growth, although smaller than all professional education (with a small “glitch” in 2009).

According to DGEEC-MEC (2016), a department of the Portuguese “Ministry for

Education and Science” responsible for statistics in education, we know that, in 2014, the Portuguese Professional Schools have 6,002 teachers, distributed as follows (only continental Portugal data is available, as Azores and Madeira have autonomous governments and data from these regions is not available in national statistics)<sup>1</sup>:

Table 1.

*Teachers' regional distribution.*

Continental area					Azores	Madeira
North Region	Central Region	Lisbon Metro Area	Alentejo	Algarve		
37%	24%	23%	7%	1%	8%	n.a.

*Note:* Latest data available (2014)

From Table 1 we observe that: a) 37% of all teachers is located in the North of Portugal, typically a more industrial region; b) Lisbon Metropolitan Area is equivalent to all central region; c) The number of teachers in the South of Portugal (Alentejo and Algarve) is almost residual with 8% combined (same as Azores). Unfortunately, Madeira's regional data is not available. These may be good indicators for the regional distribution of professional schools, in terms of number and activity.

In Professional Schools, teachers are grouped in three main areas as presented in Table 2 (only continental Portugal data is available):

Table 2.

*Teachers from Professional Schools (by area).*

Area	Number of Teachers	Percentage
Social and Cultural	1566	26%
Scientific	1352	23%
Technical	3084	51%

*Note:* Latest data available (2014).

<sup>1</sup> Previous statistical data (2010) reported a grand total of 7 293 teachers - this reduction was due to a 25% reduction in the hours of contact for all professional courses (3600h to 2700h - DL139/2012, July 5<sup>th</sup>).



This distribution is aligned with the weight of each area in terms of “classroom hours” in the typical structure of professional courses (social and cultural: 25%; scientific: 25%; technical: 50%).

Considering the number of students, the overall student distribution, by region, is presented in Table 3:

Table 3.

*Student distribution by region.*

Continental area							Azores	Madeira
North Region	Central Region	Lisbon Metro Area	Alentejo	Algarve				
38%	21%	26%	9%	1%		5%	n.a.	

Note: Latest data available: 2014

In terms of Region and Educational Area, student distribution is presented in the table 4:

Table 4.

*Students from Professional Schools (by region and educational area).*

Professional courses by educational area	Continental area					Azores	Madeira
	North Region	Central Region	Lisbon Metro Area	Alentejo	Algarve		
Arts	19,6%	10,4%	21,8%	6,2%	13,2%	2,9%	-
Humanities	0,3%		0,4%	0,3%		1,3%	-
Business sciences	22,0%	12,5%	15,6%	16,2%	20,4%	15,9%	-
Law	0,7%	1,5%	0,1%				-
Computer sciences	8,2%	7,3%	10,0%	6,9%	15,1%	11,8%	-
Engineering	14,7%	20,1%	14,1%	20,7%		17,4%	-
Transforming industries	4,0%	0,8%	0,6%	2,9%	2,6%	4,6%	-
Architecture and building	0,5%	0,7%	0,5%	1,3%		7,3%	-
Agriculture and fishing		2,5%	0,2%	4,2%		7,5%	-
Health	6,0%	5,1%	3,2%	2,6%		3,3%	-
Social services	3,0%	7,0%	13,4%	11,1%	16,8%	7,6%	-
Personal services	19,0%	30,1%	16,1%	25,0%	31,9%	13,7%	-
Transportation	0,2%		0,9%	1,3%		1,2%	-
Environment protection	0,8%	0,5%	0,6%	0,5%			-
Security services	1,0%	1,5%	2,5%	0,8%		5,5%	-

Note: Latest data available: 2014.

### **Vocational Education and Training.**

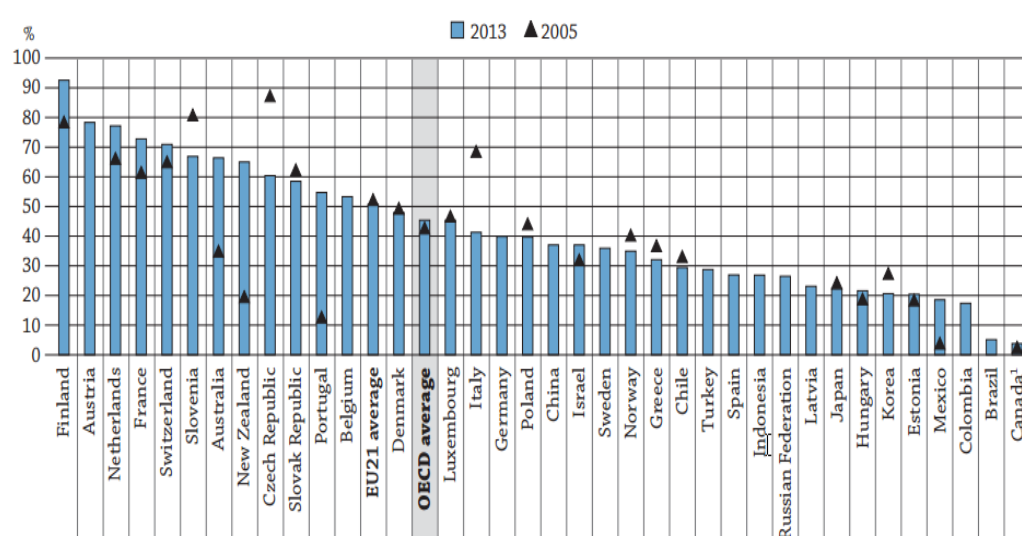
Most developed countries have more than half of their secondary education students in vocational streams (OECD, 2009, p. 12) and that was a goal defined by the Portuguese government in recent years. Depending on how “industrial” a society is, the increase of Vocational Education and Training (VET) may pay off in the labour market, as for-the-job skills are more difficult to readily acquire at the workplace. Although most companies often provide in-site training, it is far more efficient to develop job-relevant competencies before entering the labour market.

The practice in Professional Schools, in Portugal, started with the curriculum, most of it designed by specialists from the professional schools, in close interaction with companies. The courses were conceived within a generic framework designed to provide young people with the skills that support citizenship, 21<sup>st</sup> century interaction, occupational mobility and lifelong learning, and with the specific skills that meet the employers' immediate needs. This framework organises subjects in three main areas: a) “social and cultural area” (Languages, Philosophy, etc.); “scientific area” (Mathematics, Physics, Economy, Psychology, etc.) and “technical area” (subjects for each specific professional area - tourism, electronics, computer programming, business and administration, design, etc.).

In this model, three very important features should also be remarked as distinctive elements: a) the frequent participation of experts coming from enterprises that allows schools to be up-to-date with the labour market demand and with the state-of-the-art technologies available at these companies; b) the mandatory professional internship that allows students to engage in a professional environment before going into the labour market; c) the encouragement of part-time teachers that have a professional occupation in course-related areas, to increase the interaction between the school and the industry

demands.

**Chart A2.2. Trends in vocational upper secondary graduation rates (2005 and 2013)**



1. Year of reference 2012 instead of 2013.

Countries are ranked in descending order of vocational upper secondary graduation rates in 2013.

Source: OECD. Table A2.4. See Annex 3 for notes ([www.oecd.org/education/education-at-a-glance-19991487.htm](http://www.oecd.org/education/education-at-a-glance-19991487.htm)).

*Figure 3. Global trends in vocational secondary graduation rates.*

Source: OECD (2015).

It becomes visible from Figure 3 the remarkable score of Portugal in the vocational stream of upper secondary education. In fact, the conclusion rate increased from 12% to 55% in only eight years, positioning Portugal above OECD and EU21 average, ahead of countries like Denmark, Germany, Norway, Sweden, Japan or Canada (OECD, 2015, p. 52).

### **The Research Blueprint**

Most Professional Schools are well equipped in terms of computers and educational technology resources in general, both in terms of quantity and quality. However, as in many other countries, there is a general feeling that these resources may not be fully used by teachers and students as one would expect. There are many doubts that teachers systematically use digital technologies in their practices and it is necessary to understand the reasons for (not) using those technologies in the classroom. That is a

problem that needs to be addressed by creating solutions and studying their impact. This thesis aims to document that process in three stages:

1. A first study, called “A new development in the Technology Acceptance Models”, was based on the models available from the literature, that aims to develop a new model in order to:
  - a. Determine teachers' attitude towards technology (computers and Internet);
  - b. Determine teachers' ICT skills level;
  - c. Identify the obstructing factors that inhibits teachers' ICT use;
  - d. Determine teachers' acceptance level regarding online training courses;
  - e. Measure the impact of ICT skills over the attitude towards technology.
2. A second study, “A Quest for Digital Proficiency”, which consists in the design and implementation of training actions (in two modalities) that aims to:
  - a. Improve ICT proficiency;
  - b. Empower teachers to create and share Digital Educational Resources;
  - c. Increase the use of Virtual Learning Environments (VLE) in teaching activities, as a way to share resources with students;
3. Conclusions and future directions.

### **Theme.**

The aim of this thesis is to identify and investigate the questions and problems related to the following areas:

- a) Teachers' professional development regarding digital technologies;
- b) Instructional models, production of Digital Educational Resources, and Virtual Learning Environment;
- c) Online learning in school organisational environments.

Despite these underlying themes, this thesis is particularly focused on “teachers’ professional development and ICT skills”. The other two dimensions are complementary and instrumental as we look for answers.

### **Social relevance.**

As previously stated, in 2014, “professional schools” in Portugal, had a share of 12.5% of the students in secondary education. Nevertheless, no scientific studies involving this empirical field are available, that allow us to characterise this stream of secondary education, created almost 30 years ago. We have contacted ANESPO, the association that represents most Professional Schools in Portugal, in order to make them aware of the project and the intention was received with enthusiasm. Thereafter, ANESPO contributed by promoting the importance of gathering information about Professional Schools and how they handle ICT integration, among local teachers and governance bodies. It was important to collect a relevant number of answers to the questionnaire. The email answer received from ANESPO is presented in appendix B.

Moreover, we believe this study has social relevance as it addresses a problem that transcends the Professional Schools and is shared by the entire educational system, from kindergarten to higher education.



## **Chapter 1. Literature Review**

### **Information and Communication Technologies**

The concept of Information and Communication Technologies (ICT), considered strictly in educational terms, may be considered as being part of the Educational Technology, something that exists from ancient times and encompasses a wide range of artefacts that helps teachers to teach and students to learn.

Defining ICT and describing its history and evolution in the second decade of the 21<sup>st</sup> century is not only redundant, it is unnecessary. However, considering that some of the readers may not be familiarised with the evolution of ICT in education, particularly in Portugal, we will limit this introduction to a small characterisation of the term and a short description of the most important historical facts that lead us to the point where we stand, nowadays.

ICT in education is understood as “the tools and the processes to search, access, save and retrieve, organise, manipulate, produce, interchange and present information using digital technologies (computers and software) and telecommunications” (adapted from Sunkel, 2006, p. 3). As Costa (2007, p. 16) refers, “usage of the technological means, in education, has essentially two different approaches: one that supports teachers' communication and the processes involved in knowledge transfer; other that suggests its importance in supporting and organise students learning”. What we aim to develop in this study is the way to incorporate ICT in teachers' practices, in all dimensions suggested by Costa, as they are both valid and contribute to incorporate ICT in education. In fact, as Moreira defends, “what we can discuss are the ways, goals, approaches and processes to incorporate media to school's reality” (1998, p. 1).

That is the scope of the present research.

**ICT in education: the Portuguese instance of the story (made short)**

In a study about ICT in education in Portugal, it is mandatory to refer the projects that shaped the Portuguese reality, configuring the “Portugal’s ICT geography”. From the historical perspective, the first mention should be made to the “MINERVA project” (an acronym, in Portuguese language, for “computer media in education: rationale, enrich and update”), implemented between 1985 and 1994 to promote ICT introduction in non-superior education in Portugal (Ponte, 1994, p. 3). As the author refers:

The major objectives of this project, as stated in the education ministry order 206/ME/85 that officially created it, are:

- a) the curricular inclusion of the teaching of information technology;
- b) the use of information technologies as teaching supports for other subjects;
- c) the training of coaches, trainers and teachers.

All levels of education were included in the project’s scope, from kindergarten to the 12<sup>th</sup> grade, and we recommend the curricular use of information technology in all subjects (general and vocational), instead of creating new specific subjects for direct teaching of computer sciences and its applications (Ponte, 1994, pp. 6-7).

Although that was the suggested path, corroborated by many researchers afterwards (Sutton, 2011, p. 46), the reality was somewhat different. In fact, courses as “ITI” (Introduction to Information Technologies) and, later, “ICT” are completely the opposite of Ponte’s proposal. Still, the decisive contributions of the MINERVA project may have been a proposal to break with the conventional teaching methods, aiming to introduce Information Technology in all courses and starting a cycle of continuous equipping effort that still lasts today.



In 1994, in the MINERVA project final report's conclusions, Ponte refers that:

(...) The tools are not important - it's what you can do with it that matters. Its interest relies mainly on fostering new forms of creativity. Over the last nine years, action and reflection cycles raised by the introduction of information technologies have been a very significant factor to transform schools in Portugal. It is an experience whose balance sheet is certainly positive, claiming an adequate continuity (Ponte, 1994, p. 54).

The continuity suggested by Ponte was assured by two other projects that coexisted in time.

The first project was the «Nónio Século XXI» project, between 1996 and 2002, which had two components:

- 1) Equipping schools with digital equipment ("to provide basic and secondary education schools with multimedia equipment and follow up with appropriate teachers' training, directed to full-time teachers, aiming to develop the installed potential");
- 2) The production and application of ICT in education, organised in four sub-programs:
  - a) Application and development of ICT in education;
  - b) Training in ICT;
  - c) Creation and Development of Educational Software;
  - d) Information Dissemination and International Cooperation.

Another objective was the educational dissemination of the Internet, by supporting the availability of web servers that provided the appropriate hosting to websites and its related services (e.g.: e-mail).

The second project was the "Internet in Schools" program, organised by the

Ministry of Science and Technology, which took place between 1997 and 2003, coordinated by UARTE (Educational Telematics Network Support Unit), and aimed to install a multimedia computer in all libraries of primary and secondary schools. It also provided internet access via ISDN land telephone lines (with speeds of 64 Kbps, the best speed available at that time). For this program a key contribution was provided by FCCN - National Foundation for Scientific Computing, which financed and developed the technological infrastructure through the RCTS network (Science, Technology and Society Network).

Afterwards, the ECRIE (Computers, Internet Networks in School) project was launched between 2005 and 2008, with a mission to design, develop, implement and evaluate the initiatives to integrate computers, networks and the Internet use in teaching and learning processes, in schools. In May 2007, it was approved the Technological Plan for Education (PTE) declared to be "the greatest technological modernisation program of Portuguese schools" (PTE 2011, ¶ 1) and "a unique effort in school's technological infrastructure, providing the content and online services to strength teachers and students ICT skills"(PTE 2011, ¶ 2). This plan presents itself as "an opportunity to transform Portuguese schools into interactive and sharing spaces without barriers, preparing new generations for the challenges of the knowledge society" (PTE 2011, ¶ 3).

The PTE was inspired by the "European Union Lisbon Strategy" and had three thematic lines of action (Technology, Content and Training) and a fourth transversal axis (Investment and Finance), comprising several measures:

- a) High-speed Internet;
- b) Local Area Networks and Internet in the classroom;
- c) e.school, e.teacher, e.opportunities;
- d) e.kindergarten;

- e) Technological kit;
- f) ICT support centre for schools;
- g) S@feSchool: video surveillance and alarms;
- h) School portal;
- i) School administrative simplification (the “simplex programme”);
- j) ICT skills;
- k) ICT internships;
- l) ICT academies.

In May 2008, the Portuguese Government created the “Educational Resources and Technologies Team for the Educational Technology Plan” (ERTE / PTE) being assigned with the responsibility to design, develop, implement and evaluate the initiatives to mobilise and integrate the use of technologies and Digital Educational Resources in teaching and learning processes in schools, operating in the following areas:

- a) ICT curricular integration in primary and secondary education;
- b) Promoting and boosting the scholar usage of computers, local area networks and the Internet;
- c) Design, production and deployment of Digital Educational Resources;
- d) School guidance and monitoring to support activities carried out by Competence Centres in Educational Technology and the Centres ICT Regional Support.

These centres, as expressed in "C2TI - Lisbon University (Institute of Education)" webpage, had the mission to provide "the coordination and integration of research and training in ICT educational contexts, making that knowledge available to the educational community" (C2TI 2011, ¶ 1).

It should also be mentioned the initiative “School, Teachers and Laptop

Computers", although the impact on the Professional Schools (the empirical field of our investigation) was residual. This project, directed only to public schools (thus excluding the Professional Schools, almost all private), "allowed the process of equipping schools of 2<sup>nd</sup> and 3<sup>rd</sup> cycles of primary education, and secondary education in continental Portugal, with a total of 27,711 laptop computers"(Ramos, 2009, p. 12). We only refer that program in this document because we consider the possibility that some of teachers from public schools, involved in this project, may have had some kind of collaboration with Professional Schools, something that happened along the almost 30 years of coexistence of the two subsystems.

The current perspective is the "2015 Educational Program" an intermediate point in the goals of Iberian-American States Organisation for 2021, that Portugal subscribed. This program, targets are defined in terms of educational and school equipping policies but, more importantly, opens finally the door of Lifelong Learning, which is the cornerstone for teachers' professional development. This statement may emerge as a crucial element to change teachers' practices. In order to promote student learning, "ICT usage" requires time, effort, availability and willpower.

Nowadays, we may consider that Portugal has never had so much equipment in terms of ICT in schools. The practical results of this action remain to be seen, apart from the obvious fact that schools have been flooded with equipment that soon will be obsolete...

This goal is far from being achieved and the reasons may be:

- a) The fact that ICT integration is not a compulsory requirement to obtain teaching qualifications;
- b) The lack of digital proficiency that may enable teachers to overcome their own ICT usage difficulties;

- c) The insufficient weight given to “ICT knowledge” and “ICT training” in pre-service teachers' education;
- d) The inadequacy of lifelong training programs, often built for career progression purposes, rather than providing the professional development that teachers need to improve their skills and job performance;
- e) Improve teachers' attitude towards technology, albeit behaviour is not determined only by the attitudes of individuals, but also by social norms, habits, and behaviours expected consequences (Gross, 2010; Triandis, 1971).

In 2009, Usun suggested that “Teachers need support and training to positively integrate technology into their classroom and teachers' attitudes toward ICT may be a significant factor in the implementation of ICT in education” (p.331).

### **ICT integration in classroom**

Digital technology in classroom has been an omnipresent discussion topic throughout time, involving those with responsibilities in the definition of educational policies. Today, even with the exponential growing of free (or low-cost) available technologies, it is more or less consensual that we are still far from what we would expect. As Miranda (2007, p.48) points out “The effective use of technology in classroom and the use of Virtual Learning Environments is still a privilege of a few students and teachers”. In fact, the technological progress of the last thirty years has made even clearer the resistance that has always existed in the adoption of technology by teachers and its integration in the classroom. Although technology is available like never before, the most common teaching method is "Chalk and Talk" (Watts & Becker, 2008, p. 283). These authors, discussing the situation in the United States, as a result of nationwide surveys conducted in 1995 and 2000 about teaching of economics, concluded that the prevailing teaching methods are still "Chalk and Talk", although in recent years there has been a

slight increase in the use of technology, imposed by young people when assuming faculty positions. Nevertheless, we should not underestimate the inertia force that leads academics to stay in the track of "Chalk and Talk". Or, as Moran (2005, p. 69) emphasises "we put the technology in universities and schools but in general, we continue to do the usual - the teacher talks and the students listens - now with a veneer of modernity. The technologies are used by teachers to illustrate contents, instead of creating new educational challenges."

It appears, therefore, that the use of technology is not universal in the classroom, nor do we foresee that it will be in the near future. It is necessary to work not only in the tools' usage, but also in the conceptual models that allow teachers to use the tools that allows them to improve both teaching and learning processes.

The introduction of technology in the classroom and the revolution of the school's concept is a subject that has over a hundred years, as claimed by Swail & Kampits (2001, p. 2) referring to the predictions of Thomas Alva Edison about the cinema applied to schools. Indeed, Edison foresaw the replacement of books by cinema, and other thinkers in the same line could foresee the replacement of teachers by television or video cassette recorders. More than a century later, we can only smile about it, as we know how dramatically all these predictions failed. Similarly, some would be tempted to predict that the introduction of ICT in classrooms is just a trend that, in time, will also be abandoned. However, it does not seem to be the case, not only for reasons related to the wide technological offer and its obvious application in schools, but mainly due to the democratisation of the access to technology, which allows the reuse of produced materials with low effort. That means cost savings and therefore more efficiency in the processes. This is of supreme importance as the changes are imposed from the outside to the educational system. In fact, this democratisation led to a key transformation: most of

today's students craving for digital technologies. Thus, teachers' use of technology, rather than an imposition from school administrations, is a requirement from the "customers", i.e., the students.

Moreover, the introduction of Information and Communication Technologies in the classroom is considered by some authors as one of the supporting pillars of future schools. Authors like Prensky (2001, p. 1) designate today's students as "digital natives". According to the author, these students, born and raised in an environment where technology is ubiquitous, are not able to imagine a world without it. They require a different approach from school in order to make learning interesting and appealing. This may be, indeed, an issue as there may have been a transformation of the student's brain (Prensky, 2001). This author, quoting Dr. Bruce D. Perry, from Baylor College of Medicine, states that the life experiences of today's students have the consequence that their brains process the information differently from the students who preceded them:

It is now clear that, as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors. These differences go far further and deeper than most educators suspect or realise. "Different kinds of experiences lead to different brain structures", says Dr. Bruce D. Perry of Baylor College of Medicine. (...) it is very likely that our students' brains have physically changed - and are different from ours - as a result of how they grew up. But whether or not this is literally true, we can say with certainty that their thinking patterns have changed. (p.1)

According to Prensky, these "brain changes" (whether or not taken in a literal way) cause that digital natives thinking patterns may have changed when we compare it with previous generations. As the author points out, today's students have mastered the

"digital language" resulting from computers, video games and the Internet. On the other hand, continues Prensky, digital natives:

- i. Are used to receive information very quickly;
- ii. Are able to perform "parallel processing and multitasking", mimicking what they see on computers since they were born;
- iii. Prefer graphics rather than plain text;
- iv. Prefer the random access that gives them the hypertext;
- v. Work well in a network;
- vi. Need for instant and frequent compensation;
- vii. Prefer games to "serious work".

Prensky (2005) adds that school, in the formal educational perspective, is becoming irrelevant to students who relocate to "after school" non-formal education, their preparation for the 21<sup>st</sup> century challenges.

This is something that, according to Prensky, today's school is not prepared to deal with: "If our schools in the 21<sup>st</sup> century are to be anything more than holding pens for students while their parents work, we desperately need to find ways to help teachers integrate kids «'technology rich after-school lives» with their «lives in school»" (p. 13).

According to Prensky, this is a problem that today's teachers, called by the author as "digital immigrants", cannot ignore. Similarly, the higher education institutions, responsible for initial and post-graduate education for teachers, cannot overlook these considerations when aiming to prepare teachers that will work with that population. And still "As we educators stick our heads up and get the lay of the 21st century land, we would be wise to remember this: If we don't stop and listen to the kids we serve, value their opinions, and make major changes on the basis of the valid suggestions they offer, we will be left in the 21st century with school buildings to administer - but with students



who are physically or mentally somewhere else" (Prensky 2005, p. 13).

This catastrophist and radical vision may be disputed, starting with the rather arguable dichotomy "Natives vs. Immigrants". In our opinion, being a "digital native" does not necessarily imply technological proficiency, and being a "digital immigrant" does not necessarily imply being "technophobic" or adverse to technologies. The real picture is far from a black or white scenario, and there is a continuous scale with an endless set of grey tones in the middle, that we would prefer to call "digital proficiency scale", in which each person is positioned. This assumption is valid for both students and teachers. Additionally, it is equally arguable that this may be the fundamental cause of all the problems that today's school faces, as it seems to be a global issue and the result of recent social changes. Hence, we consider not to assert peremptorily that:

“It is amazing to me how in all the hoopla and debate these days about the decline of education in the US we ignore the most fundamental of its causes.

Our students have changed radically. Today's students are no longer the people our educational system was designed to teach” (Prensky, 2001, p. 1).

Although this statement is common sense, as students have changed even in recent years, we should not "close the perspective" as this opinion of Prensky is disputed by many other authors.

A characterisation of the various generations in the 20<sup>th</sup> century (Oblinger & Oblinger, 2005, p. 2.9) may help us understand some of the issues raised by today's students.

	<b>Matures</b>	<b>Baby Boomers</b>	<b>Generation X</b>	<b>Net Generation</b>
Birth Dates	1900–1946	1946–1964	1965–1982	1982–1991
Description	Greatest generation	Me generation	Latchkey generation	Millennials
Attributes	Command and control Self-sacrifice	Optimistic Workaholic	Independent Skeptical	Hopeful Determined
Likes	Respect for authority Family Community involvement	Responsibility Work ethic Can-do attitude	Freedom Multitasking Work-life balance	Public activism Latest technology Parents
Dislikes	Waste Technology	Laziness Turning 50	Red tape Hype	Anything slow Negativity

*Figure 4. Characterisation of the various generations of the 20th century.*

Source: Oblinger & Oblinger, 2005, p. 2.9.

Although some designations presented in figure 4 may not be directly transposable to the Portuguese reality (e.g. the “Baby Boomers”), we can accept that the designation of the current generation, dubbed as the “Net Generation” (NetGen) can be generalisable to the entire western society, as a corollary of the mass usage of the Internet and the social and economic transformation called “globalisation”. In the absence of further or better characterisation of the so-called “Net Generation” (or NetGen) we can accept that current students in vocational education have similar characteristics to those referred in figure 4.

Oblinger (2008, p. 18) draws our attention to the most significant aspect of the NetGen: “digital comfort” does not mean “digital proficiency,” particularly when dealing with the use of digital tools in school. It is rather disappointing, unlike what would be expected from the point of view of young people’s digital comfort, to find students who are not able to enter a basic formula in Excel or use a Wiki. In fact, ICT and digital technologies must be treated as mere tools and, as we know, tools have no meaning without the content and the context that sustain its use. That is the reason why, even with

this caveat, the factors resulting from the "likes" and "dislikes", as presented in Figure 4, should be taken into account when we reflect about "education for the NetGen".

### **Education for the "NetGen".**

While some authors advocate a revolution in education is necessary, others are not convinced this is the way to proceed. Bennett, Maton & Kervin (2008, p. 783) point out that the capabilities of young people in the use of technology are far from uniform:

We may live in a highly technologized world, but it is conceivable that it has become so through evolution, rather than revolution. Young people may do things differently, but there are no grounds to consider them alien to us.

Education may be under challenge to change, but it is not clear that it is being rejected.

The time has come for a considered and disinterested examination of the assumptions underpinning claims about digital natives such that researchable issues can be identified and dispassionately investigated. This is not to say that young people are not engaged and interested in technology and that technology might not support effective learning. It is to call for considered and rigorous investigation that includes the perspectives of young people and their teachers, and genuinely seeks to understand the situation before proclaiming the need for widespread change" (Bennett, Maton & Kervin, 2008, p. 783).

Other authors recommend not to paint a monolithic picture when looking at digital natives, as if they were an experienced generation, knowledgeable and enthusiastic about technology (Law, Pelgrum & Plomp, 2008, p. 93). Within this generation we find some people who grew up with technology that are, in fact, quite proficient. But many others reveal a severe lack of confidence towards ICT, which lead us to consider that not all "digital natives" are a homogeneous generation of proficient ICT users. Not even close.

Diana Laurillard (2007, p. 5) argues that "Teachers should be free to respond critically as well as creatively to these technologies, but they cannot afford to ignore them if they want to engage with their learners". In fact, there is a structural change caused by the introduction of new technologies in education, with the student as a central element in the learning process, transforming a teacher into a "coach", a facilitator that selects information and guides students' access to knowledge (Swail & Kampits, 2001, p.2).

However, the concept of "active teaching", first presented by Hattie in 2009, reminds us about the consequences of the teacher's actions as an activator, instead of a facilitator (Hattie & Yates, 2014, p. 73). By comparing the effect sizes (Cohen's  $d$ ), the Hattie & Yates determined that the effect on students' learning and achievement of an "activator" teacher is far more significant than the effect of a "facilitator" teacher (table 5).

Table 5.

*Effects of "teacher as an activator" vs "teacher as a facilitator".*

Teacher as activator	$d$	Teacher as facilitator	$d$
Reciprocal teaching	0.74	Simulations and games	0.32
Feedback	0.72	Inquiry-based teaching	0.31
Teaching students self-verbalization	0.67	Smaller class sizes	0.21
		Individualized instruction	0.20
Meta-cognition strategies	0.67	Problem-based learning	0.15
Direct instruction	0.59	Different teaching for boys and girls	0.12
Mastery learning	0.57		
Goals—challenging	0.56	Web-based learning	0.09
Frequent effects of testing	0.46	Whole language—reading	0.06
Behavioural organizers	0.41	Inductive teaching	0.06
Average activator	0.60	Average facilitator	0.17

Source: (Hattie & Yates, 2014, p. 73)

We classify these results as good and reliable, although they were somewhat disputed by other investigators (mainly the mathematicians) who identified some possible inaccuracies in the visible-learning reported results, mainly because Hattie reported in 2009 the Common Language Effect Size, instead of the "Cohen's  $d$ " Effect Size

(something that was corrected in 2014). Hattie's visible-learning theory clearly demonstrate the advantages of an active and guided instruction (that clearly states the requirements and the success criteria for students, and provides frequent feedback about their progress and performance) when compared with the unguided, facilitative, 'helping' teaching actions, which relies on inductive problem-solving processes and separate solutions.

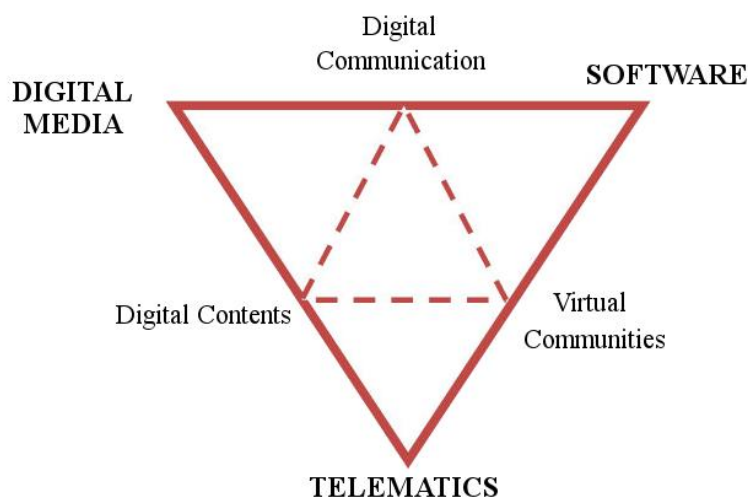
Active teaching is mostly about teachers' self-assessment, reflecting on the best way to improve student learning, and investing time and effort in the actions that may have the best impact on students' achievement:

- a) Understanding teacher's impact on students and perfecting their actions, assuming the role of a "changing agent" over students' behaviour and academic performance;
- b) Defining clear goals (objectives to attain) and showing what success looks like (success criteria);
- c) Transform student errors in opportunities for all to learn and evolve;
- d) Invest on teacher-student relationships, being a reliable agent at students' eyes, developing positive relations in the classroom and at school;
- e) Provide feedback on students' performance, so that they may correct their actions, in time;

There are several ways to implement this concept of active teaching, inducing adjustments in teachers' behaviour, as suggested by Hattie (where the effects on students' learning and achievement are higher), and some of them are related to the creative use of digital technologies to foster students' learning and achievement.

Despite many criticisms made to faculty's immobility on the adoption of ICT, we may be witnessing a change in teachers' behaviour, as many teachers already respond

with creativity and critical sense to the adoption of ICT in the classroom, allowing more consistent pedagogical approaches that meet the aspirations and needs of students in the digital age. This "digital pedagogy" in the words of Tomé (2009, p. 792) is based on the constructivist and constructionist theories of Seymour Papert and Mitchel Resnick, developed at the Massachusetts Institute of Technology, following the constructivist and social constructivist theories of Piaget and Vygotsky. Tomé suggests that a new educational paradigm should be founded in digital pedagogy, citing "Interactive Communication Systems", a concept first presented by Correia & Tomé (2007) that goes far beyond the traditional approach of ICT, suggesting the creation of a visual model, as shown in Figure 5:



*Figure 5. The double triangle model: Interactive Communication Systems.*

Source: Adapted from Correia & Tomé (2007).

The outer triangle considers the model's infrastructural aspects, which the authors described as "traditional ICT". The inside triangle presents the pillars of an "educational model" that aims to take full use of today's digital infrastructure to design educational applications using Educational Technology. Thus, the promotion of the use of these systems is an imperative to all teachers, not only due to reasons related to the demands

and needs of today's students, but especially because these technologies may be a structural element for improving teachers' professional performance. All three pillars in the inner triangle are equally important, if we want to have teachers that are "Fluent in Information Technologies" (FIT). According to Moore, Moore & Fowler (2005, p. 11.1), the National Research Council of the United States concluded that fluency in information technologies is an imperative requirement nowadays. Similarly, in Portugal, Decree-Law number 240/2001, of 30<sup>th</sup> August, approves the general profile for professional performance for teachers, for all non-superior grades (K-12: from kindergarten until the end of secondary education – 12<sup>th</sup> grade). This legal instrument states that a teacher "uses on different situations, and adequately incorporates in learning activities different languages and different media, including information and communication technologies, promoting the acquisition of basic skills in the latter area" (Annex - III.2.e, page 5570 of the legal instrument). We would say that using ICT is not an optional behaviour: it is a clear legal obligation to incorporate ICT in school activities of teaching and learning. Should all teachers be Fluent in Information Technologies (which, obviously, is not the case), the use of ICT would always be a necessary, but not sufficient, requirement. It is essential to reflect on the adequate way to incorporate technology, preventing it from being just an element of distraction and disturbance, becoming an effective facilitator for students' learning. According to the authors, this FIT requirement is a "state of mind", necessary to communicate to the NetGen that can be characterised as follows:

- 1) They have an online life;
- 2) They use instant communication mechanisms;
- 3) They have networked social lives;
- 4) They prefer games and simulations;
- 5) They possess digital literacy.

According to these authors, the NetGen can intuit how a certain device or software works simply by observing it, and that observation alone creates an innate predisposition to use it. Yet, although they may be considered as digitally fluent, they demonstrate some difficulties to use technology consciously, lacking the skills needed to find reliable information on the Internet, for example. This is not a prerogative for students only, as it is possible to verify equivalent constraints in faculty members. Some of the conclusions of this investigation are aligned with the initial perception of this research: today's students are mostly FIT, but they lack the abilities and denote serious difficulties in selecting and organising reliable information. Moreover, most teachers are less FIT than students, but they have the critical thinking that empowers them to overcome that lack of FIT. This deficit has to be worked out over time, from a professional development perspective, because teachers must to be able to respond to these challenges.

In the document "Educating the Net Generation", Oblinger & Oblinger suggest teaching practices to foster engagement of the NetGen in school activities: "Defining what constitutes faculty development is an important first step. Expertise should be developed, not just in how to use technology or in pedagogical practice, but also in how to understand learners and how they perceive technology" (2005, p 1.1). That means that is not enough to refer to "faculty professional development", although this is one of the first steps to overcome teachers' lack of "FITness". It is also necessary to reposition the pedagogical practices, not only through the integration of technology in the teaching activities, but also through the understanding of how today's students deal with technology and how its integration may induce additional motivation in our students.

Be that as it may, ICT integration in teaching and learning processes are, nowadays, a teaching fundamental vector, without which the school will lose its attractiveness for students. Indeed, in the words of Costa (2004, p. 25), "when directly



asked about the subject, students are indeed particularly critical of the role of schools and teachers at least in terms of facilitating the work with your computer". Costa (2004, p 26), for example, questions "how far are our schools willing - and able - to deal with this problem and lead the changing process itself".

### **NetGen as teachers.**

It is somehow predictable that the Net Generation, once in the teaching positions, and as a corollary of an initial or postgraduate course, can materialise the changes in the educational system, as advocated by the authors previously cited. In fact, Miranda (2007, p 44) concluded that:

"The effective use of technology in schools, particularly in classrooms and in Virtual Learning Environments is still a privilege of some teachers and students. (...) Still we need to rethink technologies (...) as a domain, as important as all other domains that already exists in schools. This would create a generalised use of technology in education. Or, perhaps, in a pessimistic (or realistic) look, we must wait for the momentum of the generations born in the "information society" era, because, according to Arendt (2005), novelty is (and must be) brought by new generations. This is the natural and cultural flow and destiny of mankind".

This argument is founded on the poor adherence of teachers, in general terms, on the integration of ICT in their teaching practices. The lack of resources is no longer a reason for not using technologies, as it is now clear a continuous effort to equip schools with ICT resources, at a dizzying pace. The succession of plans that aimed to reequip our schools just confirms that one of the essential conditions for the integration of ICT in teaching practices has been completed. However, Miranda (2007, p. 44) considers that "Research has shown that the strategy of adding technology to existing activities in

school and in classrooms, without changing the usual teaching practices, does not produce good results in terms of students' learning (cf. De Corte: 1993; Jonassen: 1996; Thompson, Simonson & Hargrave: 1996)".

Thus, the complex variable of this equation is yet to be solved: "Changing teaching practices towards the integration of ICT".

The reasons beneath the non-use of technologies may be: a) the fact that most teachers have not obtained the basics ICT skills in initial training; b) the fact that teachers generally do not have "digital expertise" to autonomously overcome difficulties. So, concludes Miranda (2007, p. 48), this is a reality that will only change with the arrival of new generations to faculty positions. It is also necessary to see what happens when the availability of material resources and educational technologies in schools converge with the arrival of the NetGen to teaching duties.

If the NetGen were born in 1992 (Oblinger & Oblinger, 2005, p. 2.9) they would be arriving to faculty positions now. So, what are the beliefs of these students in relation to technology and its role in teaching activity?

In "Digital natives as preservice teachers: what technology preparation is needed?" Lei (2009, p. 89) summarises a study on beliefs of future teachers about technology. In this study, he concludes that participants fall into the "digital natives" category (using Prensky's terminology), because:

- a) Regarding access to technology: an overwhelming majority of participants (94%) has a history of access to personal computers since the 6th grade; 94.5% have an MP3 player; more than half of them (54.4%) have more than five devices incorporating technology. These results match the characteristics of the "digital natives".

- b) Regarding the time spent on computers: all participants (100%) work with computers on a daily basis and, of these, 76% spend more than four hours using a computer. In overall terms, 86% spend more than two hours a day using a computer, which also sets the participants as "digital natives".

So, considering that no information is available on NetGen as teachers, let us accept that this study may open a window to observe the beliefs of preservice teachers belonging to the NetGen. In this case, it would be expected to observe the “divide” that Prensky advocated and the results could not be more surprising. In fact, these so-called "digital natives":

- a) Revealed to have strong convictions regarding the usefulness of technology, but a moderate confidence and a reserved attitude about its use in education;
- b) They use technology predominantly (80%) for social purposes and only 10% for activities related to learning and teaching;
- c) They are proficient with basic technologies, but are not familiar with technologies related to teaching (Teaching Related Technologies) such as, for example, the use of interactive whiteboards or specific software programs;
- d) Although familiar with the Web 2.0 (and 58.2% of these students have profiles on social networks), they do not bind their existence and widespread use to education, and only a very small the number of participants actually consider themselves experts, for example, in audio production podcasts, creating blogs, image editing, video production or Wiki development.

The reason that may explain these findings is that most people live their entire lives being just information “consumers” instead of being information “producers”.

When we look for the reasons that justify these results, we may follow various lines of reasoning. If we consider the reserved attitude towards the use of technology in

the classroom, it is legitimate to consider that we are in the presence of a typical attitude from digital natives towards "work" because, as Presnky observed, "they prefer games to serious work" (2001, p. 2). In fact, digital natives are "information consumers", and just a small segment can be labelled as "information producers".

On the one hand, we can perceive that digital natives have a mature view of the difficulties related to the use of technology in the classroom, which may indicate that, after all, digital natives may not be active technology users in the classroom. On the other hand, the fact that they use social Web 2.0 technologies but do not even consider an educational application of these tools. Such may reveal that, during initial training, they may have never been confronted with concrete situations where their teachers actually used technologies. Nevertheless, digital proficiency (at least in terms of basic skills) of digital natives allows us to assume that this would not be a serious problem to overcome. In terms of not using digital equipment in the classrooms, such as interactive whiteboards, is nothing more than a result of not having been taught with this technology. Therefore, they cannot foresee the need or the advantages of using ICT in their practices. Likewise, as they have never had the opportunity to learn from their teachers how technology can be used to support learning, they do not envisage its use in their own teaching.

When we are able to find a balance in the use of these technologies to teach, overcoming the "enchantment" of technology, then we may say that the cornerstone was placed in the construction of a new building for the use of ICT in education for this millennium.

### **Technology integration standards.**

Since 2002, the United States are using a guidance document from NCATE (National Council for Accreditation of Teacher Education) for the integration of technology, field experience and simulated practice along the initial training activities

(NCATE, 2008). Also, "ISTE NETS for teachers" (ISTE, 2008), a document which presents recommendations to: a) integrate technology; b) facilitate and inspire the creativity of students; c) design and develop experiences and exercises for learning and working in "digital age" both for students, colleagues and the community in general, promoting accountability and digital citizenship. Similarly, it recommends active involvement in their own professional development. These are the "standards" that (at least in the United States) teachers must comply with.

In Portugal, as mentioned earlier, the profiles for professional performance of teachers, prepared under the ANEFA direction and published by Decree-Law No. 240/2001, of August, 30<sup>th</sup>, leaves no room for doubt about the need to adequately incorporate ICT in all dimensions of the teacher's activity. That is not an option: it is mandatory. So, what is missing? Why aren't technologies being already used in the classroom?

### **Teachers' Professional Development regarding ICT**

When we address the problem of teacher's training, there are two pillars to consider: "initial education" and "lifelong training".

#### **Initial education.**

The Bologna Declaration suggests that higher education in Europe must be comparable across countries and based on three cycles (with different designations depending on the countries). It also suggests that, after the initial training, graduates should be able to start a professional career. We should not confuse "initial training" with the Bologna's 1<sup>st</sup> cycle. If in most professions the 1<sup>st</sup> cycle is enough to acquire the academic qualification for entering the professional world, in the case of teachers (and some other professions that have specific Community Directives - e.g.: Architects,

Medical Doctors), the 1<sup>st</sup> cycle is not enough to qualify for the exercise of the teacher's profession. Thus, teachers need to obtain a specific 2<sup>nd</sup> cycle degree (again using Bologna's terminology) additional to the 1<sup>st</sup> cycle, and only after the completion of the 2<sup>nd</sup> cycle, graduates may start their professional careers. This means that, regarding the teacher's profession, "initial training" means Bologna's 2<sup>nd</sup> cycle.

In Portugal, formal academic qualification to become a teacher can be obtained in Universities (for basic and secondary education) or in Polytechnic Institutes (for parts of Basic Education or for specific courses). That is the reason why instead of the term "Universities" we use the term "Higher Education Institutions", which encompasses both subsystems.

A graduate with the 2<sup>nd</sup> cycle of higher education studies in the teacher's education area should have, among others, "the ability to communicate persuasively and with opportunity, using a variety of languages and supports, including Information and Communication Technologies" (Ponte, Sebastião & Miguéns, 2004, p. 7).

For example, Brito, Duarte & Baía (cited by Viseu, 2007) reported:

... ICT training can be considered at two levels: technological and pedagogical.

a) "At the of computer literacy level, teachers basically contact with the Office tools and other product design multimedia software; and b) The curriculum integration (disciplinary or interdisciplinary) emerges from daily professional problems, from the epistemology of each subject and / or from its teaching methods and look for an approach that may provide the context to the actual use of specific computer tools for different areas of knowledge, or in new curricular areas or in other educational spaces of today schools, such as laboratories, clubs, study rooms or resource centres. (Viseu, 2007, p.43).

In a study with 26.707 Portuguese teachers, Paiva (2002, p. 38) points out that

only 26% of the teachers use ICT with students in the educational context. The initiation in ICT is due to "initial training" (22%), "self-training" (49%), Lifelong training (32%) and "family/friend support" (38%).

In this context, and considering the low percentage of teachers that declared that ICT integration was due to initial training, it would make sense to analyse what has been done in terms of initial training in Portugal (and additionally in postgraduate education) regarding the integration of ICT in teachers' practices.

We can identify two key parameters when we relate ICT and initial teacher's training: the "computer literacy" and the "skills to integrate technology in education."

Some studies are available (Ponte & Serrazina, 1998, cited by Viseu, 2007, p. 44; Matos, 2005) where both parameters are analysed. In the first study, the authors report the "more academic nature of public university courses [that] play against the inclusion of ICT subjects in the curricula of initial training teachers". The second study (Matos, 2005 cited by Viseu, 2007, pp. 44-45) refers that, when ICT appears in courses, "the number of credits is (...) too low", although it is important "not to disturb a balance between the technical component and the pedagogical use of ICT". Viseu (2007, p. 44) also refers that "... we can perceive a trend, that started in 1998, when the institutions provided an increasing importance to the specific subjects associated with ICT usage and initiated the process of reflection on how ICT can be integrated in education". Still, its proportion is clearly inadequate (Matos, 2005, p. 166). The constraints identified from the collected data in this study are:

- a) Difficulty of integrating ICT in the curriculum, and the reduced number of credits (which translates into the student's workload) when that happens;
- b) Lack of available resources (in some institutions) and the critical lack of faculty ICT training in Higher Education institutions;

- c) The narrow ICT scope that pre-service teachers obtain in initial training;
- d) The need to increase the number of studies that allows us to know in detail how teachers are trained with ICT".

Notwithstanding these findings, Matos reports:

“Higher Education Institutions seem to be more concerned with ICT use and to reflect on how ICT can be integrated in education, other than provide training on the technical aspects of ICT use, following the trend identified in previous study [in 1998] with an apparent reduction in the number of credits related to ICT". (2005, p. 160).

Nevertheless, there is a sense of evolution in “ICT use” during initial training and post-graduate courses in education, that occurred after Matos’s and Paiva’s studies, in the main Portuguese Higher Education Institutions, considering ICT integration in the initial teacher’s training and classroom equipping.

So far, there are no published longitudinal studies that characterise the ICT integration in initial teacher education in Portugal, throughout the years. Some questions also rise about the ability of future teachers to use ICT in their teaching practices, with a critical and sustained analysis. This problem cannot be answered in this study, but it is important to point out the need to know more about it.

There is still another issue regarding the population of our study: the adequate academic qualifications for teaching. In the “social and cultural” and “scientific” components, teachers’ professional qualifications requirements are mostly met. In the technological area, however, due to a lack of sufficient qualified human resources in almost all technical areas, the required qualification for teaching is still not completely fulfilled, although the contribution of field experts in professional schools was never neglected in this stream of secondary education. In fact, that influence has always been



considered to be a positive contribution to professional schools as it brings the “business mindset” to educational context (something that career teachers will never have). Only in recent years, the subjects of the technological component (and not all of them) are covered by the higher education institutions responsible for initial teacher's training.

To fill this gap, the Portuguese Ministry of Education published the Decree-Law 287/88, setting out the standards for “in-service professionalisation” that applies to the teachers from the secondary education who did not acquire the appropriate academic qualification. Since 1988, many teachers used this mechanism to acquire their professional qualification, when no offer was provided by higher education institutions.

Until recently, professional qualification was not required for vocational education teachers, but an ordinance from the Ministry of Education (ministerial order nr.14940/2008) made it mandatory in 2009, with a few years of transitional provision to allow teachers to obtain it. In recent years, a new generation of teachers that acquired professional qualification through an academic degree (Master, or 2<sup>nd</sup> cycle) has been increasing. However, their behaviour regarding ICT use in the classroom is not different from those teachers who preceded them. That is the reason why we cannot completely rely on higher education institutions contribution “to provide the groundwork for teachers' use of technology” (Teo, Su Luan & Sing, 2008, p. 275). These institutions are far from being an example for future teachers when we consider the dimensions that “may influence pre-service teachers' attitudes towards computers to design teacher-training curricula that will prepare teachers to face the challenges in the information age” (Teo, Su Luan & Sing, 2008, p. 275). As Fisher defends, “Technology-rich field experiences within the schools should be identified where our pre-service teachers can work with master teachers who use technology effectively in the classroom. A challenge for teacher education lies in the implementation of these types of recommendations during the

restructuring of course content" (Fisher, 2000, p. 119-120). That scenario is still far from reality.

That is the reason why the main focus of this research is centred on "continuous training" or "Lifelong training" while we are still waiting for those profound changes in the traditional practices in higher education institutions to happen.

### **Lifelong learning.**

The day that a student completes the "initial training" academic degree, allowing him/her to become a teacher, is the precise same day when a new cycle begins. Sooner or later there will be a need to update one's knowledge, skills and aptitudes in order to become aware about the new theories, trends and technologies that may be suited to the profession. Typically, these update procedures may be obtained through academic formal education (post-graduate, doctoral or post-doctoral studies) or via Lifelong Learning.

The concept of Lifelong Learning may have had its origin in the last decades of the 20<sup>th</sup> century, with the publication of "Lifelong Education: A sketch of the range and significance of the adult education movement", by Basil Alfred Yeaxlee (1929). The concept of "education throughout life" was brought to discussion at an international level by UNESCO in the sixties and seventies of the last century, with "Recurrent Education" programs. The report "Education: The Treasure Within " (UNESCO, 1996) clearly brought Lifelong Learning to the spotlight. For the first time, Lifelong Learning emerged as a global strategy to be adopted by humanity, suggesting that schools should always be open to welcome ex-students, once they have completed their cycles. This report also considers Secondary Education as a sort of "turntable" for every citizen's life.

The concept of lifelong learning was incorporated by the Prague Statement, in 2001, which continued and developed the Bologna Declaration (1999) objectives for a new European Space in Higher Education. In 2009, the Declaration of Leuven (Belgium)

reinforced lifelong learning as one of the political priorities of the European Union for the next decade, now in higher education.

In Portugal, teacher's training was enshrined in the Education Act of 1986, but only operationalised in 1992 (Decree-Law No. 249/92 of 9 November), by channelling European funds to schools through PRODEP, a European Program for Educational Development in Portugal. As expected, PRODEP led to a race in the creation of "continuous training" and "accreditation of trainers". The result: a vast set of disarticulated training offers that only served the needs of the training centres and not the teachers. From 1992 onwards, lifelong learning was accredited by the "Coordinating Council for Continuing Education" and later by the "Scientific and Pedagogical Council for Continuous Training". Yet, it is rather surprising the lack of published information about the results achieved by these teacher's continuous training programs over the years.

### **Impacts on Teacher's Education.**

At a conference in Lisbon, under the Portuguese Presidency of the European Union, designated as "Teachers' professional development for quality and equity of Lifelong Learning", held on the 27<sup>th</sup> and the 28<sup>th</sup>, September, 2007, Nóvoa (2007, p. 26, citing Bertrand Schwarz, 1967), stated that '... permanent education began as a right reclaimed by generations of educators. Then, it became a necessity and, now, it has been transformed into an obligation'. The author continues:

Most training programs have proven to be of great futility, serving only to complicate an already strongly demanding quotidian life. Teachers should refuse these consumerism courses, seminars and activities that features the so-called "training market" that feeds a feeling of "obsolescence" among teachers. The design of the Continuing Education requires us to think the opposite, building training devices that meets the people's needs and the demands of the

profession, by investing in the construction of collective networks that are supported by training practices based on sharing and professional dialogue (p. 26).

As Nóvoa clearly conveyed, such is a faithful picture of the current situation: regarding lifelong training for teachers, Portugal has been a textbook example of how lifelong training should have never been done: teachers "had" to attend training in order to progress in their professional careers. That is, the need was not triggered by ethical reasons (to learn more, to be a better teacher) or by professional development purposes (to improve the quality of the "service" we provide our students) but it was only based on financial or career motives. And we found that successive lifelong teachers' training programs have resulted in products that often misfit their needs.

In that same event, Canário (2007, p 146) stated that:

Being a teacher today, implies an effort towards learning and permanent improvement in a continuous training dynamic to be understood as a personal right and not as an external imposition. It is in schools that you learn to be a teacher, in a learning process that overlaps professional socialisation. This is the basis for providing "lifelong teachers training" a strategic priority, other than keep focusing the debate on policies for initial training.

Again, this reality is not a black and white scenario, as initial training should not be overlooked nor the vital importance of lifelong training should be neglected as a strategic national priority, as Canário (2007) suggests.

This path is also defended by the Iberian-American States Organisation policies, of which Portugal is a full member, defined in 2010 (at the Buenos Aires meeting) as one of the goals for 2021 (with an intermediate point in 2015): "In 2015 at least 20% of all schools and teachers should participate in continuous training programs and educational

innovation and, at least, 35% of it in 2021 "(OEI, 2010, p. 157). Portugal established a goal regarding lifelong learning. It remains to be seen if the goal is only "participation" (as it has happened in the past) or if we will embrace a different direction, in line with Nóvoa's suggestion. Nowadays, the facts are clear: so far, teachers' training is not effective (we are not doing the right thing) nor efficient (we are not doing the right thing, with the least possible effort).

### **Theories and models around teacher professional development.**

There is a variety of definitions in literature about the concept of teachers' Professional Development (Day, 1999; Guskey, 2002; Mitchell, 2013), but Evans simply defines it as "the process whereby people's professionalism and/or professionalism may be considered to be enhanced" (2008, p. 30). The author also defines two key elements of Teachers' Professional Development: Functional Development (the process whereby people's performance is considered to be improved) and Attitudinal Development (as the process whereby people's attitude to their work is modified). Regarding "functional development", Evans considers that it incorporates two constituent changing features: procedural and productive (referring respectively to development in relation to procedures used, and to "what" and/or "how much" is produced or done, at work). About "attitudinal development", Evans considers that it also incorporates two constituent changing features: "intellectual" and "motivational" (referring respectively to the individuals' development in relation to their thinking, through processes and ideas, and to their motivation).

Guskey's Professional Development model (2002) defends that "a change in the teachers' classroom practices" induces "changes in the student outcomes" and that triggers "a change in teachers' beliefs and attitudes". This model focuses on supporting teachers and professional developers to understand how changes in teachers' attitudes and

beliefs occur.

Clarke's and Hollingsworth's (2002) model is proposed as an analytical tool for understanding the teachers' learning and professional development, involving four domains: external (experiencing), practice (trying), consequence (drawing new conclusions) and personal (changes in beliefs or feelings).

Desimone (2009), rather than focusing on teachers and developers, addresses the impact of professional learning on knowledge instruction, and student's achievement (p. 183).

Opfer's & Pedder's (2011) model arises from a review of the existing literature that included the previous three models. It emerges from a concern that a 'process-product logic has dominated literature on teacher's learning, which has limited its explanatory ability' (2011, p. 376). Their primary concern is theoretical, aiming to model the complexity of professional learning processes and argues that professional learning cannot be fully understood otherwise.

Evans (2011) highlights the multi-dimensional nature of professional development (behavioural, attitudinal and intellectual), suggesting that this model should be considered as a tool for the educational leaders responsible for the professional development related activities in schools. It argues that professional development is more effective when teachers understand that there may be 'better alternative ways' of doing something. This appears as an evolution of her 2007 model, detailing each component in 11 sub-components, as presented in Figure 6 (Evans, 2011, p.866): behavioural development (changes in processual, procedural, productive and competential areas), attitudinal development (changes in perceptual, evaluative and motivational areas) and intellectual development (changes in epistemological, rationalistic, comprehensive and analytical areas).

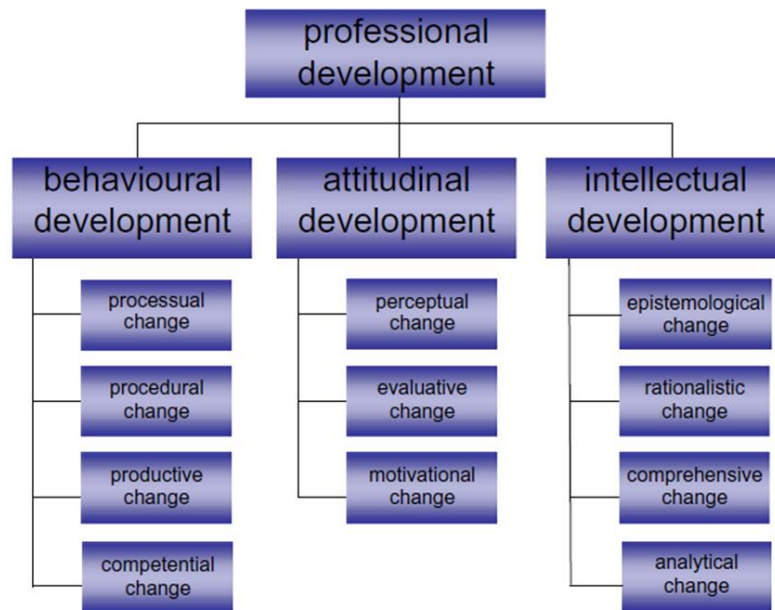


Figure 6. The componential structure of professional development.

Source: Evans (2011, p. 866).

The number of international reports that relates dissatisfaction with training courses regarding professional development are surprisingly high. Such studies, developed over a considerable period of time, reported the same results no matter the form, content or location.

When analysing the international literature for the models that describe teachers' professional development, Kennedy (2014) identified several models (Figure 7).

Model of CPD	Purpose of model
The training model The award-bearing model The deficit model The cascade model	Transmission
The standards-based model The coaching/mentoring model The community of practice model	Transitional
The action research model The transformative model	Transformative

Figure 7. Spectrum of Continuous Professional Development models.

Source: Kennedy (2014, p. 248).

These models, according to Kennedy, can be described as Transmissional, Transitional or Transformative, when analysing its purpose.

In the Transmissional models, Kennedy identified:

- a) "Transmission-based training" model, which supports a skills-based technocratic view of teaching, whereby Continuous Professional Development (CPD) provides teachers with the opportunity to update their skills in order to be able to demonstrate their competence. It is generally 'delivered' to the teachers' by an 'expert', with an agenda determined by the deliverer, with the participants assuming a passive role.
- b) The "award-bearing" model, which emphasises the completion of award-bearing programmes of study (usually, but not exclusively, validated by universities). This external validation can either be viewed as a mark of quality assurance, or as the exercise of control by the validating and/or funding bodies.
- c) The 'Cascade' model, which involves individual teachers attending 'training events' and then cascading or disseminating the information to colleagues. It is commonly employed in situations where resources are limited;
- d) The 'Deficit Model', which is grounded in performance, is specifically designed to address a perceived deficit in the teachers' performance. This assumes that any shortcomings in teaching can be attributed to the individual teachers' and professional development is key to overcome these shortcomings;

The Transitional Models, that may involve master/apprenticeship relationships, and that can be mutually supportive and challenging depending on 'the quality of



interpersonal relationships', are also described by Kennedy:

- a) The 'Standards-based' model is based on accountability, reduces the teachers' knowledge to a set of behaviours, which might be assumed as 'a lack of respect for the teachers' own capacities for reflective, critical enquiry'.
- b) The Coaching/Mentoring model, which is characterised by a one-to-one relationship, in which the mentors' knowledge is mainly practical and the mentoring process helps to develop both mentor and the mentee;
- c) The 'Community of Practice' model, in which emerges the mutually supportive and challenging form of the coaching/mentoring model previously mentioned. The essential difference between the two models is that a community of practice generally involves more than two people;

In the Transitional Models, Kennedy identifies the models that provide teachers with a greater capacity for professional autonomy, and the context for sharing knowledge and experiences.

The findings of a study, carried out in England involving early career teachers (Spencer, Harrop, Thomas & Cain, 2018, p. 43), are far from encouraging, drawing a portrait where teachers declare to feel overworked, overloaded and stressed. Regarding the support they need, they mostly find it in informal conversations and in social media. School-based professional development and mentoring also helps but, for many, these are orientated towards complying with policy and "ticking boxes". In the empirical data collected, the notion of teachers' development as a continuing formation and realisation of educational values and ideals is hardly mentioned. It seems that most teachers do not know what they are missing.

One of the most recent scientific publications about teachers' professional

development suggested a shift from “Professional Development” to “Professional Learning” (Labone & Long, 2016, p. 55). That change of paradigm from “development” to “learning” implies a fundamental change in “focus” and “responsibility”. Development implies a more passive role for the teacher, in which the responsibility is on the developer to improve the teacher.

This “passive role”, combined with the term “development”, implies that “something should be done to the professional ... who is in need of developing’ and shifts emphasis from the ‘knowledge-deficient [teacher in this case] to the knowledge-possessing provider’. In comparison, “learning” implies a more internal focus or constructivist approach in which the teacher becomes an active participant who is responsible for his/her own learning, which is instrumental to the changes within their own context. The shift to “learning” reflects a model in which teachers are responsible for their professional growth as a life-long process, embedded in the teachers’ daily activities and closely linked to their identities (Labone & Long, 2016, p. 55).

Additionally, some researchers sustain that “teachers are motivated to engage in professional development via job-embedded learning opportunities that are a part of the teachers’ daily routine - without compromising their teaching and their students’ learning” (Appova & Arbaugh, 2018, p. 17).

This suggests a need for the teachers’ professional development to evolve beyond ‘activity’. Instead, it supports the teachers’ learning from a growth model perspective, in which teachers play a key role in designing their own professional development opportunities. In other words, these findings strongly suggest that teachers’ motivation to learn is not a ‘carrot and stick’ phenomenon. It is predominantly based on the teachers’ professional and learning needs, their readiness to learn, as well as on the available and accessible learning opportunities.

## **The models in the literature**

### **Attitude and behaviour.**

Digital technology integration into instruction, carried out in the teachers' daily activities, is closely connected with the contexts in which teachers interact, their beliefs, and their attitudes towards teaching and learning (Cuban, 2001, cited by Keengwe, Onchwari & Wachira, 2008, p. 80).

Attitudes have been widely studied by social psychology and the application of these studies to the educational field is essential to predict peoples' behaviour. However, research clearly indicates that attitudes alone are rather poor predictors of behaviour in general, and that attitudes are better predictors of behaviour if we focus on those which are very specific to the predicted behaviour, and thus relate more to behavioural intentions (Hogg, 2000, p. 315).

Attitudes are grounded on three psychological functions (Lima, 2010, pp. 203-208):

- a) Motivational, related to the personal stimulus or individual psychological needs – these can be instrumental or related with assessments, as people tend to opt with the attitude that: i) better grants social integration in a group; ii) better expresses their personal values or identity;
- b) Cognitive, related with how people process information – these are grounded on two theories: i) balance (each individual adopts stable behaviours avoiding unstable situations); ii) reduction of cognitive dissonance (keeping the consonance and consistence of attitudes facing an object or situation);
- c) Action-oriented functions, related to what people do with the processed information.

On the one hand, attitude is a complex construct that encompasses several non-

observable dimensions that aim to explain behaviour. Following the work of other researchers, Triandis (1971, p. 2) used a three-component definition for “attitude”: “An attitude is an idea charged with emotion which predisposes a class of actions to a particular class of social situations”. The components present in this definition are: the idea (cognitive component), the emotion attached to the idea (affective component), and the predisposition to act (behavioural component).

Behaviour, on the other hand, has five main characteristics (Triandis, Adamopoulos, & Brinberg, 1984, p. 26): a specific actor, a specific action, in a specific context, at a specific time, with a specific target (“Who, does what, to whom, where, and why”). But behaviour is variable and all the variability in behaviour is not predictable from attitudes (often people don't do what they say, want, or intend to do). People often do what is legal, moral, or ethical. Yet, that is variable as well, both in an historical perspective (laws, costumes and traditions have changed throughout the years), or from a cultural or geographical perspective (what is accepted and common in a specific group of people or a specific region may not be so in a different group or geographical region).

Consequently, the relation between attitude and behaviour is reciprocal (attitudes predispose actions, and actions help to shape attitudes). Therefore, the relation between attitude and behaviour, in a broad historical and cross-cultural perspective, confirms that individuals shape their attitudes according to what is socially accepted in a particular historical period within a particular culture. Such attitudes predispose a behaviour, and when a behaviour is shaped by contemporary events (e.g., new laws, social movements, travel to other countries, etc.), people acquire new attitudes (Triandis, Adamopoulos, & Brinberg, 1984, p. 27).

### **The models and theories that relate Attitude and Behaviour.**

Several theories and models have tried to explain the consistency of the

relationship between attitude and behaviour. In our research, the importance of connecting attitude and behaviour is mostly related with the teachers' attitude and behaviour that may lead to the adoption of digital technologies in education. We must point out that, while some models merely try to explain the relation between these concepts, other models tried to explain the teachers' technology acceptance (attitude) and its influence over their behaviour to adopt and integrate digital technologies in their educational activities. Other researchers designed a framework that should be taken into account within the teachers' training programs and the professional development activities which incorporate the tools (technology), the processes (pedagogy) and the contents to be learned.

***TRA (Theory of Reasoned Action).***

TRA provides a framework to study attitudes towards behaviour and, according to the theory, behaviour intent is the most important determinant of a person's behaviour. The individual's intention to perform a behaviour is a combination of attitude that leads to a specific behaviour (behavioural belief, evaluation of behavioural outcomes) and subjective norm (normative beliefs and the motivation to comply). This theory suggests that if a person perceives that the outcome of a certain behaviour is positive, he/she will have a positive attitude towards performing that behaviour (the opposite is also valid). Additionally, if "significant others" consider that performing a certain behaviour is positive and the individual is motivated to meet the expectations of the "significant others", then a positive subjective norm is expected (the opposite, again, is also valid).

The TRA model, presented in 1975, aimed to predict behavioural intention considering factors as "attitude" and "behaviour" (Figure 8) and it suggests that individual "behaviour" is preceded by "behavioural intention". Furthermore, it suggests that "behavioural intention" is triggered by two other factors: "attitude towards

behaviour” (personal feelings related to the consequences of a behaviour) and “subjective norm” (other people’s opinion related to “our” behaviour).

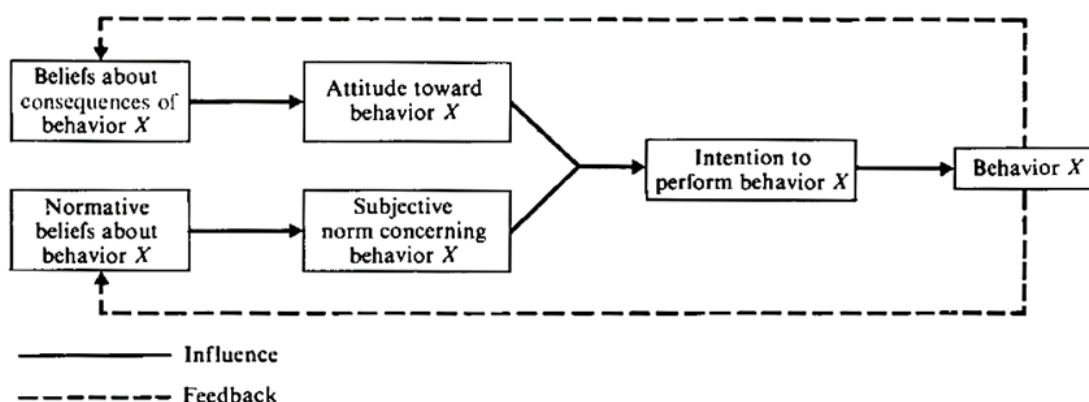


Figure 8. Theory of Reasoned Action.

Source: Fishbein & Ajzen (1975, p. 16).

From figure 8, we also observe that a certain behaviour also influences the personal and normative beliefs about the consequences of that behaviour.

This TRA model works most successfully when applied to behaviours that are under a person’s volitional control (related to personal willpower), and problems arise when this theory is applied to behaviours that are not fully under volitional control. The individual may have total control when there are no constraints of any type to adopting a behaviour (at the opposite extreme, there may be a total lack of control if the adoption of a given behaviour requires opportunities such as unavailable resources or lacking skills). Control includes both internal factors (skills, abilities, information, emotions, such as stress) and external factors (situation or environmental factors). To overcome this limitation, an adjustment was made to the Theory of Reasoned Action by adding a third antecedent of “intention” called “perceived behavioural control”, and the new theory was coined Theory of Planned Behaviour.

### ***TPB (Theory of Planned Behaviour).***

TPB (Ajzen, 1991), presented in figure 9, was developed as an extension of TRA,

by adding another variable: Perceived Behavioural Control (personal motivation is influenced by how difficult behaviours are perceived, or the way an individual perceives his/her ability to perform a specific task). If a person holds strong beliefs about the existence of factors that will facilitate a behaviour, then he/she will have a high perceived control over that behaviour (the opposite is also valid). This perception can reflect past experiences, the anticipation of upcoming circumstances, and the influential norms that surround the individual (McKenzie & Jurs, 1993; Schiffman & Kanuk, 2009). This theory, the combination of “attitude towards behaviour”, “subjective norm,” and “perceived behavioural control”, leads to the formation of “behavioural intention”.

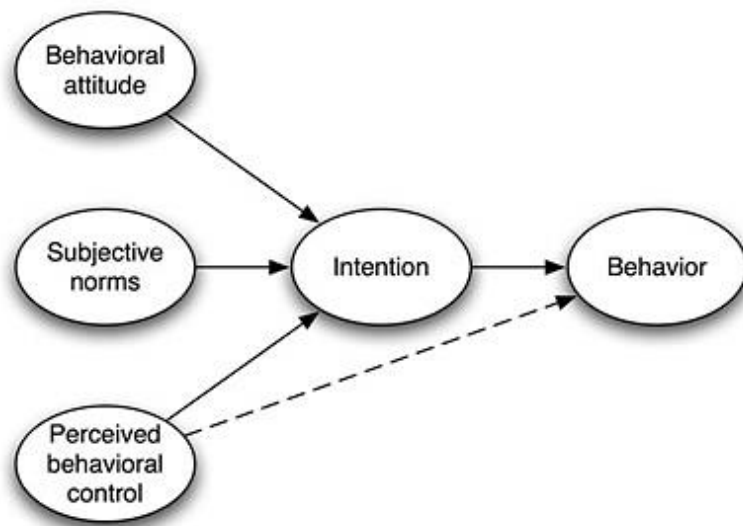


Figure 9. Theory of planned behaviour.

Source: Ajzen (1991, p. 182).

In fact, the way people perceive control of a situation is also a trigger for the intention that precedes behaviour.

### ***TAM (Technology Acceptance Model).***

TAM was developed by Davis, Bagozzi & Warshaw (1989, p. 997) as an adaptation of TRA model, specifically tailored for the individual acceptance of information technology integration, based on the following constructs: “Perceived

Usefulness”, which is the prospective user’s subjective probability that using a specific application system will increase his/her “job performance” within an organisational context. “Perceived ease of use” refers to the degree to which the prospective user evaluates how easy and free of effort the process of learning how to use a specific system is.

Similar to TRA, the TAM model postulate that computer usage is determined by Behavioural Intention, which is viewed as being jointly determined by the individual’s “attitude” toward using the system, “perceived usefulness” and “perceived ease of use” (Davis, 1989, p. 994), as presented in figure 10.

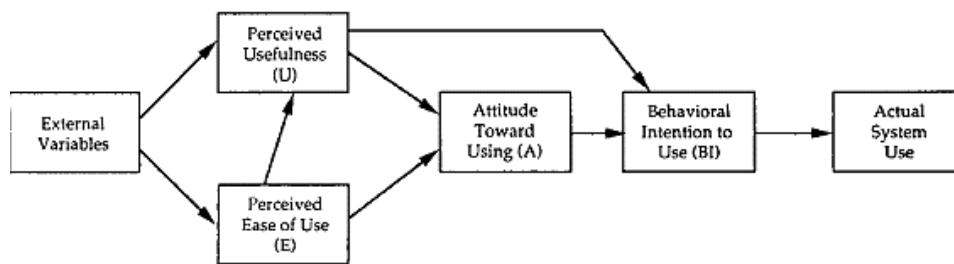


Figure 10. Technology Acceptance Model – version 1.

Source: Davis, Bagozzi & Warshaw (1989, p. 985).

### ***TAM (Technology Acceptance Model) – Version 2.***

This model had several versions, and Venkatesh (2000, pp. 344-346) proposed an extension of TAM model (designated by TAM2) by identifying and theorising about the general determinants of “perceived usefulness” (“subjective norm”, “image”, “job relevance”, “output quality”, “result demonstrability”) and “perceived ease of use”. These effects are moderated by “experience” and “voluntariness”.

- Subjective Norm: Originated in TRA, Subjective Norm consists in the degree to which an individual perceives that most people (important to him/her) think he/she should, or not, use a system (this variable is a determinant for “perceived usefulness” and “intention to use”);



- Image – The degree to which an individual perceives that the use of an innovative technology would enhance his/her status on a social system;
- Job Relevance: The degree to which an individual believes that the target system is applicable to the job;
- Output Quality: The degree to which an individual believes that the system will help to better perform the job tasks.
- Result Demonstrability: The degree to which an individual believes that the results of using a system are tangible, observable, and communicable.

TAM2 model, proposed by Venkatesh & Davis (2000), is presented in figure 11:

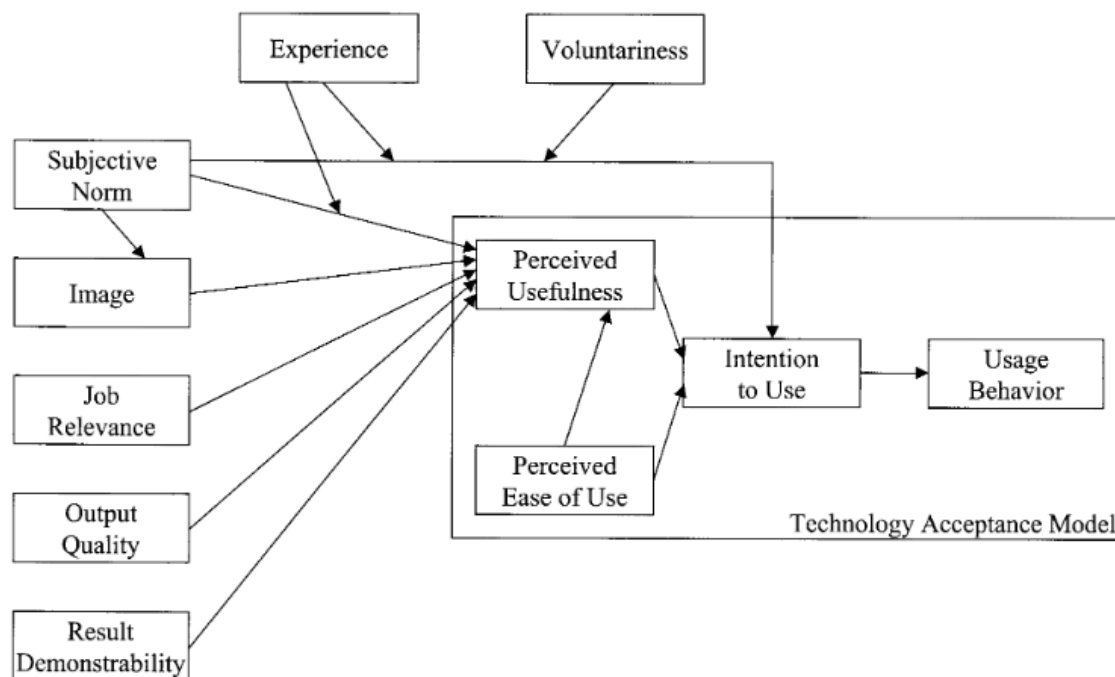


Figure 11. Technology Acceptance Model – version 2.

Source: Venkatesh & Davis (2000, p. 188).

In this second version of TAM only “perceived usefulness” has determinant factors. It became rather evidently, that “perceived ease of use” would also have determinant factors still to be determined.

### ***UTAUT (Unified Theory of Acceptance and Use of Technology).***

UTAUT model aims to explain the “intention to use” and “use” of information systems. This theory holds that the direct determinants of usage intention and behaviour are: “performance expectancy”, “effort expectancy”, “social influence”, and “facilitating conditions”. Other variables like “gender”, “age”, “experience”, and “voluntariness of use” act as moderators on the key constructs that determine “behaviour intention” or “use”, as shown in the UTAUT Model (Venkatesh, Morris, Davis & Davis, 2003), presented in figure 12.

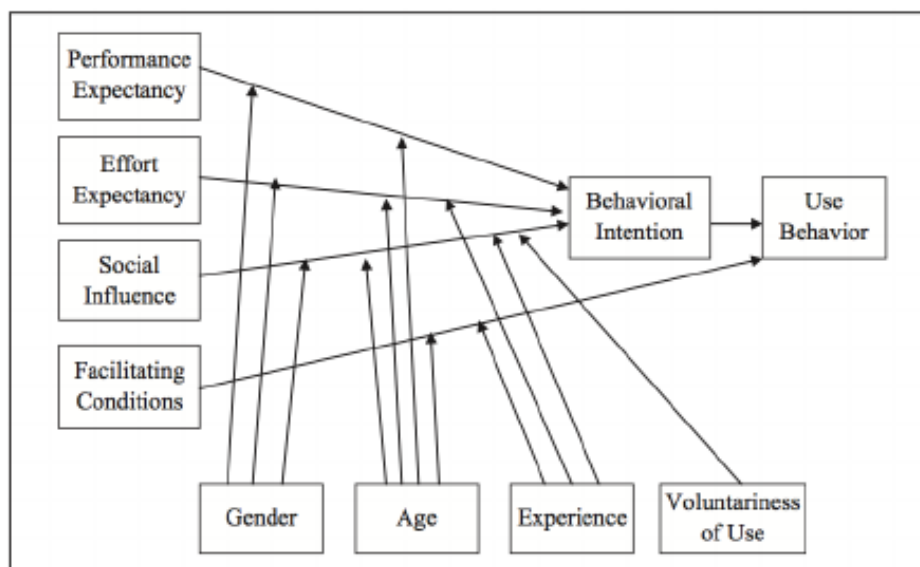


Figure 12. Unified Theory of Acceptance and Use of Technology.

Source: Venkatesh, Morris, Davis & Davis (2003, p. 447).

### ***TAM (Technology Acceptance Model) – Version 3.***

In 2008, Venkatesh & Bala identified two main elements that determine “Perceived ease of use”, grouped as “anchors” and “adjustments”. The anchors considered in this model were: “Computer Self efficacy”, “Perceptions of External Control”, “Computer Anxiety” and “Computer Playfulness”. Adjustments were: “Perceived Enjoyment” and “Objective Usability”. This third extension to TAM model (designated by TAM3) is presented in figure 13.

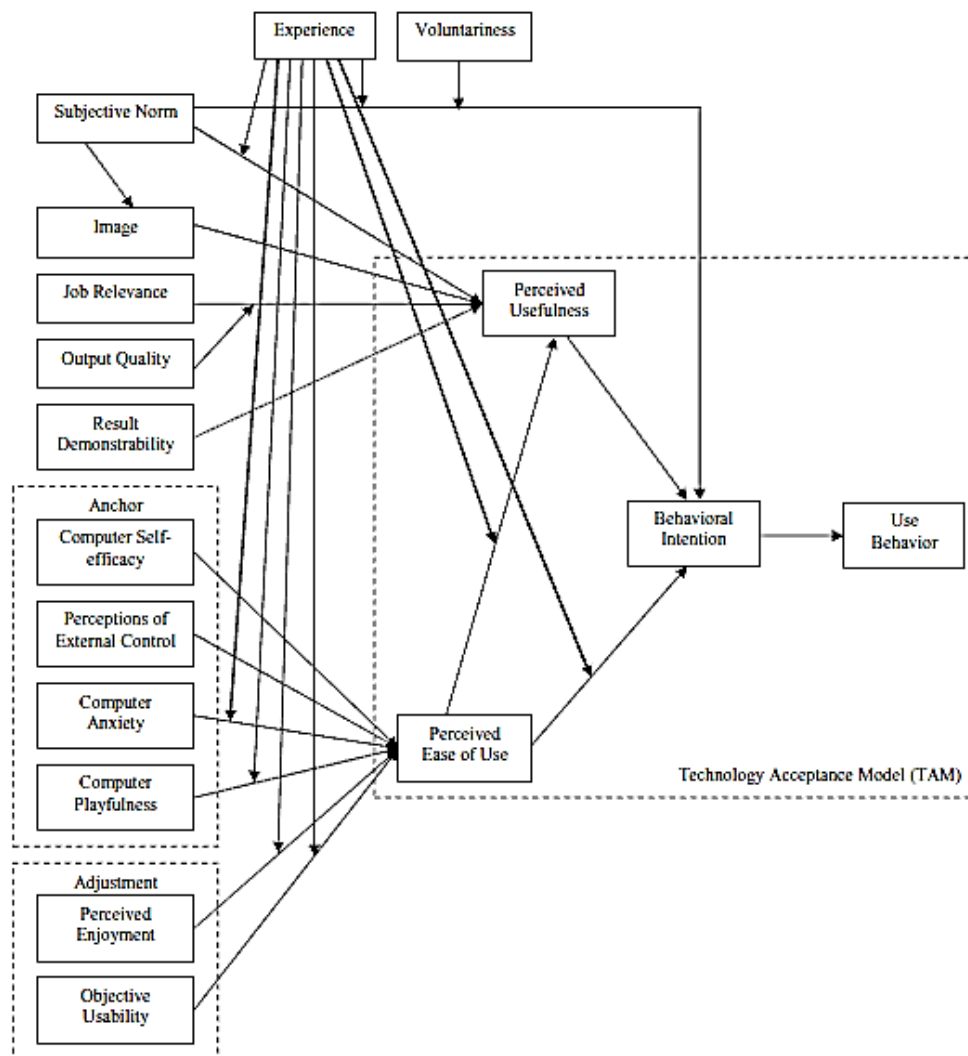


Figure 13. Technology Acceptance Model – version 3.

Source: Venkatesh & Bala (2008, p. 280).

This third extension to TAM model, besides other crossover effects, theorises the effect of “experience” over previous TAM model constructs, suggesting that there is a significant moderator effect of “experience” on the effects that: i) “perceived ease of use” has on “perceived usefulness”; ii) “computer anxiety” has over “perceived ease of use”; iii) “Perceived ease of use” has on “behavioural intention”.

The anchor and adjustment determinants for the TAM3 model are presented in table 6:

Table 6.

*Anchor and adjustment determinants of TAM3 model.*

<b>Determinants</b>	<b>Definitions</b>
Computer Self-Efficacy	The degree to which an individual believes to have the aptitude to perform a specific task/job using a computer.
Perception of External Control	The degree to which an individual believes that organisational and technical resources exist to support the use of the system.
Computer Anxiety	The degree of “an individual’s apprehension, or even fear, when she/he is confronted with the possibility of using computers”.
Computer Playfulness	“. . .the degree of cognitive spontaneity in microcomputer interactions”.
Perceived Enjoyment	The extent to which “the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use”.
Objective Usability	A “comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks”.

### ***Discussion about the models and the previous research results.***

Widely used worldwide, the Technology Acceptance Model is generally referred as the most influential and commonly employed theory in the information systems and has evolved along the years, although some remarks should be made in order to properly evaluate these developments:

- a) Attitude, one of the main constructs of TRA (in which the original TAM was based) was dropped from TAM1 to TAM2, essentially due to the inconsistency of this variable, in multiple empirical studies. That was made without any significant theoretical support, although some authors argue that “acceptance

behaviour” is only determined by Perceived Ease of Use, Perceived Usefulness and Acceptance Behaviour, and that the role of Attitude is, at the best, a partial mediator.

- b) However, other authors disagree with the path followed by TAM model developments and, on the contrary, they point out that

“attitude strength towards using a system has a significant effect on both the cognitive process of acceptance and attitude-behaviour consistency, it is necessary to employ methods or tools that will make users' attitudes strong enough to keep the adopted technology efficiently and continuously utilized” (Kim, Chun & Song, 2009, p. 75).

This is particularly important when addressing the problem of “adopted-but-not-used technology”.

- c) Moreover, Turner, Kitchenham, Brereton, Charters, & Budgen (2010, p. 471) found that “Perceived Usefulness”, and particularly “Perceived Ease of Use”, are not as good at predicting “Technology Use” or “Behavioural Intention”.

Other researchers essayed to add other components such as “user satisfaction” (Wixom & Todd, 2005, p. 91) that may indeed contribute to explain the adoption of technology. Still, in the study where the model was presented, the “variance explained” increased only 4% when compared with TAM. Nevertheless, it is interesting that this proposal integrates the “quality of the artefact” and the “personal satisfaction” with it, before considering the behavioural attitude.

In conclusion, after so many years of research and such a large multitude of studies applying TAM (and its many variants), we can affirm that we know - almost to the point of certainty - that Perceived Usefulness is a very influential variable on Use, and that Perceived Ease of Use is a predecessor of Perceived Usefulness and an important

determinant of Use.

Some academic researchers, though, have criticised TAM research for adding variables which are rather at odds with the coherence in the theory, haphazardly, leading to a progressively less coherent theory (Holden & Karsh, 2010, p. 167). That may have diverted the researchers' attention from the theoretical foundations of TRA, TPB and the initial versions of TAM, while trying to apply patches over patches in the development process of TAM. Thus, the model has seen a significant amount of development, with a possible loss of coherence, but that is a characteristic of scientific research. In a review published in 2015, Marangunic' & Granic' suggest a return to the origins of this model, and identify:

“four possible directions for future research related to the TAM model: the moderating role of individual variables, the incorporation of additional variables to the model, the investigation of actual usage and the relationships between actual usage and objective outcome measures, and the target group of older adults. A growing need for technology, especially ICT, in the professional and private life of users will certainly enhance the interest for the field of the technology acceptance for many years to come” (2015, p. 92).

That is precisely the aim of present research: to evaluate the contribution of digital skills to foster the adoption of digital technologies in education.

These researchers have analysed the publications over a period of time and summarised the extensions of the development of TAM, as described in figure 14:

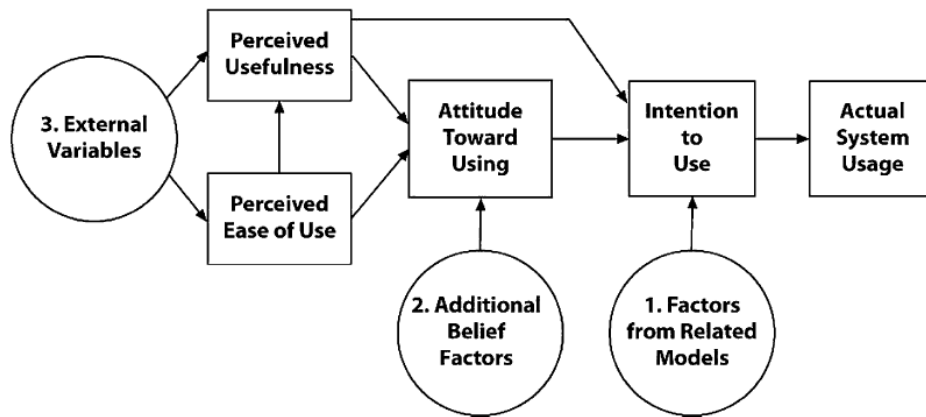


Figure 14. Extensions of the technology acceptance model

Source: Marangunic´ & Granic´ (2015, p. 87)

These authors identified three major directions for TAM development (p. 87):

- 1) Factors that derive from related models: a number of factors have been brought in (subjective norm, perceived behavioural control, and self-efficacy);
- 2) Additional belief factors: some factors from a diffusion of innovation literature addressing the “belief” construct have been introduced (trialability, visibility, result demonstrability, and content richness);
- 3) External variables or moderating factors for the two major belief constructs (perceived usefulness and perceived ease of use) have been introduced (personality traits, demographic characteristics, or computer self-efficacy).

### **TPACK (Technological Pedagogical Content Knowledge).**

The TPACK model (originally designated TPCK) was developed over the PCK model (Shulman, 1986), and aimed to study the technology integration in education. It is based on a tripod of concepts – technology, pedagogy and content (Mishra & Kohler, 2006, p. 1025) –, and its intersections (figure 15):

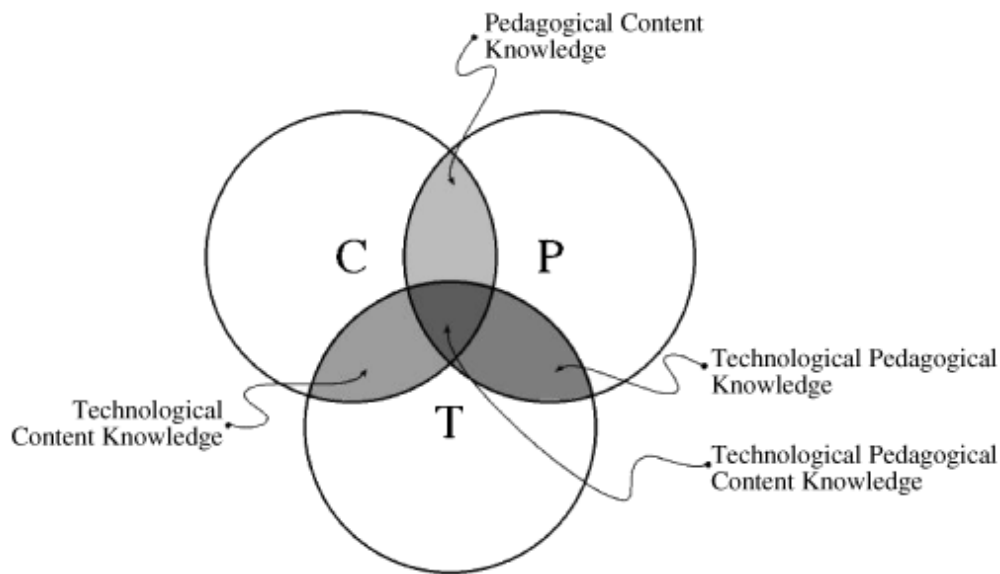


Figure 15. *Technological Pedagogical Content Knowledge.*

Source: Mishra & Koehler (2006, p. 1025).

The basic elements of this model are:

- Content knowledge (CK), which is knowledge about the subject that will be taught and learned.
- Pedagogical knowledge (PK), which is the deep knowledge about the processes and the practices (teaching and learning strategies and methods) and how they encompass, among other things, educational purposes, values, and aims.
- Technology knowledge (TK) which is knowledge about how to use ICT hardware and software and their associated peripherals. The term Technology Knowledge could also encompass all old-school educational technology (e.g. chalk and blackboard, pencil and paper, etc.). However, Cox & Graham (2009, p. 63) refer that, in this light, it is more appropriate to consider only the emerging technologies.

When we consider the relationship between these basic elements, we may observe a more complex situation:



- a) Pedagogical content knowledge (PCK) relates pedagogy and content, and tries to determine which teaching methods and approaches better fit the content, and likewise, establish:
  - i. How the content can be organised for better teaching and learning;
  - ii. What teaching strategies do incorporate the appropriate conceptual representations in order to address learners' difficulties and misconceptions, and foster meaningful understanding of the contents;
- b) Technological content knowledge (TCK) evokes the manner in which technology and content are reciprocally related. Although technology is a constrain, due to the multitude of possible representations, technologies often allow new and more varied representations and provide greater flexibility in navigating across them. Teachers need to know not just the subject-matter they are teaching, but also the manner in which the subject-matter can be better construed by students with the application of technology.
- c) Technological pedagogical knowledge (TPK) considers the various available technologies that may be used to develop these learning environments, and the conscience that teaching methods may evolve when integrating technology. This comprehends the awareness about the range of tools available for a particular task, the ability to quickly choose a tool based on its requirements, the strategies for using the tool's affordances, the knowledge of pedagogical strategies and the ability to apply those strategies when considering the use of a particular technology.
- d) Technological pedagogical content knowledge (TPCK) is an emergent

form of knowledge that goes beyond all three basic components (content, pedagogy and technology). TPACK may be the foundation of “good teaching with technology” and requires:

- i. An understanding of the representation of concepts using technologies;
- ii. Pedagogical techniques that use technologies in constructive ways to teach content;
- iii. The knowledge of what makes concepts difficult or easy to learn and how technology can help to overcome some of the problems that students are confronted with;
- iv. Information about students' prior knowledge and theories of epistemology;
- v. Knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones.

Thus, this model of technology integration in teaching and learning argues that the ability to develop “good content” requires a thoughtful interweaving of knowledge. There is no single technological solution that suits every teacher, every course, and every concept of teaching. Quality teaching should require the understanding of the relationships between technology, content, and pedagogy, and should use this understanding to develop appropriate, context-specific strategies and representations. Productive technology integration in teaching has to consider all these concepts together, within the complex relationship defined by these three key elements.

Nevertheless, in this research we are particularly interested in the Technological Knowledge and we are mostly focused in that component.

There are numerous ways to employ the TPACK model to design ICT integrated

lessons. Some studies (Polly, Mims, Shepherd & Inan, 2010) started by providing technical skills training, followed by the discussion on how technologies can be used in teaching and learning (TPK), transforming content into digital representations (TCK) and finally integrating the subject matter (TPACK). Other studies (Chai, Koh, & Tsai, 2010; Chai, Koh, Tsai, & Tan, 2011) started building the TPACK approach from the Pedagogical Knowledge followed by how Technology (TK) can enhance meaningful learning. The teachers then applied the knowledge to design a TPACK lesson for a specific topic (CK). Some other studies (Angeli & Valanides, 2009) began by identifying content that are suited for technology integration and, then, mapping the processes in which all elements of the TPACK are considered at the same time.

#### ***Brief history of the development of the TPACK.***

In the mid-80s, by presenting the pedagogical content knowledge framework (PCK), Shulman (1986) suggested new directions for effective teaching: “By integrating content and pedagogy, teachers are best able to anticipate students’ learning needs for a particular topic, select the optimal instructional approach and understand how to scaffold the learning experiences for students” (Hofer & Grandgenett, 2012, p. 84). This new approach has triggered the redesign of teachers’ educational programs, by integrating these two elements together in teachers’ training programmes. Back in the 1980s, the concept of technology was probably not mentioned in Shulman’s articles as it was not a commonplace in every school; the technologies used in that decade in most schools were not even considered as true technologies (e.g.: textbooks, overhead projectors). In 1987, Shulman argued that “the goal of teacher education is not to indoctrinate or train teachers to behave in prescribed ways, but to educate them to reason soundly about their teaching as well as to perform skilfully” (p.13). We would say that this statement is still valid today and what may have changed is the type of skills that teachers need to develop. By

adding another element (Technology) to Shulman's PCK model, in 2006, Mishra & Kohler point out the need to empower teachers to take advantage of technology to support the pedagogical strategies to deliver contents in a classroom. The TPACK model was presented as "an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help address some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones" (p. 1029).

According to this model, there is no such thing as "the correct balance" between the three elements and each one should find its position in the intersection. Although most studies may agree that these aspects should be taken into account in initial training, facts have shown that the efforts made to integrate technology in the teachers' training curriculum in higher education institutions are clearly insufficient and, until now, the results are far from satisfactory (Silva, 2003; Birch & Irvine, 2009; Sutton, 2011). It should be wiser to induce behavioural changes through professional development, rather than waiting for the higher education institutions to introduce profound curriculum reforms that would provide pre-service teachers with the adequate ICT skills to properly perform in-service.

Regarding teachers' attitude towards the use of computers, Zhao, Tan and Mishra (2001) suggest that attitude is directly related to the use of computers in the classroom. Most teachers are still considering the computer a tool to accomplish satellite tasks (managing groups, communicate with parents and students) instead of fostering student success (p. 162). Teo (2008, p. 413) suggests that student success with computer technology will depend largely on teacher's attitude towards computers and their

willingness to embrace technology, even if “attitude” may be considered as two separate constructs: “cognitive attitude” and “affective attitude” (Yang & Yoo, 2004, p.27).

Other aspects may be considered, such as the substantial influence that “perceived enjoyment” and “perception of usefulness” has on “perceived ease of use”. In fact, a balance between utilitarian and hedonic activities should be made in order to acquire relevant skills for the job as teachers. Simultaneously, pleasure and enjoyment may be rendered from these activities (Teo & Noyes, 2011, p. 1652).

### **Technology (non) integration**

Given the previously presented models, widely studied, we should expect that teachers would profusely use digital technologies in the classroom, as all these theories converge to identify “Perceived Usefulness” and “Perceived Ease-of-Use” as the common factors that foster “intention to use ICT”. If a teacher perceives that technology is “easy to use” and “useful”, he/she will probably accept it (and integrate it) in practice.

Additionally, if a particular technology is able to promote better results in students' learning and academic achievement, that may be a good reason to integrate it, as well. However, aspects like the “dichotomy between teachers' ICT skills and students' ICT skills” (Deissler, 2006) must be addressed, as teachers usually do not feel confident when leaving their “comfort zone”. In fact, many teachers declare to avoid to use ICT in classes, because they fear to lose control over the teaching process. This may generate anxiety and the decrease of self-confidence related with ICT.

According to Zhou, Hu & Gao (2010, p. 4636), along with the intention to use ICT, the declared desire to further learning, clearly demonstrates that teachers have the intention to use technology in the near future. Therefore, the question we must ask is: Why do teachers declare to have the intention to use digital technologies with students when they do not consistently do so? Clearly, we are not appropriately preparing teachers,

both pre-service and in-service teachers, to a society that is strongly technological, nor are we providing them the conceptual tools and the technical skills that allow them to rethink their teaching processes and contemplate the possibilities associated with technology integration.

Lack of time is known to be a strong constraint to the use of technology. Although most teachers recognise the need to use digital technologies, the time that is required to be a proficient user of digital technologies in the classroom is a strong barrier to most teachers, typically overloaded with bureaucratic duties. That means that we need to clearly demonstrate that “Perceived ease of use” and that “Perceived usefulness” signify “decreasing the time spent to perform the job and achieving more efficiency and accuracy” (Teo, Su Luan & Sing, 2008, p. 267).

### **ICT use and ICT knowledge**

The revision of literature on “ICT use” leads us to question whether “ICT Knowledge” may be the missing key to empower teachers to use the numerous digital tools available today. We pondered if teachers' integration of technology on their educational practice can be achieved by providing them with “ICT Knowledge” and if online environments may be helpful in that quest. Those two constructs combined, may develop the confidence most teachers need to incorporate technology as a tool to improve their educational practices. Moreover, teachers should be encouraged to produce and share their digital resources with students (in Virtual Learning Environments) and with their fellow colleagues in an open repository that can serve both students and teachers from other schools.

Nevertheless, some aspects should be considered as influential factors towards the integration of technology: 1) the course design to foster professional development in line with TPACK suggestions (Mishra & Kohler, 2006), not dissociating the PCK

(Pedagogical and Content Knowledge) from the TK (Technological Knowledge); 2) the development of online courses that may fit the teachers' needs, eliminating identified constraints like "cost", "time" or "distance", preserving most of their daily routines; 3) providing some complementary activities, in their own context, that would sow the seeds that will eventually empower teachers to develop and share the Digital Educational Resources, in their teaching activities, promoting progressively active learning environments; 4) to provide collaboration opportunities and promote the debate among teachers. These elements combined can foster ICT integration (Kibrick, van Es, & Warschauer, 2010, p. 160).

Although it is widely accepted that individuals' behavioural "Intention to Use ICT" is determined by "Perceived Usefulness" and "Perceived Ease-of-Use" (Venkatesh & Bala, 2008, p.275) in the present research we wonder if there are other factors, mostly related to "ICT skills" or "ICT Knowledge", that may act as significant predictors for "Intention to Use ICT", the strongest factor that triggers "ICT use" (Venkatesh, Morris, Davis, & Davis, 2003, p. 427).

### **Instructional Design**

There is an obvious tension between teaching and learning...

When a teacher conceives a plan about what he/she intends their students to be able to learn, he/she must reflect on what may be the best way to accomplish his/her goals. And that is the root and foundation of "Instructional Design".

Although this is a process that has been empirically implemented from ancient times, it was during World War II that these processes were scientifically systematised "by psychologists and educators who had training and experience in conducting experimental research (...) and develop training materials for the military services." (Reiser, 2001b, p. 58). This process was implemented when thousands of soldiers needed

to be trained in a short period of time to perform complex tasks. At that time specialists thought that the most efficient method for teaching these complex tasks was to divide them into simpler tasks, so soldiers could better understand and comprehend each step of the process.

That concept was extended by behavioural theorists (Thorndike; Watson & Pressey; Skinner) connecting empirical research to the demands of an educational system that desperately needed to incorporate that concept. After that, Benjamin Bloom classified learning objectives on three domains: cognitive, affective and psychomotor. In 1965, Gagné expanded those learning outcomes to five (verbal information, intellectual skills, cognitive strategy, attitude, and motor skills) and nine instructional events that comprise the “conditions of learning”:

1. Reception: gaining learners attention;
2. Expectancy: Informing learners what the objective is;
3. Retrieval: Stimulating recall of prior knowledge;
4. Selective perception: Presenting the stimulus;
5. Semantic encoding: Providing learning guidance;
6. Responding: Eliciting performance;
7. Reinforcement: Providing feedback;
8. Retrieving: Assessing performance;
9. Generalisation: Enhancing retention and transfer.

Consequently, Instructional Design (ID) considers “teaching methods and theories” and “learning theories” and combines “strategies” (the educational methods and teaching activities), “resources” and “activities” (meaning student’s actions) that induce learning improvement.

In 2008, Willis identified two main perspectives in the Instructional Design:



- a) Pedagogical Instructional Design, as “the systematic process of translating general principles of learning and instruction into plans for instructional materials and learning” (p. 317).

The main characteristics of this perspective are:

- i) Process is sequential and linear;
- ii) Planning is top-down and systematic;
- iii) Objectives guide development;
- iv) Careful sequencing and teaching of subskills are important;
- v) The goal is “delivery of pre-selected knowledge”;
- vi) Summative evaluation is critical.

- b) Process Instructional Design as “the process by which instruction, computer-based or not, is created. Instructional Design provides a framework for the creative process of design and ensures the learners' needs are met” (pp. 16-17).

The main characteristics of this perspective are:

- i) Process is recursive, non-linear and chaotic;
- ii) Planning is organic, developmental, reflective and collaborative;
- iii) Objectives emerge from design and development work;
- iv) Problem solving skills are valued and it is essential to provide students with the adequate skills to overcome the problems they identify;
- v) The goal is “personal understanding within meaningful contexts”;
- vi) Formative evaluation is critical.

Obviously, these two methods emerge from opposite sides: one from order and the other from chaos. But, although these visions may indicate antagonistic perspectives, we may actually consider that (at least in some points) they can be considered as

complementary.

Regardless of the instructional designer's personal beliefs, convictions and skills, and despite the scope of the endeavour, the instructional designer should always follow a model. The most widespread are: ADDIE, Backward Design, ASSURE.

The ADDIE model, initially developed by the Florida State University for the United States Army (Branson, Rayner, Cox, Furman, King, & Hannum, 1975), is a sequential linear five-phase approach (19 steps) for developing training courses, which are: Analysis, Design, Development, Implementation, Evaluation. This model, designed as linear and sequential, was developed by van Merriënboer (1997, p. 3), who considered that "the phases may be listed in a linear order, but in fact are highly interrelated and typically not performed in a linear but in an iterative and cyclic fashion".

The Backward Design model (Wiggins & McTighe, 2005) is a three-step approach that begins with the desired outcomes and starts the process from there:

1. Identify the desired outcomes - a clear idea of what students should know, understand, and/or be capable of doing, when the teaching/learning process is concluded. The goals are based on a Taxonomy for Learning, Teaching and Assessing (Anderson & Krathwohl, 2001) that describe the cognitive learning processes related to increasing levels of abstraction and complexity, from basic to advanced, around which learning outcomes can be organised:
  - i. Remember: the ability to recover and access knowledge from long-term memory;
  - ii. Understand: the ability to understand, interpret, classify, summarise and compare, and to construct meaning;
  - iii. Apply: the ability to perform an unfamiliar task by applying previous knowledge to a new situation or problem;

- iv. Analyse: the ability to organise, differentiate and attribute;
  - v. Evaluate: The ability to judge, reason, and assess;
  - vi. Create: The ability to innovate and produce new knowledge.
2. Determine the appropriate criteria for evaluating students' progress (how can we gather the appropriate evidence of learners' understanding and knowledge);
  3. Plan the instructional methodology and learning experience (that encompass the learning experiences and teaching actions which best promote understanding, engagement and excellence).

We may identify significant differences between this model and the ADDIE model, but the most relevant are: a) this model places learning outcomes at the centre of the process, offering teachers the flexibility to structure the learning experiences and the assessment tools, so that they both align adequately; b) its effectiveness, as the “content” and “process” phases can be developed simultaneously, interacting and influencing one other, saving time in the development process.

ASSURE (an acronym that stands for the various steps in the process) is an instructional design model, whose goal is to promote more effective teaching and learning. The following is a breakdown of each step:

A - Analyse learners

S - State standards and objectives

S - Select strategies, technology, media and materials

U – Use technology, media and materials

R - Require learner's participation

E - Evaluate and revise

The biggest disadvantage of this model is that a precise knowledge of the learners'

previous skills is necessary to proceed to the sequent phases (which, in most situations, is not possible to have in advance).

### **Instructional Design and Technology**

Reiser (2001a, p. 53) added technology to this equation and defined Instructional Design and Technology (IDT) field as encompassing:

“the analysis of learning and performance problems, and the design, development, implementation, evaluation and management of instructional and non-instructional processes and resources intended to improve learning and performance in a variety of settings, particularly educational institutions and the workplace. Professionals in the field of instructional design and technology often use systematic instructional design procedures and employ a variety of instructional media to accomplish their goals”.

Educational resources, on their own, have no effect on learning, unless a learning strategy is present. This also means that Digital Media is useless without a learning strategy and, typically, that is a teachers' responsibility. Therefore, we can define IDT as the instructional design that encompasses the media selection, useful for educational purposes, and that may serve teachers' instructional design strategy.

In today's “multimedia world”, there is an enormous parade of Digital Educational Resources suited to be used in educational activities, which might meet the teachers' goals and may prove to be adequate for their strategies. The problem may be the amount of time necessary to select the appropriate resources that each teacher's requirements. Also, nowadays, producing Digital Educational Resources is easier and cheaper than ever and, when we consider digital resources for educational purposes, everyone should be able to shift from “digital consumer” to “digital producer”.

The “promised revolution” regarding technologies in education, that has been

around for several generations of educators, has not arrived yet (and probably never will) just because technology, by itself, does not replace the instructional methods and the strategies that promote students' achievement. Either way, digital technology is an element that serves an "educational strategy" instead of being a "strategy" by itself. In 2014, Clark remarked that, should the same instructional methods be applied, the results will not differ significantly from a lesson delivered by film, by an instructor or by paper resources, as she advised us to "ignore panaceas in the guise of technology solutions in favour of applying proven practices on best use of instructional models and methods to all media you use to deliver training" (Clark, 2014, p. 10). That means we must carefully plan (from the instructional design perspective) all media resources we intend to use in our schools, whether they are self-produced or selected from a wide-range of online resources, for free.

## **The Multimedia use in Education**

### **Multimedia and the science of learning.**

Most "old guard" students remember at least one teacher who lectured a complete (and boring) lesson from his/her chair without any other educational resource except his/her voice. Or, a teacher that dictated for the students to write down (yes, with a pen or pencil) the "knowledge" to the student's paper notebooks that they carried daily and diligently to school in heavy schoolbags. From that, we perceive how schools have dramatically improved in the last few decades.

Obviously, that scenario would be intolerable in today's school, and most teachers have upgraded their practices. As Baldwin (1998, p. 10) said "technology calls traditional faculty instructional roles into question" and "the traditional professor is now a course designer, a lecturer, a discussion moderator and a learning evaluator. New technologies

challenge these roles because some aspects can be performed more effectively and efficiently using technology". Many teachers are now aware about the need to integrate additional methods and resources that aim to facilitate their daily activities and, most importantly, to support and improve student's learning. Fortunately, the image of a "lecturing teacher", sitting in the chair, sharing knowledge, with the passive students writing in their notebooks is an image that is quickly fading away. In fact, in today's student eyes, that would just look ridiculous.

The research of Sweller, van Merriënboer & Paas (1998) described the human cognitive architecture and its implications on learning, pointing out how instructional design should be developed to deal with. In fact, they concluded that the working memory, which is very limited, is used to process all instructional material. However, "its capacity can be enhanced when using both visual and auditory channels". Furthermore, they concluded that "all material handled by the working memory can be transferred to the long-term memory, which is virtually unlimited, in the form of schemas that can vary in their degree of automaticity. Both schema construction and automation have the dual function of store information in the long-term memory and reduce the load on the working memory" (p. 289).

That usage of the visual and auditory channels is the basis of what Mayer calls "multimedia instruction hypothesis" (Mayer, 2017, p. 483): "People learn better from words and pictures than from words alone". This statement was, indeed, the first lines of Mayer's 2001 (1<sup>st</sup> edition) book "Multimedia Learning" (Mayer, 2009) where he presented his "Cognitive Theory of Multimedia Learning". In 2003, Mayer suggested that deeper (meaningful) learning can be fostered by multimedia, that is, the combination of words and pictures in multimedia instructional messages that can serve as aids to human learning (Mayer, 2003, p. 127). In this phrase, two concepts are present and entwined:

- a) The instructional message has to combine words (in a written or spoken format) and pictures (whether it is static - illustrations, maps, charts, photos, etc. - or dynamic - video animations);
- b) The presentation should be designed to provide meaningful learning (p. 128).

The learning process is built upon mental representations that learners are able to construct from the multimedia presentation (Mayer, 2009, p. 2).

The Cognitive Theory of Multimedia Learning (CTML), presented by Mayer, is based on three assumptions, as suggested by cognitive science researchers about the nature of human learning (figure 16):

- a) The dual channel assumption;
- b) The limited capacity assumption;
- c) The active learning assumption.

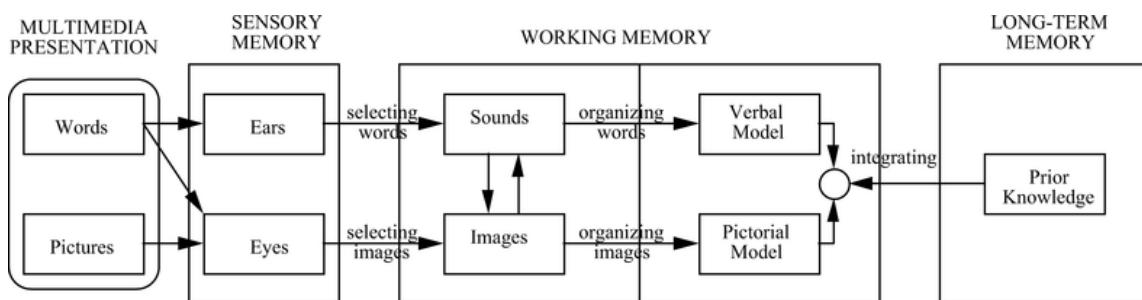


Figure 16. Cognitive theory of multimedia learning.

Source: Mayer (2009, p. 52).

The dual channel assumption enables Instructional Designers to take advantage of the two separate channels that humans possess which can be used to process visual and verbal representations and it “derives from the work of Paivio (1986), Clark & Paivio, (1991) and Baddeley (1992, 1998)” (Mayer, 2003, p. 129). These two processing channels, although functionally independent, are interconnected. An example of this dual channel usage is the “video animation”, in which pictures (both static and/or animated)

are processed by the visual/pictorial channel and audio (whether it is music or spoken words) is processed by the auditory/verbal channel.

The limited capacity assumption means that “the amount of information processing that can take place within each processing channel is extremely limited (Baddeley, 1992, 1998; Chandler & Sweller, 1991; Sweller, 1999; Van Merriënboer, 1997)” (Mayer, 2003, p. 129) and that is a crucial problem that instructional designers should consider when planning educational resources. In fact, according to Sweller's Cognitive Load Theory (1988, p. 265), “we know that human short-term memory is severely limited and any problem that requires a large number of items to be stored in short-term memory may contribute to an excessive cognitive load” and that suggests that learning is improved when using conditions that are aligned with human cognitive architecture (even though, so far, that architecture is not completely known).

According to Sweller, Ayres, & Kalyuga (2011, p. 57), there are three types of cognitive load: i) intrinsic; ii) extraneous, and iii) germane;

The intrinsic cognitive load emerges from the basic structure of the information that the learner needs to acquire for achieving the learning outcomes, regardless the instructional procedures.

The extraneous cognitive load results essentially from ineffective instructional design and it needs to be minimised. This type of cognitive load is only related with the nature of the instructional material and the methods used to present it. This type of cognitive load, under many circumstances, is unnecessary and extraneous to the learning goals, and instructional design should aim to minimise it, because “reducing extraneous cognitive load frees working memory capacity and so may permit an increase of resources devoted to intrinsic cognitive load” (Paas & Sweller, 2005, p.38).

The germane cognitive load is imposed by processes directly relevant for learning



(schema construction and automation). A well-designed instruction should optimise germane cognitive load within the limits of the total available working-memory capacity.

The central finding of the Cognitive Load Theory, which Mayer classifies as the second assumption, considers that “each channel in the human information-processing system has limited capacity - only a limited amount of cognitive processing can take place in the verbal channel at any one time, and only a limited amount of cognitive processing can take place in the visual channel at any one time” (Mayer & Moreno, 2003, p. 44). This theory, the first to consider the limitations of working memory (also known as short-term memory) and its implications towards learning and instructional design, proposed that, as working memory is limited, learners' distraction by irrelevant aspects of a problem should be avoided. Therefore, the use of schemas (or a combination of elements with the fundamental aspects of a problem) are the cognitive structures to be used.

Additionally, the management of learning materials is crucial to avoid that learners to becoming overwhelmed with information. Moreover, if the complexity of the instructional materials is not properly managed, this will result in a “cognitive overload” which impairs schema acquisition and, eventually, leads to poor student learning.

Thus, it is recommended the use of solved examples to promote schema acquisition, and later (as they gain expertise) its replacement with partially-completed problems (van Merriënboer & de Croock, 1992) until they eventually are able to autonomously solve complete problems and acquire skills automation (Sweller, Ayres, Kalyuga & Chandler, 2003). This is reunited in the 4C-ID theory (as presented in figure 17), designed for skill acquisition and complex learning (although we strongly believe that this theory is applicable in many other leaning situations, not only in complex learning), which encompasses all these suggestions.

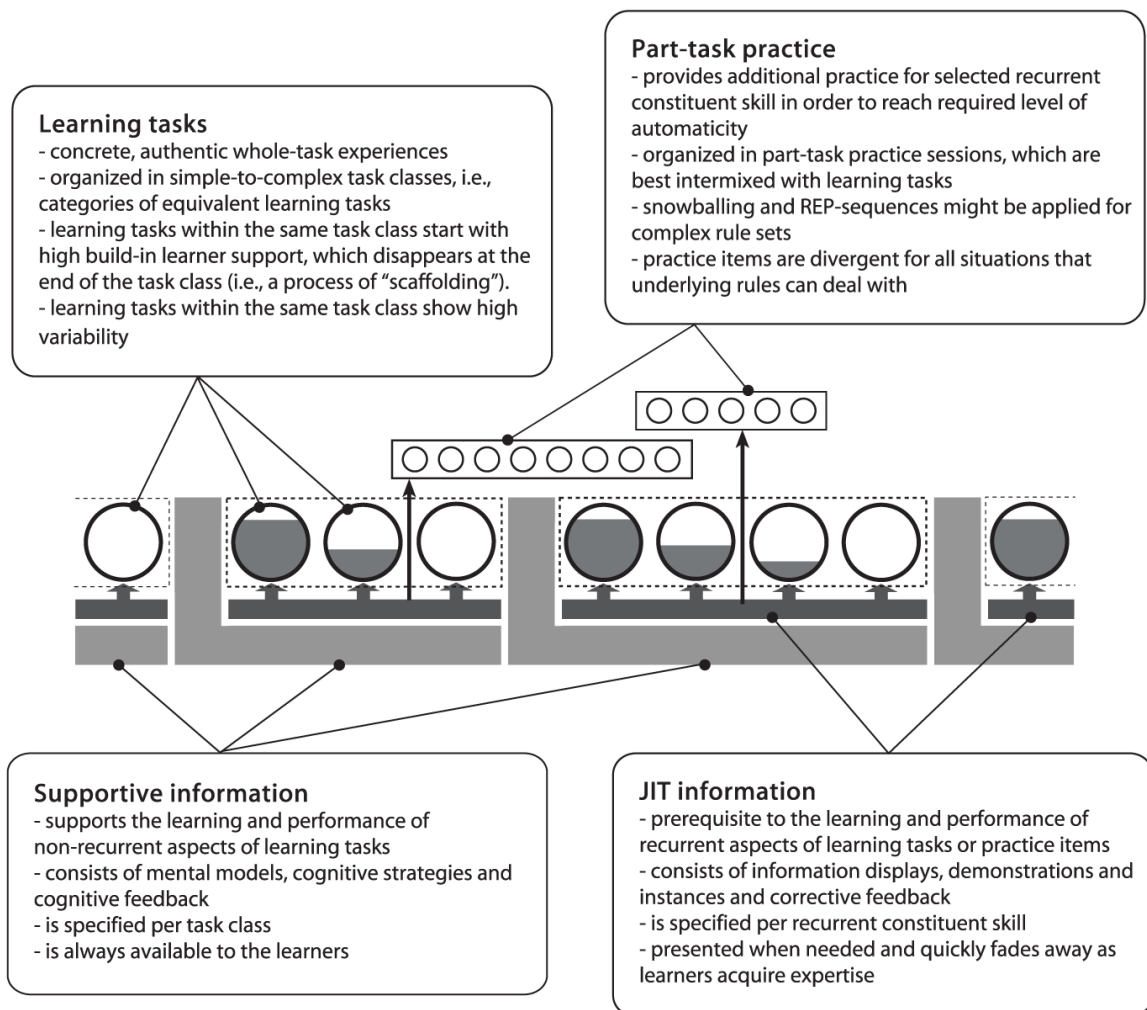


Figure 17. The 4C-ID model.

Source: van Merriënboer, Clark & de Croock (2002, p. 44).

The 4C-ID theory states that “environments for complex learning can always be described in terms of four interrelated blueprint components, based on the four categories of learning processes that are central to complex learning” (van Merriënboer, Clark & de Croock, 2002, p. 44):

- a) Learning Tasks;
- b) Supportive Information;
- c) JIT (just-in-time) information;
- d) Part-Task practice.

This 4C-ID model is considered to have developed the Cognitive Load Theory from an “instructional message design theory” to a “full-fledged instructional design model”, becoming particularly useful for designing larger courses and training programs that are characterised by a high level of interactivity. In fact, this theory has indicated the methods for sequencing and providing problem-solving support, for encouraging students to invest germane load in learning and taking their levels of expertise into account, and for student assessment and the development of adaptive forms of instruction (van Merriënboer & Sweller, 2005, p. 172).

In the sequencing process it is crucial to assure some scaffolding principles, such as the “simple to complex” principle, to prevent cognitive overload, assuming as obvious that the cognitive load of a simpler task is smaller than the whole-task. This principle can be obtained through the following modalities: a) complex performances are broken down into simpler parts, that are trained separately, or; b) in a part-whole approach in which tasks are combined into a whole-task performance. The broader concept of “task classes” was introduced by van Merriënboer (1997) to define simple-to-complex learning tasks, and he stressed the need to assure that each new “task class” contains learning tasks that are in the learners’ “zone of proximal development” (Vygotsky, 1987, p. 208). When learners start to work on a new task class, it is essential to lower extraneous cognitive load through the introduction of adequate support (van Merriënboer, Kirschner & Kester, 2003, p. 7).

The third assumption of Mayer’s CTML is that:

“Meaningful learning requires a substantial amount of cognitive processing to take place in the verbal and visual channels. This is the central assumption of Wittrock’s (1989) generative-learning theory and Mayer’s (1999, 2002) selecting - organising - integrating theory of active learning. These processes

include paying attention to the presented material, mentally organising the presented material into a coherent structure, and integrating the presented material with existing knowledge” (Mayer & Moreno, 2003, p. 44).

That assumption is also present in the 4C-ID theory: active learning, with an evolution as suggested by the Cognitive Load theorists - First we should provide students with solved problems; later, with partly solved problems; and eventually students will become ready to face and solve problems from the scratch. All that should be accompanied by supportive information (that provides information supporting the learner to fill in the gap between prior knowledge and the learning tasks) and “Just in Time” information, presented only when needed (and quickly fading away when students gain expertise), intermixed with part-task practice (“snowball kind” or “task repetition”, useful when acquiring crucial skills considered as fundamental to accomplish learning tasks).

Mayer terms these assumptions as “The science of learning”, although the first reference to that expression has been made by Skinner, in 1953, in an article called “Current trends in psychology and the behavioral sciences” (pp 38-58), first published in the “science and human behaviour” journal, and republished in 1968 (Skinner, 1968, pp. 9-29).

### **Multimedia and the science of instruction.**

The concept of “science of instruction”, when applied to the Educational Technology field, is grounded on Skinner’s “programmed education” (1953, 1968), and encompasses the processes related to the conception, development, management and assessment of learning. In fact, the terms “Educational Technology” and “Instructional Technology” cover all the theory and practice of planning, development, use, management and evaluation of learning (Miranda, 2007, p. 40).

In 2003, considering the findings of the “science of learning”, Mayer & Clark

published their theory about the “science of instruction”, making the connection between the “science of learning” and the processes related with multimedia for educational use, supported by an extensive empirical base of findings that emerged from research. In other words: if we know the basic principles of how people learn, what should we do, as instructors, to facilitate the learning processes and how can we incorporate digital technologies in these processes?

Mayer & Clark sustained this theory on evidence from research (around 100 studies over two decades) and identified twelve multimedia instructional principles that should be taken into account when designing multimedia educational resources:

1. Coherence: People learn better when extraneous material is excluded.
2. Signalling: People learn better when we highlight the essential material.
3. Redundancy: People learn better from graphics and narration than from graphics, narration, and printed text.
4. Spatial Contiguity: People learn better when corresponding words and pictures are placed near each other (rather than far from each other) on the page or screen.
5. Temporal Contiguity: People learn better when corresponding words and pictures are presented at the same time rather than in succession.
6. Segmenting: People learn better when a multimedia lesson is presented in user-paced segments rather than as a continuous unit.
7. Pre-training: People learn more deeply from a multimedia message when they receive pre-training on key components.
8. Modality: People learn better from graphics and narration than from graphics and printed text only.
9. Multimedia: People learn better from words and pictures than from words alone.

10. Personalisation: People learn better from a multimedia presentation when the words are in conversational style (rather than in formal style).
11. Voice: People learn better when the words in a multimedia message are spoken by a friendly human voice rather than a machine voice.
12. Image: People do not necessarily learn more deeply from a multimedia presentation when the speaker's image is on the screen (this means that "talking heads" in video resources are not only superfluous: it can induce distraction from the essential points of the message and harm the learning processes).

In 2008, Mayer revised the "redundancy principle" by adding an important caveat to the redundancy principle "People learn more deeply from graphics and narration than from graphics, narration, and on-screen text" by adding the following exception: "except when the on-screen text is short, highlights the key action described in the narration, and is placed next to the portion of the graphic that it describes" (Mayer & Johnson, 2008, p. 385).

Mayer (2017, pp. 491-495), organised these principles in three categories, with the corresponding effect sizes (Cohen's  $d$ ):

1. Principles for reducing extraneous processing:
  - i. Coherence – Reduce extraneous words and pictures ( $d=1.0$ );
  - ii. Signalling (or cueing) – Highlight essential words and pictures ( $d=0.5$ );
  - iii. Redundancy – Do not add onscreen text to the narrated graphics ( $d=0.7$ );
  - iv. Spatial contiguity – Place printed words near corresponding graphics ( $d=1.0$ );
  - v. Temporal contiguity – present corresponding words and graphics simultaneously ( $d=1.3$ );
2. Principles for managing essential processing in multimedia learning:

- i. Segmenting - break a continuous lesson into manageable parts ( $d=1.0$ );
  - ii. Pre-training – provide pre-training in names and characteristics of each main concept ( $d=0.8$ );
  - iii. Modality – accompany graphics with spoken words, rather than printed words ( $d=1.0$ );
3. Principles for fostering generative processing:
- i. Personalisation – put words in conversational style ( $d=1.0$ );
  - ii. Voice – use friendly human voice for speaking words ( $d=0.7$ );
  - iii. Embodiment principles – include onscreen agent that exhibits human-like gestures and movements ( $d=0.6$ );

This theory has been developed throughout the years and other principles were identified (Mayer, 2014), called as “advanced principles of multimedia learning” such as “the guided discovery” (pp. 215-228), “the worked-out examples” (pp. 229-246), “the collaboration principle” (pp.247-270), “the self-explanation principle” (pp. 271-286), the “the animation and interactivity principles” (pp. 287-296), “the navigational principle” (pp. 297-312), “the site map principle” (pp. 313-324), “the prior knowledge principle” (pp. 325-339) and “the cognitive aging principle” (pp. 339-354).

Moreover, Mayer & Moreno (2003) identified nine solutions to overcome cognitive overload, describing the methods to be considered in the Instructional Design phase that can actively reduce cognitive overload:

- a) “One channel is overloaded with essential processing demands”.

Solution 1: Off-load that channel by shifting some of the processing to the other channel (example: present words as narration and relieve the cognitive load demanded to the visual channel when words are present in the message in the written form).

- b) “Both channels are overloaded with essential processing demands”.

Solution 2. Segmenting the message.

The segmentation: i) Provides learner with the ability to select words and images from the segment; ii) Allows the time and capacity to organise and integrate the selected words and images.

Solution 3: Pre-training. When segmenting is not feasible, pre-training can solve it, by providing prior instruction concerning the key components in the “to-be-learned” system. Constructing a mental model involves two steps - building component models (i.e., representations of how each component works), and building a causal model (i.e., a representation of how a change in one part of the system causes a change in another part, etc.).

- c) “One or both channels are overloaded by the combination of essential and incidental processing demands”.

Solution 4. Weeding (eliminating interesting, but extraneous material);

Solution 5. Signalling (when removing all the embellishments in a multimedia message is not possible, cognitive load can be reduced by providing learners with small cues about how to select and organise the material).

- d) “One or both channels are overloaded by the combination of essential and incidental processing demands”.

Solution 6. Aligning words and pictures (if on-screen text is placed at the bottom of the screen and the corresponding graphics are placed on the top of the screen it forces the learner to engage in a great deal of eye movement to figure out which part of the animation corresponds with which words—creating what we call incidental processing);

Solution 7. Eliminating redundancy (eliminate the words that are presented both



as narration and simultaneously as on-screen text).

- e) "One or both channels are overloaded by the combination of essential processing and representational holding".

Solution 8. Synchronising - synchronise the presentation of corresponding visual and auditory material. When presentation of corresponding visual and auditory material is simultaneous, there is no need to hold one representation in working memory until the other is presented).

Solution 9. Individualising - when synchronisation is not possible, an alternative technique for reducing cognitive load consists in making sure that the learner possesses the necessary skills for holding mental representations in memory.

### **The "Attention Span".**

When designing digital educational resources, a problem we must take into account is related to the attention that students must dedicate to the resources, in order to process the information that teachers intend to convey. People's average attention span is around 15 to 20 minutes, so our resources should be designed to match that length and if we are designing e-learning lessons, length should be restricted to less than 10 minutes (Clark, 2014, p. 243, citing Hattie & Yates, 2014). Again, this may not be another black or white question, as it depends on the essence of the topic and the way it is delivered (with clarity, enthusiasm and drama, with a cognitive break every now and then) (Wilson & Korn, 2007, p.88, citing Bligh, 2000). Because prolonged attention is related to the working memory (which is limited as seen before) we might as well decide not to overload it by accepting those limits.

In nowadays digital society, the "always on" generation has some characteristics that we must take into account, which can be expressed in this phrase: "Say it quickly, say it well".

In a study published in 2012, a medicine student stated that: “the biggest consequence I foresee is an expectation of immediacy and decreased patience among people”. Those who grow up with immediate access to information, quick response to email and rapid answers to all questions, will never take long routes to find information, looking for ‘quick fixes’ rather than taking the time to come to a conclusion, or to reach an elaborated answer (Anderson & Rainie, 2012, p. 12).

This lack of patience is expressed in numerous studies about the consumer behaviour and that is an issue we must consider during the development of digital educational resources, as that is a variable we do not control. The need for focus is also an important issue, as most people who will access our resources may not be absolutely focused in it. At this point we should bring into consideration the Reticular Activating System (RAS), located at the posterior base of the brain, which helps to filter which surrounding data is allowed to pass towards the brain. Actually, it helps to classify as “important” (and let it pass) the messages regarding the issues we are focused on. That is the reason why “focus” is so important.

When producing videos, another variable we do not control is the drop-off rate from the people who start to watch a video resource, but leave before its end. That does not necessarily mean a lower engagement (people accessing the video may be looking for a specific information and, once they have it, they leave), but we expect that shorter videos may have lower drop-off rates than longer ones. In figure 18 we present a published study that addresses this problem (Ruedlinger, 2012).

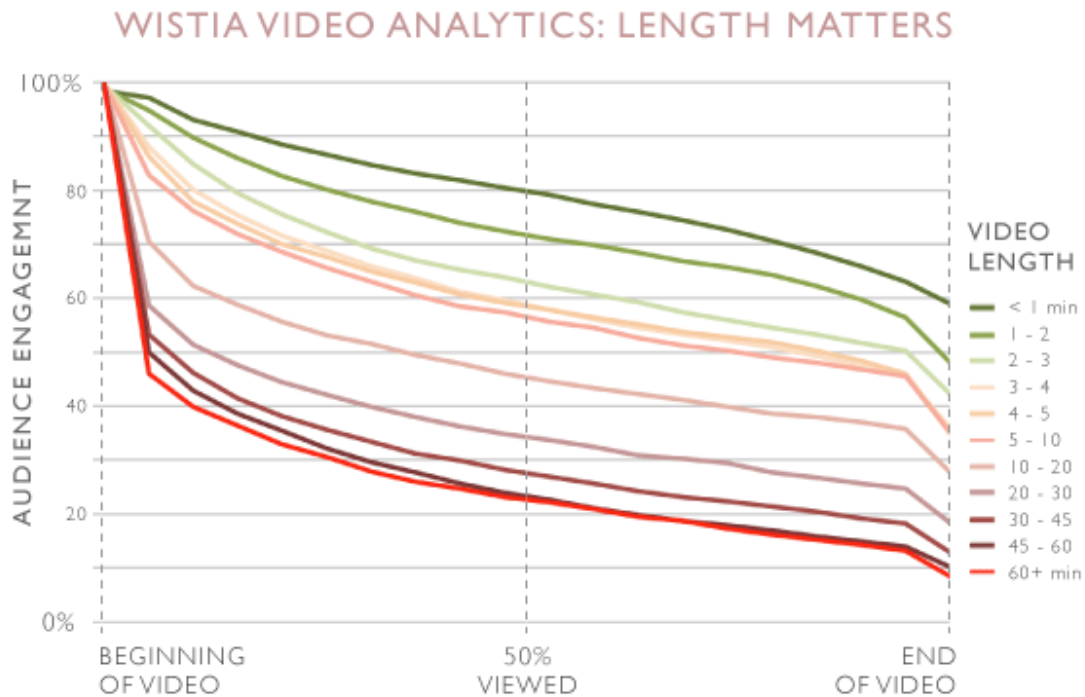


Figure 18. Audience engagement vs video length (2012).

Source: Retrieved from wistia.com.

Is noticeable from figure 18 that, after a certain point, the engagement average flattens out (there is not a major engagement difference from a 4-minute video when compared with a 10-minute video). From this, we can suggest that the most important messages should be placed at the beginning of the video (when possible) in order to maximise the use of the highest “audience engagement” (the first 5% of its length is crucial).

For longer videos, we can perceive that: a) The drop-off at the beginning of the video is extremely steep, and apparently most viewers quickly decide whether or not they continue to watch; b) Once that decision is made, they tend to stay until the end of the video; c) When viewers detect that the video is wrapping up, another drop-off occur. For this reason, we may consider a hard stop to the video, rather than a meandering wrap-up.

Overall, we can say that:

- a) Shorter videos are more engaging than longer videos. We should strive to make the content concise enough to achieve the highest audience engagement.
- b) If the message is more complex, we should consider to give it the time it deserves, but we should be aware that a portion of the audience may not make it until the end of the video.
- c) Consider front-loading the produced video with the most important information at the beginning.

Some rather interesting comments on Ruedlinger's article are:

- a) "A video can never be too long, only too boring";
- b) "I lose interest in the first 5 minutes, unless the video is so full of good information that I keep watching".

Obviously, teachers are not developing resources for marketing purposes but they can learn from it. Again, this section does not intend to bring to the discussion another "black and white" question.

Having all that in mind, whose guidelines should producers consider when developing digital resources, in such a short attention-span world?

- a) Don't make people wait for the information. Before consider the content, make sure the resources are quickly presented to the audience. Some studies have shown that 32% of audience will be distracted in less than 5 seconds, when waiting for content. To make people wait for the important information objectively provide them a motive to disperse their attention, and to move to another resource, which configures a lost opportunity.
- b) Include key information upfront, and begin stating what is the purpose of the resource. That may convince users to stay with the resources, as long as they

know where they are heading to.

- c) At the end of the message, highlight the key aspects with small phrases (bullet points when possible) to wrap up your messages and make resources “easier to digest”.
- d) Keep content short and punchy (if applicable, make sure any detailed content can be presented separately). With the limited attention span and the need for instant gratification of today's generation just to realize the length of a resource can be enough for the audience to disperse at some point, or even don't start to access the resource. In the presence of a very extensive content, consider splitting it into relevant (and easily digestible) segments, which allows people to access it, one piece at a time, without necessarily having to continue to the next.
- e) Present information in a logical, sequential pattern - a key element of RAS, with impact on focus and attention.
- f) Tell the audience what they need to know (and nothing more). That may sound obvious, but far too many people neglect this point. When passing a message, the audience should be told everything they need to know and, once done, stop there, leaving supplementary materials for later, or to separated resources.

### **Video type and duration.**

When asked to produce digital educational resources, most teachers tend to replicate in video what they do in classroom. The video recording of face-to-face lectures is wrong for many reasons (some of them presented before). Nevertheless, in some situations (laboratory experiments, cooking, equipment assembly, etc.) the recording of the classroom activity can actually be the most adequate way to deliver content.

Still, in most cases, we can produce a small number of short videos that can

highlight the key points of a lecture without compelling students to watch hours and hours of video.

It is notorious that the drop-off rate is very significant on longer videos. But, unless we are shooting a commercial video, a 30 second video may not be adequate, from an educational perspective. In another study, published in 2006, Fishman demonstrated that engagement is very good in short videos and if that can suit our needs we do not need to stress about the difference of a few seconds: when possible, keep the video length under 2 minutes.

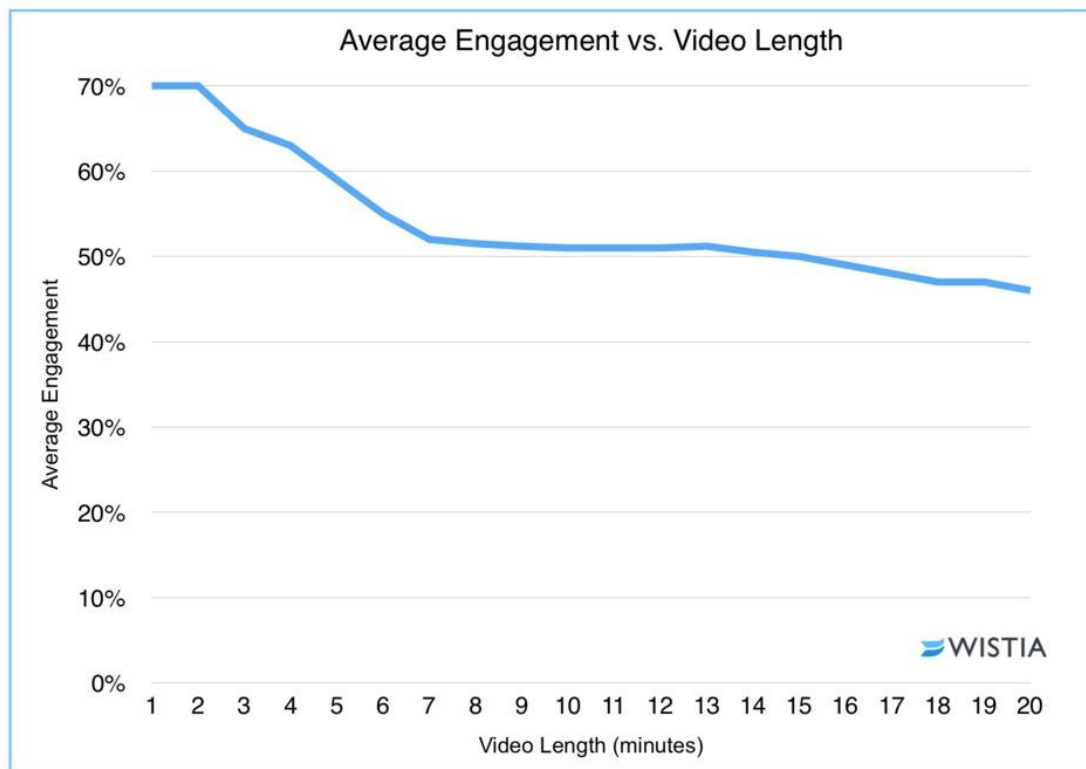


Figure 19. Audience engagement vs video length (2016).

Source: Retrieved from wistia.com.

From figure 19 we can perceive that:

a) After 2 minutes engagement decays and starts to level off after the 6-minute mark. So, if it is not possible to deliver an educational message in less than 2 minutes we should be prepared to a significant drop-off;

b) Drop-off is not significant between 6 and 20-minute video length, and is close to zero between 6 and 12 minutes, which means that, if we cannot produce a video with length lower than 6 minutes, we do not need to worry to speed up if we can produce the resource with less than 20 minutes (it shouldn't have a significant effect on the audience engagement);

c) Videos longer than 6 minutes are probably conversational, narrative stories or tutorials. In all these cases, the viewers would expect the video to be long, and they prepare themselves for it, anyway.

It is also noticeable that the drop-off from 12 minutes to 20 minutes is less steep than the drop-off from 2 to 6 minutes. That is very important because longer videos are often more time-consuming to make, and not all platforms are able support these video lengths in free (non-commercial) accounts.

In most situations, we do not have to persuade our users to access our resources, as they need to access that content in order to obtain the necessary knowledge to perform in future situations. Nevertheless, we should always offer our viewers a reason to stay with our video and, as seen before, that should be done within the first minute of watching time. We need to “hook” our viewer’s attention in that brief window of “decision-making time” that user’s will allow our video, before deciding to move on. Once the viewer is hooked, there is no reason to cut our video ridiculously short or speed up our language, just to meet pre-established length requirements.

Bottom-line: Like in most real-life situations, balance is crucial...

### **A synthesis from the Literature Review**

From this chapter we realise that most teachers have a very positive attitude towards digital technologies. The models of technology acceptance are very well studied, documented and developed but there are some obvious gaps between the models and their

transposition to the teachers' practices, essentially in terms of ICT use. In today's school, it is very clear that attitude towards technology don't match technology use.

Most schools are insufficiently preparing students for a proficient digital technology use. Faculty is still generally averse to the use of technologies. Even the "NetGen" members, now assuming faculty positions in Higher Education Institutions, are still reproducing what "old guard" faculty have been doing for years (teachers' talk, students' listen).

Even the promised revolution of multimedia learning (using the words of Richard Mayer) is yet to arrive, despite the affordance and immense potential of today's digital tools.

Considering all this, the present research intends to identify the possible reasons for the gap we still recognise between "attitude" and "use" of digital technologies.



## **Chapter 2. The Empirical Research**

In this research, we first decided to propose a new development in the existing technology acceptance models, in order to identify the factors that may contribute to the increase of the use of technologies in classroom, namely by studying the relation of “ICT skills” with the other variables already present in the models. However, a model development just did not seem enough to provide all the answers we were looking for, and a second study was carried out, aiming to test some of the findings that emerged from the first study.

Thus, two distinct phases (and two different studies) were conducted:

- i. The first study (a survey research) was based on the models referred in the literature review phase, with the intention to propose a new develop in the Technology Acceptance Models, where the ICT skills may be integrated. This study aimed to characterise the current situation and evaluate the impact of ICT knowledge on ICT use;
- ii. The second study (a design-based research) was based on the researcher's experience and skills and looked for ways to improve teachers' ICT skills and provided the opportunity to improve the current reality. In a “hands-on” approach, the purpose was to implement the training actions that would enable to transfer digital skills to the participants, in order to achieve a more proficient use of the digital resources available.

### **The First Study – A development in the Technology Acceptance Models**

#### **The research problem and purpose statement.**

Creswell (2009, p. 23) suggests that the research problem should start with a small phrase that encompasses the central idea to reflect about in the study.

When we first started this investigation our advisor asked us “what is your major concern? What bothers you in terms of ICT and education?”. The first idea that emerged was “Why, in the 21<sup>st</sup> century, with so many affordable technologies available, teachers (in general) still don't use digital technologies in their scholar activities?”. That became our research problem and the starting point for this study, and that is a problem for a good number of reasons:

- a) We strongly believe that digital technology increases teachers' professional performance and contributes to relieve their workload;
- b) The use of digital technology, objectively, reduces the time and effort that must be put in place to accomplish teachers' goals and to perform most of teachers' duties, increasing teachers' efficacy and efficiency;
- c) Teaching with digital technology is far more appealing to students, whoever they are, and that fact alone should contribute to enhance student achievement.

According to Locke et al. (cited by Creswell, 2009, p. 111) the purpose statement indicates the reasons why we want to study something, and what are the goals we intend to accomplish. Therefore, the purpose of this research, is to develop a theory that tests the effect of “ICT skills” over “ICT use”: what is the contribution of ICT skills to the perception of ICT use. Or, in other words “is ICT skills a strong predictor of ICT use”? If yes, maybe if we provide teachers with the appropriate training and knowledge in terms of “ICT skills”, they will make a better and more proficient use of ICT.

We already know from the literature that “Intention to Use ICT” is the strongest predictor of “ICT use”. Thus, we developed and tested a causal model (figure 20), where we hypothesised that:

(H<sub>1</sub>) “ICT Knowledge” is a strong predictor of the “Intention to Use ICT”?

(H<sub>2</sub>) What is the influence of “Learning through ICT” over the “Intention to Use ICT”?

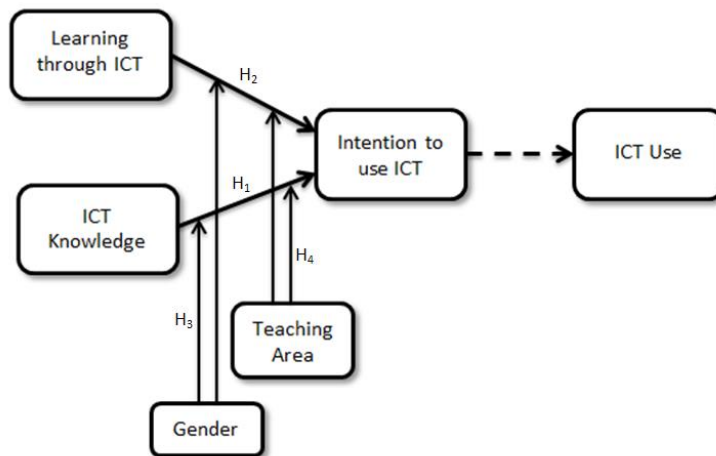


Figure 20. Hypothesis for the ISTTU model.

Source: Brás, Miranda & Marôco (2014, p. 58).

Additionally, we hypothesised that “Gender” (H<sub>3</sub>) and “Teaching Area” (H<sub>4</sub>) may have some influence on the effect of “Learning through ICT” and “ICT Knowledge” over “Intention to Use ICT”.

But, where to start?

First of all, a decision had to be made: should we test these theories with pre-service teachers or in-service teachers (or both)?

We choose to work with in-service teachers for the following reasons:

- i. To eliminate aspects related with the uncertainty of where (or if) participants will find an appropriate job after training;
- ii. To assure that all necessary academic or professional qualifications are achieved, which was crucial to assure that all focus was centred on ICT knowledge, alone.
- iii. Additionally, working with in-service teachers, allow us to assume that pedagogical knowledge (PK) and content knowledge (CK) are already acquired by all participants (questions related to job stability can be considered, though).

The question mark is, mostly, around the TK component of Mishra & Kohler TPACK model (2006, p. 1025), and we questioned if TK improvement can trigger “ICT use” in classroom. That would evoke a deliberate action in a of teachers' professional development context, in order to improve teachers' digital skills and promote ICT use.

### **The research questions.**

From the investigation problem, we started to develop our research questions that conducted the whole investigation:

1. Is “ICT Knowledge” a strong predictor for “Intention to Use ICT”?
2. Is “Learning through ICT” a strong predictor for “Intention to Use ICT”.
3. May “Gender” influence the effect of “Learning through ICT” and “ICT Knowledge” over the “Intention to Use ICT” (or, in other words, are men more likely to use technology than woman)?
4. May “Teaching Area” influence the effect of “Learning through ICT” and “ICT Knowledge” over the “Intention to Use ICT” (or, in other words, are teachers from technical areas more predisposed to use ICT than teachers from cultural or scientific areas)?

Other lateral questions, that may also be analysed in our research, are:

5. Admitting the intention to use ICT, will teachers be receptive to online models that aim to deliver the appropriate training, which may improve their ICT skills?
6. Regardless geographical dispersion, will online models be suited to deliver ICT skills (or, in other words, is it appropriate to use ICT to deliver ICT skills)?
7. Will online training courses be adequate to overcome barriers and empower

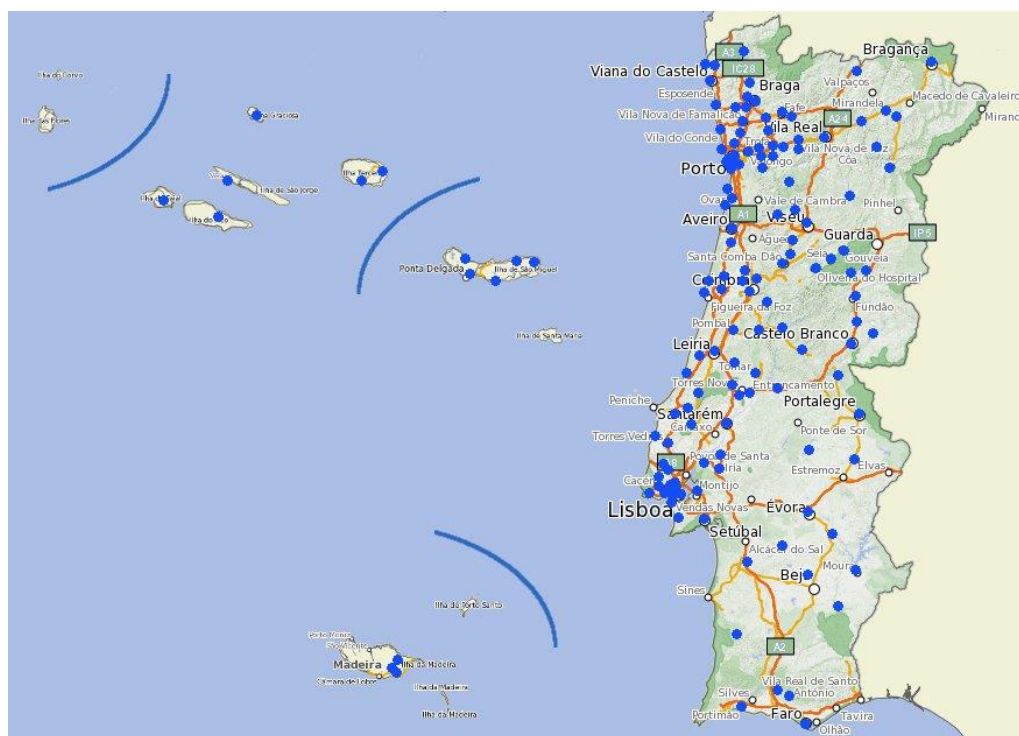
teachers to produce and share their own digital educational resources?

8. The encouragement to use Virtual Learning Environments in teachers' practices may increase ICT use?

We considered the “intention to use” because the “use”, itself, is not measurable, unless we are authorised to be present inside the classrooms. As behavioural intention is present in many studies, we analysed that variable, instead.

### **The empirical field.**

The empirical field for this project is the teaching staff of all 208 Professional Schools in Portugal, as described in Chapter I. According to GEPE (the statistical cabinet from the Portuguese Ministry of Education) in the scholar year of 2008/2009 the population was  $N=7,293$  teachers (GEPE, 2010a; GEPE, 2010b). Although Portugal is a rather small country, Professional Schools are geographically spread, with a nationwide presence, more significant in the coastal strip between Lisbon and Braga, with a particular incidence in Lisbon and Porto metropolitan areas (figure 21).



*Figure 21. Geographical distribution of the Portuguese Professional Schools.*

### **Instruments used.**

The models in the theory (TAM, UTAUT, TPACK) are widely studied and most of them already have questionnaires, which allows their evaluation and further application. However, none of these questionnaires was previously validated for Portuguese samples and different questionnaires were developed to measure the same variables. For instance, the questionnaire presented by Birch & Irvine (2009), with 23 items, focused pre-service teachers, while Teo's (2011, p. 2439) questionnaire, with only 20 items, was directed to in-service teachers.

Often, previous theories are not confirmed by empirical data when applied in different samples in different contexts. For instance, Birch & Irvine (2009) studied the UTAUT model and concluded that "only effort expectancy was a significant predictor of teachers' intentions to use ICT in their practicum teaching" (p. 312). Furthermore, they determined that "UTAUT model has been very successful in the business sector" (p. 311) but its application to teachers probably needs to integrate other variables such as "technology skill level". The same problem arises in other models, most of them tested with pre-service teachers. As Birch & Irvine (2009) also point out, "in-service" teachers may have a better understanding of the professional demands, students' needs, technology and resources available. Using the Structural Equation Modelling (SEM) technique, Teo (2011) concludes that "Perceived Usefulness", "Attitude Towards Use" and "Facilitating Conditions" are the variables with direct influence on Behavioural Intention to Use Technology, which is consistent with the relations described in the original TAM (Davis, Bagozzi & Warshaw, 1989) and UTAUT (Venkatesh, Morris, Davis & Davis, 2003). Additionally, Teo (2011) concludes that "«Perceived Ease-of-Use» and «Subjective Norm» have direct influence on «Behavioural Intention to Use Technology» and indirect influence through variables like «Attitude Towards Use» and «Perceived Usefulness»,

respectively” (p.2437).

In the present research, using instruments already validated in Portuguese samples, we intend to find out if “Attitude Towards Technology” and “Technology Skill Level” are predictors of “Intention to Use Technology”, Consequently, we used:

- a) The questionnaire “Perceptions of Computers and the World Wide Web”, developed by Liaw (2002), in order to measure “attitude” towards computers and the Internet;
- b) The “Technology implementation” questionnaire, developed and presented by Wozney, Venkatesh & Abrami (2006);
- c) The Technological Knowledge section of TPACK Questionnaire (Mishra & Koehler, 2006); and
- d) The “ICT use” questionnaire, developed and applied by Luzio (2006).

These questionnaires (or sections from it) were translated to Portuguese and later retroverted to English, in order to assure the validity, accuracy and reliability of the process.

#### ***Attitude towards computers and Internet.***

The questionnaire “Perceptions of Computers and the World Wide Web” (Liaw, 2002) was “formulated within the frames for assessing attitudes towards computers set out by these other instruments: Computer Attitude Measure (Kay, 1989, 1993), Computer Attitude Scale (Al-Khaldi & Al-Jabri, 1998; Loyd & Loyd, 1985; Nash & Moroz, 1997), and TAM (Davis, et al., 1989; Fenech, 1998; Lederer et al., 2000; Lin & Lu, 2000; Moon & Kim, 2001)” (p.20). This instrument has been used to estimate teachers' attitude towards Computers and the Internet, and was already translated to Portuguese and validated on a Portuguese sample by Jorge & Miranda (2002). Later, it was applied by Luzio (2006), Fernandes (2006), Jorge (2011) and Monteiro & Miranda (2011).

According to Jorge (2011), “The questionnaire developed by Liaw, cited by more than one hundred researchers and widely replicated, partially or integrally (Birgin, Çatlıoğlu, Gürbüz & Aydın, 2010; Fini, 2008; Teo, 2009; Yang & Lester, 2003) fits the purpose of simplicity and accuracy that all instruments must have” (p.88). Because this instrument was already validated for Portuguese samples, we considered that it would serve our purpose. Liaw’s original scales were scored on a seven-point Likert scale, but Jorge & Miranda (2002) reduced it to a six-point scale to avoid neutral answers.

This instrument has two scales, each one with 16 items, now scored in a 6-point frequency rating scale that ranged from 1 (totally disagree) to 6 (totally agree). In our survey, these questions were presented in group II, ranging from 201 to 216 (Computer Attitude Scale - 16 questions) and from 217 to 232 (WWW Attitude Scale - 16 questions). For the Computer Attitude Scale, applied on a Portuguese sample by Jorge & Miranda (2002), the reported Cronbach's alpha was 0.91 and the corrected item-total correlations ranged from 0.44 to 0.75. For the WWW Attitude Scale Cronbach's alpha was 0.93 and the corrected item-total correlations ranged from 0.47 to 0.80.

This instrument has been used, over a long period of time, to estimate teachers' attitude towards computers and the Internet but, in the original publication, the only available psychometric property was Cronbach's Alpha and it was reported that this questionnaire typically reveals “a high internal consistency”. However, no information was present regarding the other psychometric properties (validity and sensitivity), nor the factorial structure that emerged from that analysis. Over time, several studies published with Portuguese samples reported some inconsistencies in its factorial structure.

### ***Technology Integration.***

Questions from the “TIQ - Technology Implementation Questionnaire” (Wozney, Venkatesh & Abrami, 2006, pp. 204-205), specifically from sections “III -Your



Experience with Computer Technologies“, and “IV - Your Process of Integration” were integrated in group III of our baseline questionnaire: “Technology Integration” (questions 301 to 304).

### ***Technology Use.***

The “Technology Use Questionnaire” (Luzio, 2006) has 25 questions scored on a 6-point Likert scale that ranges from 1 (never use) to 6 (always use). In our survey, these questions were presented in group IV, ranging from 401 to 425. The Cronbach's Alpha reported by Luzio for this scale, in his sample, was 0.935.

### ***Technological Knowledge.***

The TPACK Questionnaire (Mishra & Koehler, 2006) integrates three sections: PK (Pedagogical Knowledge), TK (Technical Knowledge) and CK (Content Knowledge). Our sample is composed only by in-service teachers, most of them with significant professional experience (average=8.0 years, SD=6.2). So, we may assume that they already hold Pedagogical Knowledge and Content Knowledge (otherwise they could not already be teachers). That is the reason why we only used the “Technological Knowledge” (TK) section in our survey in order to measure the construct. This section contained 6 questions scored in a 6-point Likert scale, ranging from 1 (totally disagree) to 6 (totally agree) to evaluate how the participants agreed or disagreed with the statements. Profuse research with TPACK has reported Cronbach's alpha for TK, ranging from 0.84 to 0.93 (Voogt, Fisser, Pareja-Roblin, Tondeur & van Braak, 2012). In our survey, these questions were presented in group VI, numbered from 601 to 606 (6 questions), consisting in digital proficiency measurement (Group V intended to measure the declared perception of the individual digital proficiency).

The authorisation to translate, and to use and apply the questionnaire is presented in Appendix A.

### The baseline questionnaire.

As schematically presented in figure 22, the baseline questionnaire that allowed to collect empirical data for our research was built from the integration of four instruments:

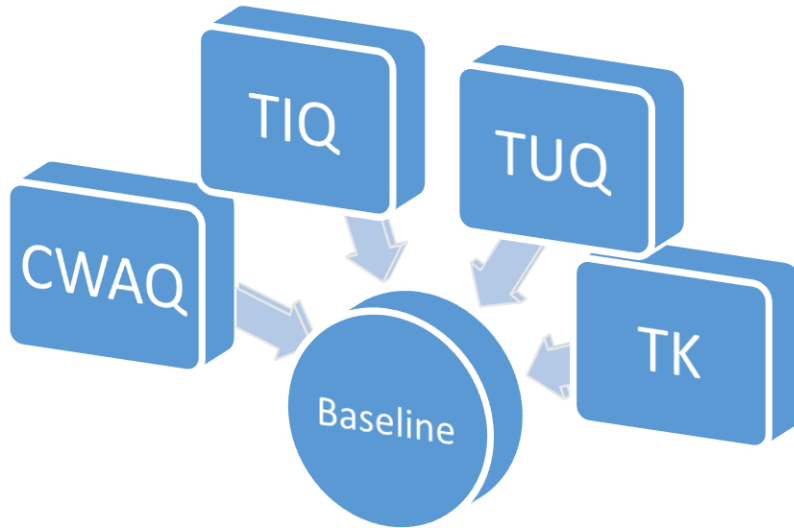


Figure 22. Origins of the Baseline questionnaire.

Therefore, the baseline questionnaire was composed by:

- Section I (personal characterisation) - 11 items
- Section II (Attitude) - 32 items (from CWAQ)
- Section III (Technology integration) - 4 items (From TIQ)
- Section IV (Technology Use) - 25 items (From TUQ)
- Section V (Training needs) – from 2 to 11 items (some of the questions are conditional, as they depend on the answer to previous questions, aiming to provide detail for those answers)
- Section VI (Technological Knowledge) - 6 items (from TPACK)
- Section VII - Identification (optional) - 3 items

To apply in our sample, we considered that it was absolutely necessary to validate the instruments, by determining all the psychometric properties, before its application to a sample of Portuguese teachers working in Professional Schools.

## **Methods.**

### ***Instrument's tuning: pre-test and the baseline questionnaire.***

A pre-test was implemented in 2011, from March until May, over a sample of teachers from the Gustave Eiffel Professional School<sup>2</sup>. All the participants involved were presented with information about the scope and the context of the study and answering the questionnaire was not mandatory. We obtained a total of 64 answers, which is about 25% from the universe of all teachers (258) from that school. However, from the results we were able to collect, we realised that some information needed to characterise the sample was still missing and some adjustments were made to the instrument for the next stage (the baseline questionnaire).

To guarantee the appropriate diffusion of the questionnaire, we required the collaboration from the Association that represents the vast majority of the Professional Schools in Portugal (ANESPO) and an email was received that confirmed the importance of this research for their associates. So, ANESPO supported the present research project with an email that was sent from ANESPO to all their associates (appendix B).

In conclusion, the pre-test was satisfactory and we decided that the baseline questionnaire would be implemented with an online survey, available to all teachers from professional schools.

### ***The Baseline questionnaire.***

The instrument designed to collect empirical data was implemented online using LimeSurvey open-source software (Version 1.90+, Build 9642) that is built in PHP programming language (version 5.2.14) over a MySQL database (version 5.0.91). This instrument was installed in an Apache-based HTTP server (version 2.2.17) over the Linux

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<sup>2</sup> The author is a teacher in that school from its creation (October, 1989).

operating system.

The template was adjusted in terms of layout and the instrument was made available at: <http://www.pedrobras.pt/quest/index.php?sid=58343> (own web server).

A preliminary test of the final version of the questionnaire was made available for a shortlist of teachers from the Gustave Eiffel Professional Schools (selected from a convenience sample of previously identified teachers with different digital proficiency levels and from different teaching areas) to determine if any doubts or issues still arise from the answering process. That procedure was made between May 23<sup>rd</sup> and June, 7<sup>th</sup>, 2011 and 13 answers were registered with a positive feedback from all participants, regardless gender, teaching area or digital proficiency level. After that, all answers from the preliminary test were removed from the database and the questionnaire was reset and placed online on June, 7<sup>th</sup>, 2011, after a procedural meeting that was conveyed in ANESPO (Lisbon). The date limit to answer the questionnaire was initially set to July, 31<sup>st</sup>, the last day with teaching activities in that scholar year.

### ***The constructs.***

The constructs (non-directly observable factors) present in the questionnaire (Maroco, 2010a, p. 488) are multidimensional and its length should be (at least) three factors, according to the scree plot criteria (Maroco, 2010a, p. 498) with no maximum limit set for that purpose.

According to this, the main constructs previously identified are:

a) Attitude towards ICT:

Computers (16 items: 201 to 216);

Internet (16 items: 217 to 232);

b) ICT use:

Lecture preparation (3 items: 401, 402, 403);

Research activities (5 items: 404, 405, 406, 407, 408);

Resource Production (3 items: 409, 410, 411);

Computer program application (5 items: 412, 413, 414, 415, 416);

Interaction/communication (9 items: 417 to 425);

c) Technological Proficiency (6 items);

d) Technology integration (4 items: 301 to 304);

e) Training needs (2 items with some additional questions depending on the answers);

### **Sample and Procedure.**

The population of our survey (teachers from 208 Schools) was determined from data available from the Portuguese Education Ministry (N=7,293). The online survey was available online from June 7<sup>th</sup> and an email was sent on June 8<sup>th</sup> to all 208 professional schools appealing for teachers' participation. An email from the Portuguese Association of Professional Schools was also sent to the government bodies of those schools renewing and reinforcing the request. The link was private and the respondents should have the link to access the survey (the link was sent in the email to the schools).

The first answer was received on June, 9<sup>th</sup> (01:40pm). Considering the universe of respondents, to assure a level of confidence of 95%, with a maximum standard estimation error of 5%, we needed to get at least 370 answers (Almeida & Freire, 2008, p.122).

Although that "magic number" was achieved on July 15<sup>th</sup> (at 11:54pm), we decided to keep the questionnaire available until September, 30<sup>th</sup>, in order to gather as many answers as possible. At the end of the survey, we obtained a total of 571 answers, as further described (the survey is presented in appendix C), with the last answer being recorded on September, 28<sup>th</sup> (12:48pm).

The ethical standards were followed with a written informed consent, explaining

the aims and the scope of the study. The acceptance of the terms was mandatory to proceed to the questionnaire. The survey was anonym (an optional identification section was available for those who had the desire to receive further information about the study.

We obtained a total of 571 answers but we have considered only the complete answers (no “missing” data) and we decided to drop all the 126 incomplete answers. Consequently, we obtained  $n=444$  completed answers, from 67 different professional schools, which is an interesting sample but not necessarily representative of that universe (we could not obtain national data to guarantee the necessary stratification), but that was never the intention of this research.

The existence of multivariate outliers was determined by the calculation of Mahalanobis square distance ( $D^2$ ) and 17 observations were considered to be outliers and, consequently, removed from the sample, resulting in  $n=427$ .

Participants on the survey ranged from 22 to 69 years, with a mean age of 36.6 (SD=7.8).

In terms of age range, 4% ( $n=16$ ) of teachers declared to have under 25 years, 19% ( $n=79$ ) were in the range 26-30 years, 29% ( $n=123$ ) were in the range 31-35 years, 22% ( $n=93$ ) were in the range 36-40 years, 14% ( $n=60$ ) were in the range 41-45 years and 13% ( $n=56$ ) have above 45 years, as presented in table 7.

Table 7.

*Teachers' age range distribution.*

Age	N	%
<=25	16	4%
26-30	79	19%
31-35	123	29%
36-40	93	22%
41-45	60	14%
>45	56	13%
Total	427	

Gender wise, we received 243 (56.9%) answers from women and 184 (43.1%) from men. Considering the teaching area, 136 participants (31.9%) come from the social and cultural area (languages, philosophy, etc.), 81 (19.0%) from the scientific area (Mathematics, Physics, Economy, etc.), and 210 (49.2%) from the technical areas.

In terms of professional experience (number of teaching years) the mean was 8.0 years of teaching (SD= 6.2).

Considering the “professional teacher title”, granted by a higher education institution, 58% (n=259) of the respondents declared to have the professional qualification to teach and 42% (n=185) declared not to possess that title, yet.

### **Procedure.**

In the original studies, the only psychometric property presented for the scales used in our survey was Cronbach's Alpha, and that is only part of the instruments' validation process. In fact, if we aim to measure a construct, we need to assure that the construct really reflects the variable that we are trying to measure. For that reason, all psychometric properties must be presented to ensure that: a) the instrument is suited to our sample and; b) it measures the constructs we intend to measure. These psychometric properties are: i) sensitivity (the items allow to distinguish individuals structurally different when measuring the construct); ii) reliability (the scale measures the construct in a reliable fashion, that is, the construct, for similar individuals in different moments, is measured the same way) and; iii) validity (the instrument really measures the constructs we intended to measure).

Thus, we conducted a preliminary analysis to evaluate the psychometric properties of the collected data for our multidimensional questionnaire: psychometric sensitivity (evaluated by Skewness and Kurtosis), factorial validity (assessed with an exploratory factor analysis - EFA), and reliability (measured by Cronbach's Alpha and Composite

Reliability).

### *Sensitivity analysis.*

A sensitivity analysis was conducted to determine any significant deviation from normality in the collected data. We analysed Skewness and Kurtosis to identify potential asymmetries in items and in this analysis, we need to assure that the items follow a normal distribution with absolute values of skewness  $|sk| \geq 3$  or kurtosis  $|ku| \geq 10$  (Kline, 2005; Maroco, 2010b).

### *ICT Knowledge" scale.*

No sensitivity issues were identified in "ICT Knowledge" scale, as presented in table 8 with all the 6 items from TPACK (used to estimate ICT Knowledge) revealing absolute values for skewness lower than 3 and for kurtosis lower than 10. Consequently, all items were kept in the analysis.

Table 8.

#### *Sensitivity analysis of ICT Knowledge scale*

Question	Mean	Std. Dev.	Sk	Ku
301. I know how to solve my own technical problems	4.48	1.345	-0.442	-0.798
302. I can easily learn technology	5.24	0.916	-1.098	0.588
303. I keep up with important new technologies	4.42	1.294	-0.445	-0.666
304. I frequently play around with technology	4.83	1.208	-0.690	-0.582
305. I know about a lot of different technologies	4.79	1.252	-0.861	-0.030
306. I have the technical skills I need to use technology	4.87	1.172	-0.749	-0.473

### *Liaw's Attitude scale.*

From the sensitivity analysis to Liaw's scale (presented in Table 9) we determined that 15 items (207, 209, 210, 211, 213, 214, 216, 218, 221, 224, 225, 226, 227, 231 and 232) revealed a strong deviation from normality and these items were dropped from the analysis. At this stage, Liaw's questionnaire was reduced from 32 to 17 items.



Table 9.

*Sensitivity analysis of Liaw's attitude scale*

Question	Mean	Std. Dev.	Sk	Ku
201. I feel confident using a computer	5.54	0.853	-1.966	3.618
202. I feel confident using data storage devices (floppy disks, pen-drives, CDs)	5.65	0.768	-2.566	7.035
203. I feel confident using a text processor (Word, other)	5.67	0.707	-2.539	7.577
204. I feel confident acquiring new computer ICT skills	5.51	0.846	-1.854	3.365
205. I like to use computers	5.61	0.759	-2.333	6.374
206. I like to talk about computers	4.29	1.556	-0.468	-0.877
207. I have (or would like to have) a computer at home	5.94	0.419	-9.431	99.054
208. The computer facilitates my daily activities	5.87	0.470	-5.053	34.660
209. Computers are necessary in my professional life	5.94	0.304	-7.193	72.658
210. Computers are useful tools	5.92	0.360	-7.695	86.189
211. In my daily activities I use computers for several purposes (text processing, email, internet surfing, etc)	5.93	0.339	-8.751	108.814
212. I can improve my professional performance by increasing my computer usage	5.35	1.156	-2.181	4.616
213. Computer usage is useful in my profession	5.88	0.393	-4.335	27.024
214. Computer usage can improve my chances of finding and keeping a job	5.69	0.712	-3.342	14.991
215. Computers can be excellent learning tools	5.78	0.527	-2.992	11.222
216. It is useful to know how to use computers	5.90	0.369	-5.112	36.187
217. I feel confident using the Internet/World Wide Web (WWW)	5.67	0.658	-2.359	6.186
218. I feel confident using E-mail	5.73	0.643	-3.147	12.683
219. I feel confident using WWW browsers (e.g. Internet Explorer, Netscape Communicator)	5.52	0.886	-2.038	3.772
220. I feel confident using search engines (e.g. Yahoo, Excite, and Lycos)	5.65	0.700	-2.526	8.098
221. I like to use E-mail to communicate with others	5.72	0.627	-3.047	12.661
222. I enjoy talking with others about the Internet	4.53	1.476	-0.746	-0.431
223. I like to work with the Internet/WWW	5.54	0.814	-1.981	4.022
224. I like to use the Internet from home	5.76	0.642	-3.691	16.903
225. I believe using the Internet/WWW is worthwhile	5.88	0.427	-5.419	44.384
226. The Internet/WWW helps me to find information	5.86	0.455	-4.748	34.310
227. I believe the Internet makes communication easier	5.70	0.677	-2.931	10.891
228. The multimedia environment of WWW (e.g. text, image) is helpful to understand online information	5.62	0.700	-2.254	6.797
229. I believe the Internet/WWW has potential as a learning tool	5.67	0.659	-2.429	7.972
230. I believe that the Internet/WWW is able to offer online learning activities	5.67	0.675	-2.577	8.735
231. I believe that learning how to use the Internet/WWW is worthwhile	5.79	0.577	-3.794	19.272
232. Learning Internet/WWW skills can enhance my academic performance	5.59	0.854	-2.999	10.774

*Luzio's Use Scale.*

From Luzio's scale, related to the use of computers, we carried out a similar procedure (the results are presented in Table 10), and 2 items were dropped due to severe normality deviation (401 and 416), reducing Luzio's Use scale from 25 to 23 items.

Table 10.

*Sensitivity analysis of Luzio's Use scale*

Question	Mean	S.D.	Sk	Ku
401. I use ICT to prepare tests and worksheets for my classes	5.81	0.545	-4.206	23.846
402. I use ICT to develop presentations for my classes (ex. Powerpoint)	5.29	1.024	-1.495	1.875
403. I use ICT to prepare handout texts to support my classes	5.57	0.800	-2.317	6.716
404. I use ICT to search the Internet for subjects for my classes	5.56	0.708	-1.632	2.543
405. I use ICT to search for bibliography	5.32	0.928	-1.507	2.314
406. I use ICT to search for non-bibliographic databases	5.19	1.042	-1.305	1.305
407. I use ICT to research scientific contents in my professional area	5.49	0.707	-1.274	1.078
408. I use ICT to research other issues that can increase my knowledge	5.52	0.732	-1.833	4.533
409. I use ICT to produce schemes (transparencies, etc.)	4.61	1.728	-1.013	-0.357
410. I use ICT to produce photographs	4.48	1.612	-0.753	-0.645
411. I use ICT to produce webpages	3.52	2.058	-0.005	-1.649
412. I use ICT in spreadsheet applications (Excel or other)	5.20	1.247	-1.667	2.044
413. I use ICT to develop applications over databases (Access or other)	3.64	2.030	-0.079	-1.631
414. I use ICT in applications for data processing (SPSS or other)	3.27	1.989	0.194	-1.561
415. I use ICT applications to scan and compose images (scanner or other)	5.28	1.129	-1.757	2.526
416. I use ICT in word processing applications (word, publisher or other)	5.75	0.595	-3.013	11.183
417. I use ICT to interact with colleagues (teachers at my school) via e-mail	5.58	0.816	-2.508	7.456
418. I use ICT to interact with students through e-mail, for tutoring activities	5.27	1.098	-1.731	2.764
419. I use ICT to interact with teachers from other schools via e-mail	4.59	1.692	-0.925	-0.528
420. I use ICT to interact with students in forums	3.27	1.901	0.161	-1.468
421. I use ICT to interact with my colleagues in forums	3.24	1.872	0.154	-1.434
422. I use ICT to interact with teachers from other schools in forums	2.98	1.843	0.399	-1.253
423. I use ICT for synchronous interaction with my students (E.g.: Messenger)	3.45	1.928	0.048	-1.515
424. I use ICT for synchronous interaction with my colleagues (E.g.: Messenger)	3.77	1.894	-0.235	-1.431
425. I use ICT for synchronous interaction with teachers from other schools	3.15	1.906	0.272	-1.415

### ***Technology Integration Scale.***

No sensitivity issues were identified in the items from the “Technology Integration” scale (presented in table 11) with all 4 items from TIQ (used to estimate individual ICT perception) revealing absolute values for skewness lower than 3 and for kurtosis lower than 10. Consequently, all items were kept in the analysis.

Table 11.

#### *Sensitivity analysis of Technology implementation scale*

Question	Mean	Std. Dev.	Sk	Ku
501. How often you include ICT use in your teaching activities	4,90	1,013	-0,472	-0,725
502. In average, how many hours you spend per week in ICT use other than your teaching activities	5,12	1,070	-1,032	0,091
503. Select your personal status description regarding your ICT proficiency level	4,86	0,799	0,025	-0,955
504. Select your personal status description regarding ICT	5,42	0,820	-1,593	3,057

### ***Exploratory Factor Analysis.***

Following the sensitivity analysis, we eliminated the 17 items that revealed a severe deviation from normality ( $|sk| \geq 3$  or kurtosis  $|ku| \geq 10$ ) and the initial multidimensional questionnaire that congregated elements from the four scales (“Technology Implementation Scale”, “Attitude towards Computers and Internet”, “ICT Use questionnaire” and “Technological Knowledge”) was reduced to 50 items (15 items were dropped from Liaw’s attitude scale and 2 from Luzio’s use scale).

With this new instrument we searched for the factors that emerged from the collected data, by conducting an Exploratory Factor Analysis (EFA), using the Principal Components Extraction, followed by a Varimax Rotation, using SPSS (v.19, IBM SPSS, Chicago, IL). The number of factors extracted was determined according to the Kaiser’s Eigenvalue-greater-than-one rule. The adequacy of the items for the factorial analysis, determined by the Kaiser Meyer-Olkin index, was very high (KMO=0.919).

As “Technological Knowledge” and “Technology Implementation Scale” were both unidimensional, we only looked for the factors that emerged from Liaw’s attitude scale and Luzio’s use scale.

### *Liaw’s Attitude scale.*

The Principal Component Extraction for Liaw’s attitude scale is presented in Table 12 (for this analysis, we forced an extraction with three components).

Table 12.

#### *Principal Components Extraction for Liaw’s attitude scale*

Question	Component		
	1	2	3
201. I feel confident using a computer	0.883		
202. I feel confident using data storage devices (floppy disks, pen-drives, CDs)	0.881		
203. I feel confident using a text processor (Word, other)	0.823		
204. I feel confident acquiring new computer ICT skills	0.805		
205. I like to use computers	0.629		
206. I like to talk about computers			0.818
208. The computer facilitates my daily activities		0.666	
212. I can improve my professional performance by increasing my computer usage			
215. Computers can be excellent learning tools		0.804	
217. I feel confident using the Internet/World Wide Web (WWW)	0.828		
219. I feel confident using WWW browsers (e.g. Internet Explorer, Netscape Communicator)			
220. I feel confident using search engines	0.829		
222. I enjoy talking with others about the Internet			0.857
223. I like to work with the Internet/WWW	0.440	0.472	0.468
228. The multimedia environment of WWW (e.g. text, image) is helpful to understand online information		0.736	
229. I believe the Internet/WWW has potential as a learning tool		0.869	
230. I believe that the Internet/WWW is able to offer online learning activities		0.829	
% variance explained	49.1%	13.7%	7.5%
Total Variance Explained	70.3%		
Rotated Component Matrix (Rotation converged in 5 iterations).			

The three extracted factors presented in table 12 explain 70.3% of the total variance and are defined as follows: Factor 1 - “Confidence Towards Computers and Internet” (items 201, 202, 203, 204, 205, 217, 220), Factor 2 - “Learning Through ICT” (items 208, 215, 228, 229, 230) and Factor 3 - “Interaction using ICT” (items 206, 222).

*Luzio's Use Scale.*

When analysing the factors from the "Use Scale" and considering the items kept in the model after the sensitivity analysis, we proceeded to the exploratory factorial analysis (KMO=0.896). The factor weights of the components extracted in this analysis are presented in Table 13.

Table 13.

*Principal Components Extraction for Luzio's "Use" scale*

Question	Component		
	1	2	3
402. I use ICT to develop presentations for my classes (ex. Powerpoint)			0,485
403. I use ICT to prepare handout texts to support my classes		0,554	
404. I use ICT to search the Internet for subjects for my classes		0,783	
405. I use ICT to search for bibliography		0,745	
406. I use ICT to search for non-bibliographic databases		0,694	
407. I use ICT to research scientific contents in my professional area		0,792	
408. I use ICT to research other issues that can increase my knowledge		0,799	
409. I use ICT to produce schemes (transparencies, etc.)			
410. I use ICT to produce photographs			0,619
411. I use ICT to produce webpages			0,704
412. I use ICT in spreadsheet applications (Excel or other)			0,636
413. I use ICT to develop applications over databases (Access or other)			0,767
414. I use ICT in applications for data processing (SPSS or other)			0,707
415. I use ICT applications to scan and compose images (scanner or other)		0,406	0,539
417. I use ICT to interact with colleagues (teachers at my school) via email		0,595	
418. I use ICT to interact with students through e-mail, for tutoring activities	0,415	0,583	
419. I use ICT to interact with teachers from other schools via e-mail	0,594		
420. I use ICT to interact with students in forums	0,825		
421. I use ICT to interact with my colleagues in forums	0,859		
422. I use ICT to interact with teachers from other schools in forums	0,840		
423. I use ICT for synchronous interaction with my students (E.g.: Messenger)	0,805		
424. I use ICT for synchronous interaction with my colleagues (E.g.: Messenger)	0,774		
425. I use ICT for synchronous interaction with teachers from other schools (E.g.: Messenger)	0,832		
% variance explained	39,5%	12,5%	7,0%
Total Variance Explained	59,0%		
Rotated Component Matrix (Rotation converged in 5 iterations).			

We concluded that items were organised according to three factors that explained 63.4% of the total variance: Factor 1 - "Interaction" (items 419, 420, 421, 422, 423, 424, 425), Factor 2 - "Search for Information" (items 404, 405, 406, 407, 408), Factor 3 - "Resource Production" (items 402, 410, 411, 412, 413, 414).

### *The other scales*

The other segments of this instrument consisted in just one dimension from multidimensional scales that were integrated in our instrument. Therefore, it is not advisable to factorise just one dimension.

### *Reliability.*

Regarding reliability, all the factors presented revealed "acceptable" or "good" internal consistency as evaluated by Cronbach's  $\alpha$  greater than 0.7 (Nunnally, 1978; Hill & Hill, 2009; Marôco & Garcia-Marques, 2006). The Cronbach's  $\alpha$  for the factors identified is presented in Table 14.

Table 14.

*Cronbach's Alpha for the factors identified.*

Scale	Factor	$\alpha$
Attitude	Confidence	0.930
	Learning through ICT	0.881
	Interaction over ICT	0.894
Use	Interaction	0.928
	Search for information	0.876
	Resource Production	0.829
TK	ICT Knowledge	0.945

### **The development of a model: The ISTTU Model.**

We used the Structural Equation Modelling technique to develop and test our model that we have designated by "ISTTU" (ICT Skills Towards Technology Use). A two-step analysis was conducted (Jöreskog, 1993; Anderson & Gerbing, 1988) using

AMOS software (V.19, SPSS Inc, Chicago, IL): In the first step we evaluated and adjusted the overall fit of the factors present in the measurement model; In the second step, once assured the quality of the model, we tested and adjusted the structural model, by evaluating its plausibility. The goodness of fit of the revised factors obtained in the EFA was evaluated, as well as the invariance of the measurement model.

The significance of the regression and measurement coefficients was evaluated after an estimation of the parameters using the Maximum Likelihood (ML) method.

The fitted research model is presented in figure 23, with the standardised regression coefficients and  $R^2$  for the ISTTU model ( $\chi^2(32) = 59.407$ ;  $\chi^2/df = 1.856$ ; CFI=0.990; GFI=0.973; TLI=0.986; RMSEA=0.045;  $P(\text{rmsea} \leq 0.05) = 0.663$ ).

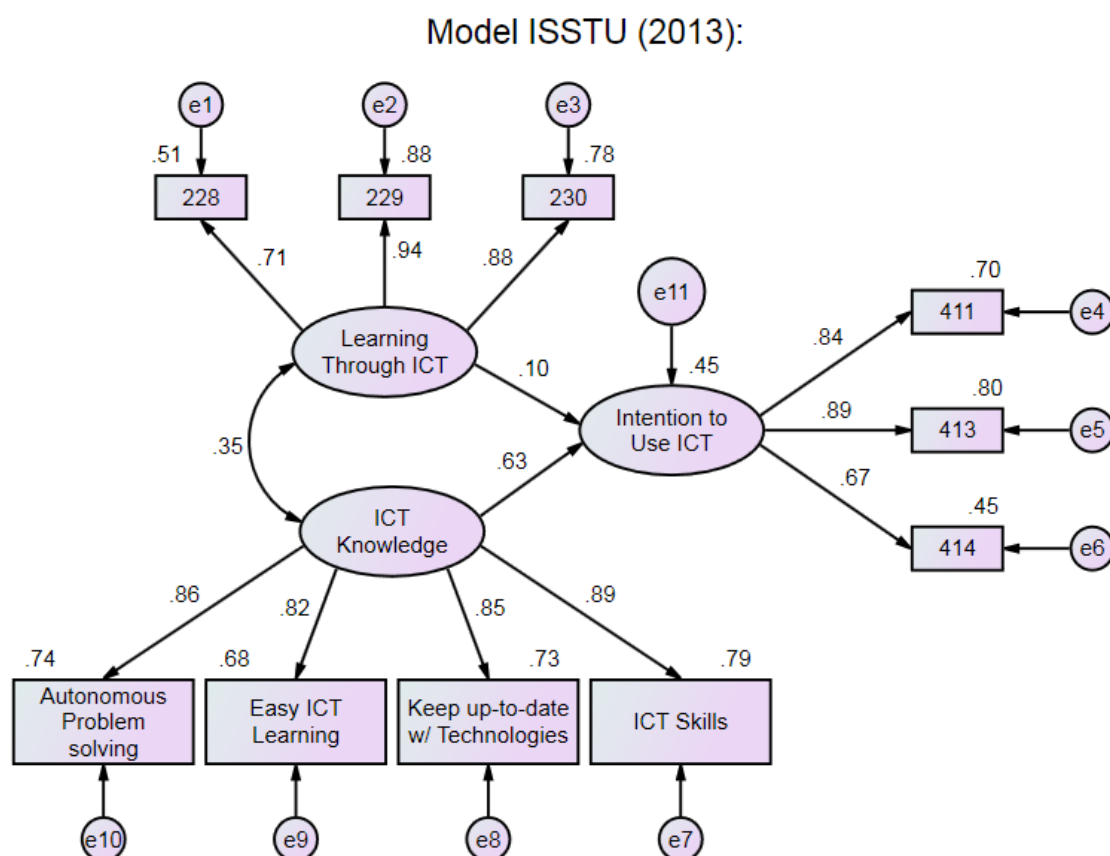


Figure 23. Structural Model ISTTU- standardised estimates

Source: Brás, Miranda & Marôco (2014, p. 61).

The overall goodness of fit of the factorial model was evaluated according to the most commonly used fit indexes, compared against their reference values:  $\chi^2/df < 4$ , CFI, GFI and TLI  $> 0.9$  and RMSEA  $< 0.05$  (Marôco, 2010a; Hair, Black, Babin & Anderson, 2010). The model was further refined by adjusting the Modification Indexes (MI  $> 11$ ;  $p < 0.001$ ) and the local goodness of fit was determined by items individual reliability.

Multivariate normality was previously assured by removing items that revealed values of Skewness and Kurtosis not adequate to the usage of the Maximum Likelihood method (Kline, 2005). The model was tested with and without the outliers identified with the calculation of Mahalanobis Square Distance ( $D^2$ ) and we opted to eliminate all the 17 observations that we have identified as outliers from the sample.

The structural coefficient significance was determined by a Z-test, produced from the Amos Software (Critical Ratio and p-value), being considered statistically significant with  $p\text{-value} \leq 0.05$ . The model coefficient estimates are presented in their standardised form.

The measurement model for the latent variables revealed a good quality of fit. The structural model explained 45% of the total variability of the variable "Intention to use ICT" ( $p < .001$ ). The highest effect of "ICT knowledge" was observed on "Intention to use ICT" (BInt.ICTK = 0.751; SE = 0.072;  $\beta = .63$ ;  $p < .001$ ). The trajectory "Learning through ICT  $\rightarrow$  Intention to use ICT" was non-significant (BInt.Learn = 0.211; SE = 0.101;  $\beta = .10$ ;  $p = .037$ ). The model also showed a moderate correlation between "ICT knowledge" and "Learning through ICT" ( $r = 0.35$ ;  $p < 0.001$ ).

## **Results.**

### *Effects of Gender and Teaching Area over Intention to Use ICT.*

We further analysed the trajectory "ICT knowledge" to "Intention to use ICT",



considering variables “Gender” and “Teaching Area”. The variable “Teaching Area” categorises teachers according to three main educational areas common to all professional courses: “social and cultural”, “scientific” and “technical”.

Table 15.

*Standardised structural weights in the ISTTU model ( $\beta$ ) and Variability Explained per Teaching Area.*

Teaching Area	$\beta$	R <sup>2</sup>	p*		
			Cultural area	Scientific area	Technical area
<i>Intention to use ICT &lt;- Learning trough ICT</i>					
Social and Cultural area	0.09	0.28	----	----	----
Scientific area	0.16	0.18	0.347	----	----
Technical area	0.04	0.51	0.464	0.584	----
<i>Intention to use ICT&lt;- ICT knowledge</i>					
Social and Cultural area	0.49	0.28	----	----	----
Scientific area	0.37	0.18	0.790	----	----
Technical area	0.70	0.51	<0.001	<0.001	----

\* p-values are for the pairwise “teaching area”  $\beta$ 's comparisons.

There were no significant differences in the model fit to the two gender groups ( $\Delta\chi^2(7) = 11.569, p=0.116$ ). On the contrary, the model was not structurally invariant between “Teaching Area” ( $\Delta\chi^2(14) = 40.433; p<0.001$ ). The different structural weights per teaching area are presented in Table 15. We also present in that table a p-value analysis for the comparison between teaching areas. The standardised weight of “ICT knowledge” to “Intention to use ICT” was significantly larger in the “Technical Area” when compared to the other two teaching areas ( $p<0.05$ ). The differences, when evaluating the trajectory in pairwise comparisons for the different teaching areas, are not significant in the trajectory “Learning through ICT” to “Intention to use ICT”.

#### ***Validity of the model.***

The validity of the constructs should be measured by factorial, convergent and discriminant validity (Marôco, 2010a).

To assure factorial validity we consider the factorial weights of each construct

and, typically, factorial validity is assured when all factors reveal factorial weights higher than 0.50. From Figure 23 we can observe that all items revealed “factorial validity” to the construct ( $\lambda \geq 0.50$ ).

Cronbach's Alpha was presented as a psychometric measure of reliability. However, Cronbach's Alpha evaluates all factors with the same weight which is not the case. Some authors (Fornell & Larcker, 1981) consider that constructs' reliability should be evaluated by presenting Composite Reliability (CR) instead of Cronbach's Alpha.

The factors presented in ISTTU model (“ICT knowledge”, “Learning through ICT” and “Intention to use ICT”) revealed values for Composite Reliability and Average Variance Extracted, as shown in Table 16:

Table 16.

*Composite Reliability and Average Variance Extracted.*

Factor	CR	AVE
ICT Knowledge	0.80	0.73
Learning through ICT	0.75	0.72
Intention to use ICT	0.85	0.65

Typically, values of  $CR \geq 0.7$  are considered to be good indicators for reliability (Marôco, 2010b) and values of  $AVE \geq 0.5$  are considered to indicate convergent validity for the factors (Marôco, 2010a; Hair, Black, Babin & Anderson, 2010). Therefore, from Table 16, we can consider that the instrument is reliable and revealed convergent validity for all three factors present in the model.

Discriminant validity is evaluated by comparing AVE with the square of the factorial weight of the correlation ( $\phi^2$ ) present in the model. As  $\phi^2$  of the model's correlation is 0.12, if we compare this value with the values of AVE presented in table 16, we conclude that  $AVE \geq \phi^2$  in all factors, assuring discriminant validity of the instrument.

### **Discussion.**

Applying the ISTTU structural model to predict “Intention to Use ICT” by measuring “Learning through ICT” and “ICT Knowledge” from constructs previously validated in the sample of 427 teachers of professional schools in Portugal, we can sustain that:

- We have confirmed H<sub>1</sub> - “ICT Knowledge” has a strong effect on the “Intention to Use ICT”.
- We did not confirm H<sub>2</sub> - “Learning through ICT” has a strong effect on the “Intention to Use ICT”. These results suggest that online training may have the same impact on people as traditional face-to-face models. This probably means that, nowadays, people naturally integrate technology in their daily activities so that “learning through technology” (in a virtual learning environment) may be as easily accepted as face-to-face classroom experiences. The fact that trajectory “Learning through ICT → Intention to use ICT” was not significant, probably means that, in this model, “Intention to Use ICT” may not be affected by the leaning modality in which people learn.
- We did not confirm H<sub>3</sub> - We may conclude that Gender does not affect the way ISTTU model performs. In previous research it was clear that men had a better attitude towards digital technologies than women (Wilder, Mackie & Cooper, 1985; Mitra, Lenzmeier, Steffensmeier, Avon, Qu & Hazen, 2000). Other investigators concluded that the differences were not consistent (Dyck & Smither, 1994; Esgin, Elibol, & Daglı, 2015). Perhaps in the last decades the gender differences towards technology were dimmed, as digital technologies (particularly the Internet) evolved towards levels that are now more appealing to women (e.g.: communication,

conversation and social interaction) and universally considered as useful.

- We have confirmed H<sub>4</sub> - We concluded that “teaching area” affects the influence of “ICT Knowledge” on the “Intention to Use ICT”. The impact of “ICT knowledge” on the “Intention to Use ICT” is stronger on teachers from technical areas, when compared with other teaching areas, although the differences in this trajectory are not statistically significant between the groups. In previous research, familiarity and experience with computers allowed to foresee a stronger attitude towards the use of digital technologies (Brown-Chidsey, Boscardin & Sireci, 2001) and the future development of learning experiences with computers (Houle, 1996). A study developed by Silva (2003) with a representative sample of pre-service teachers from Universities in Portugal revealed that teachers from the “Humanities” area declared the lowest level of contact and training with technologies (51.5% of them declared not having any contact with technologies whatsoever) and that teachers from “Sciences” areas declared to have the highest contact with technology.

In our sample, teachers from the technical area revealed the best attitude and intention to use technology. Perhaps their bindings to companies and real-world problems may have enticed their need to use digital technologies. Because of that, the ICT integration in classroom's concrete situations became natural. Additionally, “professional courses” are “practical by design” and that may have evoked from the very beginning the use of state-of-the-art and up-to-date technology necessary to prepare students for the labour market. What was somewhat surprising was the low use and attitude towards technology from teachers from the scientific area. Although they probably have had contact with technologies, they may perceive their main role as providing young people with skills associated with abstract thinking, where technology may not be very helpful and can even be considered as harmful.

### **Limitations of the model.**

Due to the choice of an online platform to implement the questionnaire, we must consider the possibility that only teachers with a positive attitude have chosen to respond and that choice may have contributed to the exclusion of teachers that do not integrate digital technology in their practices. However, geographical dispersion and the large number of teachers to inquiry dissuaded us to collect data using physical instruments (questionnaires in paper). Another limitation was the low value of the variance explained ( $R^2=0.45$ ), meaning that, in this model, 55% of the determinants to the use of technology are still unaccounted for. Perhaps the integration of other variables presented in the TAM model, such as “effort expectancy” (Birch & Irvine, 2009) or “self-esteem” or “computer anxiety” (Teo, 2011) can contribute to improve the ISTTU model.

### **Conclusions for this stage.**

The findings of this model suggest that the “Technical Knowledge” has a strong influence on teachers' “Intention to Use ICT”. From that, we may infer that promoting the development of ICT skills on teachers (increasing “ICT Knowledge”) will develop the “Intention to Use ICT”. According to Venkatesh, Morris, Davis, & Davis (2003), “Intention to Use ICT” is the strongest predictor of “ICT use”. We may therefore conclude that increasing teachers' “ICT knowledge” can trigger the use of digital technology in their scholar activities.

The results also suggest that, without a strong component in terms of “ICT Knowledge”, we should not expect that teachers' use ICT in their professional activities. That is the reason why we should first provide training to empower teachers with ICT skills and, only then, we should expect that teachers are able to proficiently use technology. Like in many other circumstances in life, we should not expect people to use

tools if they are not properly taught on how they can be used, making evident and clear the work reduction when they proficiently use these tools.

At this stage, we concluded that further field research is needed to confirm these findings, perhaps by expanding the constructs present in ISTTU model.

## **The Second Study – A Quest for Digital Proficiency**

After the first study, considering the questions and answers that emerged from it, we intended to conduct a second study, with a “hands-on” approach to test if “ICT skills” is really a factor that induces the use of digital technologies. At this point, considering all the findings previously presented, the questions were: i) how can we help teachers to improve their digital skills in order to empower them to become digital creators (instead of mere digital consumers)?; ii) After acquiring those ICT skills, will teachers become more active digital technology users (especially in classroom)?

### **Methodology.**

We decided to classify the second study in the Design Research category, although it has many similarities with the Action-Research (A-R) as the project we implemented: a) aimed to intervene on an existing situation and induce changes; b) was designed to improve the efficiency and the efficacy of teaching practices (Cohen, Manion & Morrison, 2007, p. 302). This second study follows part of the A-R investigation methodology, a term originated in Kurt Lewin's work, at the time a professor at the Massachusetts Institute of Technology (MIT). In his document named “Action Research and Minority Problems”, from 1946, Lewin describes A-R as a “comparative research on the conditions and effects of various forms of social action, and research leading to social action. Research that produces nothing but books will not suffice.” (Lewin, 1946, p.35). That's a recurrent critic made to Educational Research: its weak connection with practice.

The educational stream of A-R, the one with particular interest for the present study, is focused essentially in professional development and social learning context. As Chagas (2011, p. 3) remarks “this investigation style becomes especially appealing and motivating as it emphasises the strategies that allow to improve the working performance and leads to a significant improvement of the quality and the efficacy of the teaching

practices". On the other hand, Almeida (2001, p. 176) refers that A-R implies the abandon of non-reflexive practices and requires inter-professional collaboration and undeniably promotes the improvement of the teaching conditions.

Action-Research is executed "in a spiral of steps each of which is composed of a circle of planning, action, and fact-finding about the result of the action" (Lewin, 1946, p.38). Considering this assertion, although this second study has had multiple segments comparable with the spiral of A-R (in successive cycles, where the model was tested and refined as a result of the reflection made over the cycle that was just concluded) the participants were not the same. The refined "product" that emerged from each cycle was reapplied and tested with another group of participants.

Therefore, we decided to classify this second study in the Educational Design Research, described by Plomp as "a research design appropriate to develop research-based solutions to complex problems in educational practice or to develop or validate theories about learning processes, learning environments and the like" (2013, p. 11). Plomp also identifies Design-Based Research (DBR) as a methodology that "is not so much an approach as it is a series of approaches, with the intent of producing new theories, artefacts, and practices that account for and potentially impact learning and teaching in naturalistic setting" (2013, p. 17).

However, by identifying real-world problems followed by actions to improve the status quo, DBR resembles very much A-R, with only two little differences:

1. In DBR the major goal is to generate theory to solve authentic problems;
2. In DBR researchers usually take the initiative in the research process and, afterwards, both researchers and designers intervene (Wang & Hannafin, 2005), something that does not always happen in A-R, with the participants very much involved in the research process from the beginning.



The DBR is being developed in various subdomains, being the most published the Curriculum Research, Media and Technology, Learning and Instruction, Teacher Education and Didactics (van den Akker, 1999, pp. 3-5). This second study can be classified in two of van den Akker's subdomains: "Media and Technology" and "Teacher Education" (from the Professional Development standpoint).

According to Plomp, each cycle of this approach encompasses 4 phases, as described in figure 24: 1) problem identification; 2) Analysis; 3) Prototype design and implementation; 4) Evaluation (2013, p. 17).

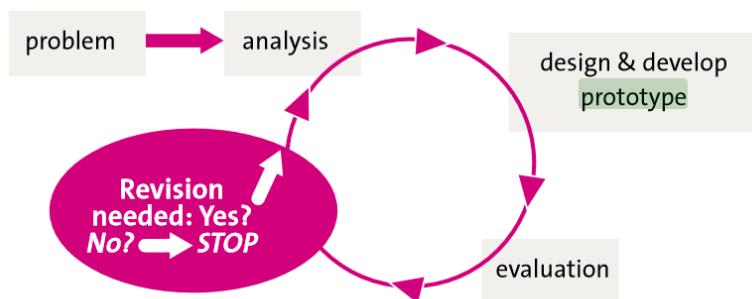


Figure 24. Iterations of systematic design cycles.

Source: Plomp, T. (2013, p. 17)

Like A-R, DBR is also composed by cycles that configure a cumulative series of cycles of thought experiments and instruction experiments, as presented in figure 25.

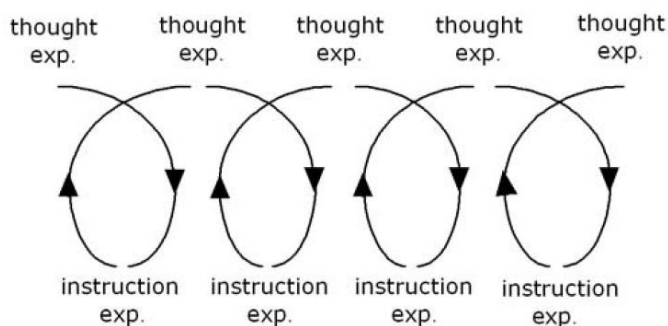


Figure 25. The cycles of Design Research

Source: Gravemeijer & Cobb (2006, p. 55)

### **The empirical field.**

The geographical dispersion of the population of all professional schools would make this endeavour virtually impossible to accomplish, with the available resources. Therefore, a smaller and more manageable sample had to be used to make this second study feasible.

For this stage, and strictly for convenience reasons, we choose a sample of that universe, from Gustave Eiffel Professional School (the biggest professional school in Portugal) in order to apply the project over a period of time (timespan: 1 year, in 2015/2016). This school is present in six different locations:

1. Amadora – Venda Nova;
2. Amadora – Venteira;
3. Lisboa – Lumiar;
4. Queluz;
5. Arruda dos Vinhos;
6. Entroncamento.

In total, 60 teachers were involved in this second study, characterised as presented in table 17:

Table 17.

*Teachers involved in the second study, by gender and location*

Location	Total	Male	Female
Amadora – Venteira	8	2	6
Amadora - Venda Nova	11	2	9
Lisboa – Lumiar	14	6	8
Entroncamento	14	5	9
Arruda dos Vinhos	13	5	8
Total	60	20	40
		33%	67%

Considering the teaching area, the distribution of those teachers is presented in table 18:

Table 18.

*Teaching areas of the teachers involved in the second study*

Teaching Area	%	# teachers
Social and cultural	57%	34
Scientific	15%	9
Technical	28%	17

**The implementation.**

The first problem addressed in this second study was the distance between the various locations of that school and how we should deliver the same training across these locations. In fact, although it was the same school, there was some geographical dispersion as well (Entroncamento is located about 130 km away from Lisbon; Arruda dos Vinhos distances 35 Km from Lisbon). We figured that some proximity should be necessary to make this second study feasible and to assure an appropriate support to all participants. Furthermore, the lack of digital proficiency may be an obstacle teachers' need to overcome when acquiring digital skills.

At this stage, two independent directions were defined:

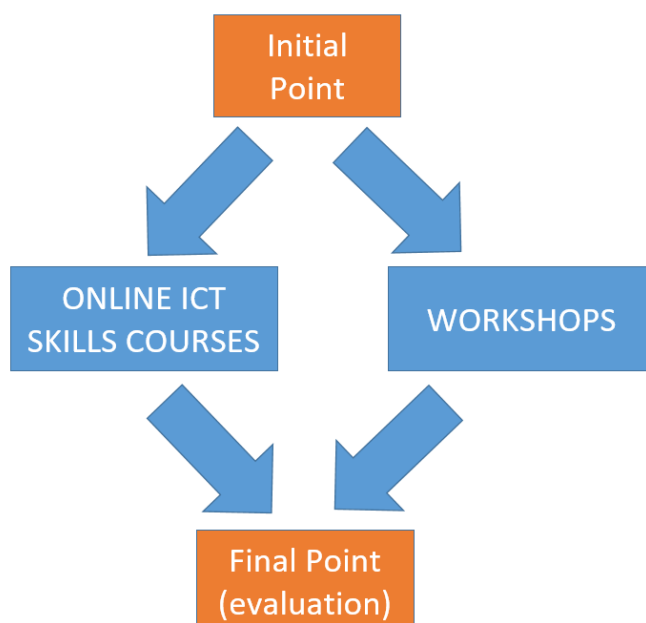


Figure 26. *The Design Research.*

This second study was planned in two dimensions, as presented in figure 26, and aimed to provide training on digital skills, in line with the findings of the first study (survey research):

- a) Online ICT training courses;
- b) Workshops on ICT skills, in a face-to-face modality.

The “Online Digital Technology courses” phase was planned to provide teachers the contact with the resources produced by the author, and to criticise and rationalise the experience. In fact, we believe that is positive that teachers, from time to time, can assume a student role, in order to recall the problems students' face when “learning tasks” are required.

The “Digital Technology workshops” phase was planned to:

- i. Discuss a different pedagogical approach, that integrates technology in classroom, and discuss with teachers whose pedagogical models may promote the integration of digital technology in classrooms;
- ii. Demonstrate how fast and easy, nowadays, we are able to develop digital educational resources (although a serious and detailed planning phase should always be required);
- iii. Describe and analyse the problems to consider before produce any digital resources and list the available solutions to deal with it;
- iv. Provide the necessary conditions (time and tools) to produce digital educational resources;
- v. Produce digital educational resources;
- vi. Integrate these digital resources in Virtual Learning Environments (VLE) that students (and other teachers) can use;
- vii. Analyse (in group) the produced resources;

- viii. Measure the success of the resources and reflect on their quality and how they can be improved or refined.

### **Planning.**

Nowadays, lecturing may still be the most common method when teaching adults (Bligh, 2000, p.6). Considering that we intend to work with in-service teachers, providing the contexts and the resources to acquire digital skills, we developed the resources that simulate a “lecture” and may be considered as “performance support or job aid” (Clark, 2014, p. 274). These consisted in “a set of directions or demonstrations that guide the worker through a procedure” and, regarding these guidelines, evidence showed that animated or still pictures result in better outcomes than text alone (p. 275). This was the reason why we choose to use online video to deliver the information that leads to the ICT Skills acquisition. In these resources, a number of guidance topics were taken into consideration (p. 281):

- a) The video resources included animated pictures (screen recordings) and audio explanations (voice to illustrate the screen recording);
- b) A “Tell, Show, Practice, Feedback” approach was implemented;
- c) Segments of content followed by practice drills were planned;
- d) Some demonstrations with solved exercises are available at the beginning of the practical segments to increase participants' self-confidence;
- e) Work-authentic assignments were planned and quick feedback was provided throughout the course.

However, as Raaijmakers et al. very well point out, “the way in which the video modeling examples are designed can have a significant impact on the success of the training. This should be kept in mind when implementing video modeling examples for training self-regulation skills” (2018, p. 287).

Moreover, this research intention was to foster the acquisition of digital skills, regardless the hardware or software used, at any given moment. In this area of activity, and particularly regarding digital technologies, people may be overwhelmed by the myriad of new proposals that emerge, in a daily basis. The idea was to establish a baseline-technology suite that fulfils one's needs, assuring that participants feel confident with that suite, considering to change only if proven improvements emerge from new technologies.

Another important aspect for this stage was to closely tie technology with authentic teachers' contexts or, in other words, it was crucial to encourage teachers' reflection on how technology can be useful (and easy to use) for the activities they daily carry out (with or without their students).

After a series of preparatory meetings with the participants (teachers) in this phase, we agreed on the basic principles that would guide this whole stage:

- a) The resources to be produced by teachers are meant to complement their face-to-face in-school activities (and not to replace those activities) as students in professional schools age in the range between 15 and 18 years-old, where the socialisation process is still in course. Occasionally, it may be used to replace lectures students may miss due to any attainable reason (illness, compulsive presence elsewhere, etc.).
- b) Because resources will be designed for students in the age range mentioned before, voice clarity, language complexity and speech rhythm must be adapted to that specific audience: adolescents (not children, nor adults).
- c) In the training phase, the resources will be shared with participants in a personal VLE (<http://www.pedrobras.pt>) using the same platform used in school (Moodle) - Authentication required, therefore, not available for non-authorized persons;

- d) The produced resources can also be shared with all school colleagues that may want to use it in their activities. In a second stage, sharing the resources with teachers from other schools can be considered, but technological requirements related to the platform that support that repository must also be considered (repository platform, available disk space, enrolment processes, level of access, etc.).

### **Executing.**

The practical stage of this research is based on two alternative paths:

1. Online courses, designed for those who consider themselves:
  - i. Digitally prepared to learn in an online environment and;
  - ii. To have the “discipline” to deal with it;
2. Face-to-face Workshops, for those who were not:
  - i. Very self-confident with those subjects, or that;
  - ii. Preferred to have someone available by their side, to provide help, support and guidance.

#### ***The online courses.***

The online courses were prepared and placed online to provide teachers' the contact with digital technologies. For convenience reasons, each course was organised in small groups of around seven participants each, all from the Gustave Eiffel Professional School, regardless the location, gender or teaching area.

We prepared seven courses, all regarding the use of digital technologies (some screenshots of these courses with the resources and the suggested activities, as published in the VLE that supported these courses are presented in annex D):

- Using Excel (basics)
- Using Excel (Advanced)

- Using Word (advanced)
- Image edition
- Creating Digital Presentations
- Audio creation/editing
- Video creation/editing

From the literature review we developed a checklist for the production phase that bring together what we considered the most important features resources should incorporate. Having all the instructional principles in mind, we present in table 19 those we consider as the most pertinent.

Table 19.

*The key instructional features for the resource production.*

Feature	Meaning	Reason
Principled explanation	Address the “what, when, why and how“ for each segment (not necessarily for each resource produced).	People need to know why the resource is important. If we cannot explain that, maybe we should reflect on the importance of the resource
Concise and focused	Keep the video length below the 10-minute threshold and the explanation should be concise and focused (do not maunder).	Maximise the use of the attention span that people may dedicate to the resources.
Adjust the language to the audience	Speech speed and language complexity must be adequate to the audience	People need to clearly understand the message
Focus on the essential	Avoid irrelevant details that induce extraneous processing	Avoid to disperse and distract the audience with irrelevant details - non-essential to the message
Visual	Resources incorporate explanatory visuals and minimise decorative visuals	Avoid decorative visuals that distract the audience and do not contribute to the skills acquisition
Illustrated	Resources include examples to demonstrate the concepts, procedures and principles.	People need to see an application of the concepts, procedures and principles in order to integrate that knowledge.
Combine resources with meaningful activities	After any resources, suggest a practical approach with engaging exercises in order to consolidate knowledge.	Foster moving from a passive to an active posture, as “learning environments that rely completely on instructional explanation are ineffective” (Clark, 2014, p. 231).



These courses were designed to fulfil the requirements stated by teachers, in an informal quick-survey. The process of the course design was made in a 5-step approach, according with the 4C-ID model:

- i. Definition of the course objectives and intended learning outcomes;
- ii. Topic breakdown into “learning segments” (lessons);
- iii. Sequencing the learning segments;
- iv. For each learning segment:
  - a. Design the “roadmap” for students;
  - b. Design the “Digital Educational Resources” to make available for students (in a “just-in-time” approach);
  - c. Design the “learning tasks” (modelling examples, completion problems, full problems);
  - d. Design of “supportive information”;
  - e. Design of the “part-task practice”;
- v. Design of the formative assessments and the final evaluation.

### ***The workshops.***

A sequence of four workshops was planned and implemented shortly after the online courses phase. These workshops had the following session plans:

- i) Introduction - Evaluating the models for teaching with digital technologies;
- ii) Digital production - a practical approach on the self-production of Digital Resources;
- iii) The VLE use - and how to distribute digital educational resources using a virtual learning environment;
- iv) Refinement of digital educational resources (and next steps).

### *The model.*

The first workshop (and only that one) was mandatory and a call was sent to all teachers from the local school's governance body. It is needless to say that not all teachers present in the workshop were completely comfortable with the situation. We already knew the five "adopter categories" from Rogers work (1983, p. 22): Innovators, Early Adopters, Early Majority, Late Majority, and Laggards.

In 1994, Geoghegan extended the characterisation of these groups:

1. "Innovators - This two to three percent of the population includes the "techies:" experimentalists who latch onto new technology as soon as it appears. Their interest lies more with the technology itself than with its application to significant problems. They know the details of all the new hardware and software; and they are a significant resource for vendors who need to test a new product. Innovators are often broadly connected, and they form communities of shared interest that span both disciplines and institutions" (p. 7).
2. "Early Adopters - These are the "visionaries," making up a little over 10 percent of the adopter population. Early adopters blend an interest in technology with a concern for significant professional problems and tasks. They look for the breakthroughs in instructional methods or learning effectiveness that new applications of technology enable. They explore new technologies for their potential to bring about major improvements through qualitative, discontinuous change. They are risk-takers and are not averse to occasional failure. They often favor a tightly focused project orientation in their work. Like the innovators, they are broadly connected within the academic community, with good links to "innovators", and with strong cross-

disciplinary interests and ties. They are often quite self-sufficient from a technical standpoint, either through their own skills, or through resources mustered through personal networks” (p. 7).

3. “Early Majority - These are the "pragmatists" who make up the first half of the mainstream. Although fairly comfortable with technology in general, their focus is on the concrete professional problems of teaching and research rather than on the tools (technological or otherwise) that might be used to address them. They adopt a "wait-and-see" attitude toward new applications of technology and want solid references and examples of close-to-home successes before adopting. They are not interested in abrupt, discontinuous change, but are more attuned to evolutionary modification of the existing processes and methods. They want to see compelling value in an innovation before adopting it. As a group, the mainstream is more risk averse than the innovators and early adopters. Their networks are predominantly vertical, focused within the home discipline or discipline area” (p. 7).
4. “Late Majority - This is the conservative or "sceptical" latter half of the mainstream. They are similar in many respects to the early majority, though typically less comfortable with technology. By definition, they accept innovation late in the game, once the change has already become well established among the majority. In technology products, they like the complete package, the preassembled, ready-to-run technology solution” (p. 7).
5. “Laggards - The last 15 percent of the potential adopter population is the most likely never to adopt at all. In teaching they are unlikely to employ information technology, and they may be antagonistic to its use by others.” (p. 8).

The aim of the workshops was to identify (in the first workshop) the teachers who may belong to the first three groups.

In the first workshop, teachers were expecting a “hands-on” approach, immediately immersing into technology. The first disappointment was about to happen, as our first workshop was a “hands-off” session. In fact, before entering the “hands-on” activities, we discussed what the science tells us, nowadays, about teaching and learning with technologies. That was very useful to determine whose teachers were there actually to learn and the teachers that did not want to be there (mostly the laggards). In the first workshop we discussed: a) the findings currently available regarding the use of technologies; ii) The Cognitive Load theory, Mayer’s Cognitive Theory of Multimedia Learning and the Multimedia Principles. Teachers were informed that the next workshops were not mandatory (there is no point in having uninterested people in the workshops) and most agreed that the suggested path was a good starting point for the workshop phase, with the intention to give the first step towards “digital proficiency”.

### ***Digital production.***

The second workshop was designed to demonstrate how easy it is to produce, from the scratch, an educational video. From a quick hands-up inquiry at the beginning of the workshop, we discovered that the overwhelming majority of teachers have never produced a video, before. So, this second workshop was designed:

- i. To demonstrate the process of produce digital educational resources;
- ii. To incentive all teachers to produce a video, no matter what theme was selected, and how poor the result is;
- iii. To publish the produced video in YouTube platform, protecting the resource simply by publishing in the “unlisted” mode (only those who have the full web address will be able to access the resource).

The process was also documented in video, made available in school's VLE course that supported these workshops, so that teachers can go back to review the whole process, whenever it is necessary, during the personal digital educational resource production phase.

Teachers reacted very well to this workshop and, at the end of the second workshop, most teachers felt they were able to, autonomously, produce a video. That means that the behaviour and attitude aspects, as referred in literature, were well addressed in the preparation of the workshops.

### *VLE use.*

The third workshop intended to explain the basics of the VLE used in the school (MOODLE) mostly centred in these aspects:

- i. Course management and student enrol: self-enrol (as long as they possess the course keyword) or individually hand-picked by the teacher, selecting users one by one;
- ii. The platform mechanisms to interact and communicate with students;
- iii. The mechanisms for sharing resources (for example, those resources produced by the participants in the previous workshop);
- iv. The mechanisms for receiving assignments from students.

All teachers received the credentials to manage a Moodle test course, and the digital resources produced in the previous workshop were required to be published in their "test course". A very small percentage of the teachers completed this task "on time" but, after a couple of weeks, almost one third of them completed the task.

At the end of the workshop, tips and tricks were shared with teachers, such as:

- i. How to embed the YouTube video in the Moodle course (a Moodle resource called "separator" accessed in html mode, integrating an iframe);

- ii. How to run the video, starting in maximised mode, or in a precise point in seconds (<https://www.youtube.com/embed/0AOXqOGdvjg?start=40>)<sup>3</sup>.

*Sharing the resources.*

The fourth workshop, open to all teachers (even those who have chosen not to participate in the workshops, including the laggards, obviously), was designed to encourage teachers to share their work with the fellow colleagues. Some of those who attended the workshop phase presented their achievements and shared the resources they have produced and (most of them) used in their classes. This workshop was designed to allow the participants to “shine” in front of a peer-audience. From this fourth workshop we have found that:

- i. It was very interesting to observe teachers proudly sharing the valuable digital resources they have just produced, with all their colleagues;
- ii. It was very stimulating to perceive that some teachers who did not attend any workshop before, asked for the permission to use (in their own classes) some of the resources their colleagues have produced;
- iii. It was somewhat surprising to verify, a little later, that some of the teachers who initially rejected the idea of producing digital educational resources and using digital technologies with their students, changed their minds and asked us to repeat the process so that they can also be able to become “producers”. That reinforces the idea expressed by Evans (2011, p. 866) where “shaping teacher professionalism effectively requires an understanding of what teachers may - either immediately or over time - recognise and accept, on balance, as a ‘better’ professionalism”. As Evans points out, “initial resistance and

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<sup>3</sup> Youtube changed this API (Application Program Interface) player parameters during the series of workshops, deprecating the previous “/v/” mode, replacing it with the /embed/ command;

opposition may prove temporary and it is important to recognise that, like any 'developees', teachers may not necessarily be best placed to determine the direction of their own development; they may not have the vision that allows them to take in the bigger picture within which their own working lives are located".

- iv. However, we must respect the fact that some teachers may still not be interested to adopt technologies in their activities. In fact, as Van Dusen concludes, we should avoid pitting traditionalists against enthusiasts as in the foreseeable future there will remain "a wide range of classroom activities, from the traditional lecture to virtual reality experiments, that will continue to serve the needs of students" (1997, p. 122-123). That may indicate that, in today's schools, there is still room for all, from "laggards" to "techies".

#### *Conclusions for this stage*

The "four workshops program" was repeated several times and, in each version, we tried to improve the program by reflecting on what worked well and what can we do better, next time. All these cycles are consistent with the Design-Based Research methodology. Obviously, all people are different and all groups differ from the others, but it was possible to identify some "little things" that can be improved, mainly in the resources that were refined several times, and in the suggested activities, integrating some suggestions from the participants.

However, at the end of this stage, we have had to deal with some difficulties that were completely out of our control (and there was absolutely nothing we could do about it):

- i. Lack of time. The huge amount of teaching classes and bureaucratic duties are some of the teachers' constraints and some of them quit the program.

- ii. Family problems. Some teachers faced personal family problems that eventually led to the program abandonment.
- iii. Labour problems. Some teachers were involved in labour problems during the process and did not finish the program.



## **Discussion and conclusions**

### **The First Study – A Development in the Technology Acceptance Models**

Rather than to contest or dispute the findings of previous research, we aimed to bring to the discussion other variables that may contribute to a better understanding of the problems we are dealing with.

Prior studies and research led us to a point where we do know that “Intention to Use ICT” is the strongest predictor of “ICT use”. However, the findings of our first study (survey research) suggest that teachers’ “Technical Knowledge” may also be a strong predictor of “Intention to Use ICT” (which is a trigger of “ICT use”). Therefore, we may propose that an action that fosters the development of Teachers’ ICT skills (increasing “ICT Knowledge”) should develop the “Intention to Use ICT” and, consequently, “ICT use”. Thus, we conclude that increasing teachers’ “ICT knowledge” may also contribute to foster the integration of technology in the scholar activities.

That is the reason why we should provide adequate training to achieve some proficiency in ICT skills and, only then, expect teachers to profusely use it. Further research based on field experience is necessary to confirm these findings, by integrating other variables in this model, such as: Effort Expectancy, Computer Anxiety, Perceived Usefulness, Perceived Ease-of-Use, aiming to increase the variance explained by the proposed model.

Given ISTTU results we concluded that it is possible that digital proficiency may be achieved by the continued use of digital technologies. However, the way to provide teachers with the means to achieve digital skills is another complex issue we must address. That was the purpose of the second study (Design-Based Research).

## **The Second Study – A Quest for Digital Proficiency**

From the first study, “A new development in the Technology Acceptance Models”, we concluded that we should not neglect the impact of ICT skills in the factors that may foster ICT use. But a question emerged from the first study: How should we provide teachers the means to achieve ICT skills (or digital skills)?

The survey we conducted was enough to answer that question, but it was not sufficient to propose a solution to the problem, and that became the focal point of the second study, “A quest for Digital Proficiency”. At this point we pondered what would be the best approach to achieve digital proficiency and a dilemma emerged: Should we develop “online courses” (due to geographic dispersion) or “face-to-face training”? In fact, both models have advantages and inconveniences.

The advantage of using online models is the possibility to provide training to more teachers, geographically dispersed, even in different time zones, without a significant additional effort. The disadvantage may be related to the subjects to be studied (digital skills) that may require some digital skills to interact with the resources. Also, the anxiety and the lack of self-confidence regarding the use of digital technologies may be an unsurmountable obstacle when teachers are required to use online models, only.

The face-to-face models appeared to be more suited when dealing with questions related to the variables identified: “effort expectancy”, “computer anxiety”, “perceived usefulness” and “perceived ease-of-use”. In fact, online models can increase computer anxiety, as people feel alone and abandoned in an online environment. The online models cannot provide the comfort and close support that face-to-face models provide. The demonstration of “how easy it is” to accomplish a technical task is more efficient on the face-to-face models, by far.

In the second study the variables previously identified were dealt with as follows:

- i. Effort Expectancy: We must highlight how easy it is to achieve the goal or, at least, the best way to achieve it with less effort;
- ii. Computer Anxiety: We can address this issue by providing close support to teachers to reduce or eliminate anxiety (something that is much more difficult to accomplish with online models);
- iii. Perceived Usefulness: we must clearly demonstrate the system usefulness regarding teachers' educational practices;
- iv. Perceived Ease-of-Use: we must demonstrate how easy it is to use a system.

Therefore, all the actions should have these principles in mind, no matter which modality is chosen.

The online courses were designed considering each principle presented in the “science of instruction” and the “production guidelines” from table 19.

The results of the online courses were very distant from our previous expectations. Although a lot of time and effort were spent in the resource production and refinement phase, and well in the planning of meaningful activities to complement the resources, the fact is that most teachers who demonstrated interest in the courses did not attend the online courses or did not achieve the goals we have anticipated. Most of those who attended the online courses did not complete the required tasks, despite the quality of the resources. In fact, most resources were not accessed at all, by a significant number of participants.

In short, perhaps the participants did not find the time and the motivation to attend the online courses, which constituted a setback. Probably an initial face-to-face session in which the general mechanics of the course could be explained, would be more engaging for those participants, who have never completely understood what was expected from them. A different approach, in a blended learning mode, would be interesting to test in the

future in order to better understand the reasons for the setback.

The workshop phase ended up being a success beyond our best expectations and it became the real trigger to start the process of producing Digital Educational Resources. Actually, after the workshop phase, most teachers revealed the intention to go deeper in the subjects and attend the online courses (which some completed successfully). Therefore, we conclude that the workshops model worked out very well and the online courses did not, at least in the planned way. In fact, the applicability of the “online courses” turned out to be the possibility to go deeper in terms of ICT knowledge in a self-training approach, but only after the workshops. Although the courses were designed to be an alternative way to achieve digital proficiency, they turned out to be a satisfying complementary activity for the workshops phase.

Consequently, it was a crucial mistake to start with the online courses. We learned that teachers: a) Need to see and understand the complete picture before starting the journey, by providing them with a blueprint of the whole endeavour, which is better achieved with face-to-face interactions; b) The proximity and “controlled environment” is very important in the second workshop, where the “perceived easy-of-use” is actively and deeply worked.

In fact, after the Design Research, it became foreseeable that asking a teacher (that may not be comfortable with digital technologies) to interact with digital technologies in order to learn how to use digital technologies, would be a condemned endeavour. Although in the model stage of our survey research “learning with ICT” had a low factorial weight, given the findings of the second study (design research), it became clear that “learning with ICT” is not recommended, at least when the subjects to be learned are “ICT skills”. That leads to our first conclusion: Teachers need face-to-face interactions and the comfort of live demonstrations (instead of video tutorials with exactly the same

content) on how to use technology, and close support from an “expert” to feel confident in their first approach to the use digital technologies to produce digital resources (even though the expert was available online – “it was not the same”, some teachers stated).

We also concluded that teachers always require the comfort of having an “expert” nearby when experimenting the use of digital technologies. At the beginning, the call for the “expert” was very frequent and became more spaced in time, and practice consolidates the new feeling: “we are getting more comfortable with digital technologies”. As the expert progressively retires from the scene (deliberately delaying the answers to foster mutual help among the participants), some of the participants progressively assumed the “expert” role along the process. Soon enough the fellow teachers started to require the support of the colleague-expert instead of the “expert” (that was always present, nevertheless). This is very important: creating the “local expert” role, sowing a seed to the next stage: this new expert, in time, should become able to replicate the “workshops model”. That’s our second conclusion: Teachers need close support from an “expert” to feel comfortable to explore digital technologies.

### **The conclusion (and future steps)**

At the end of this research we must conclude that teachers are able to shift from “technophobic” to “consumers” and, in time, from “consumers” to “producers”, as long as they are provided with the adequate support and a succession of a well-balanced scaffolding actions. Even the most frightened and anxious teacher (regarding ICT use) is able to convert into an active digital producer and become a leader, encouraging their fellow colleagues to do the same.

Noticeably, they need to continue to work in this field of action in order to achieve digital proficiency, but, in our opinion, the most difficult part is accomplished. Now, it is just a matter of time, organisation and persistence.

At the end of the endeavour, we conclude that:

- i. ICT skills is a “non-neglectable” predictor of Intention to use ICT;
- ii. Learning through ICT, at least in online environments, is not suited when ICT skills are the subject of study. A series of workshops is much more profitable in the first stage. After the workshops, online environments may be suited to improve the knowledge on specific technologies (for instance: image editing, video editing, advanced use of spreadsheet or word processor);
- iii. In today's world, gender is not a moderator of any kind. This is a very positive indicator and it is somehow comforting to realise that today there are no significant differences of gender regarding the use of digital technologies. In fact, we found that male predominance in the usage of digital technologies is now a myth;
- iv. Considering the “Teaching Area” we found that, as expected, teachers from technical areas, when provided with the same inputs, react much better in terms of intention to use technologies, compared with those from other teaching areas. However, we have found a surprisingly good response from teachers from the “social and cultural” areas, when compared with teachers from the “scientific” area. We believe that scientific contents are as suited as any other to make use of digital technologies, and maybe this is an area that needs to be developed. In general, teachers from technical areas are more predisposed to use digital technologies than teachers from cultural or scientific areas. This was also confirmed in the workshops phase as the “significant peer” that supported fellow teachers is mostly from technical areas.

- v. The use of Virtual Learning Environments increased the use of digital technologies. The final purpose of all teachers in the workshops was to produce resources to share with students and colleagues. Without that “little incentive”, objectively verifiable in the VLE content, we would not know for sure how they have reacted, as we do not have access to the interior of the classrooms. Another contribution may have come from the “annual teachers' performance assessment”, in which the item “using the school's VLE” contributes to the performance, with a direct impact in teachers' career progression.

At the end of this research, we are now better documented to state that teachers' proficient use of digital technology is far from a myth. It is achievable and not as difficult as many would expect. It requires time and effort from all stakeholders (mostly from the teachers). At the end, we conclude that digital skills (ICT skills) is a variable that is far from neglectable: it may actually be another trigger to “ICT use” and the missing link we have all been looking for.

In conclusion, we can actually say that, in line with Kemmis's (2009) findings, we changed the “sayings”, “doings” and “relatings” of a micro-community regarding Digital Technology use for educational purposes. It would be desirable to develop this line of research in the near future, in two dimensions: 1) Applying this model in a larger scale; and 2) Improving the survey, by identifying and integrating other variables that are still missing in the ISTTU model.

The main question (the one this research was built upon) subsists: If it is possible to induce small changes in the landscape of “ICT use” in a microscale, with limited resources and just one researcher, how many decades must we wait until the use of Digital Technology in the classroom is a widespread reality?





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In this document, APA (American Psychological Association) rules were followed, as published online at <http://apastyle.apa.org>. Other online resources related to APA style were also consulted at <http://www.docstyles.com/apacrib.htm>.

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## **Appendices**

### **Appendix A. Authorisation to translate, use and apply the questionnaires**

## Appendix A.1. TIQ Questionnaire (Ventkatesh).

**Pedro Brás | IE.UL**

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**De:** Vivek Venkatesh <VIVEK.VENKATESH@education.concordia.ca>  
**Enviado:** quinta-feira, 12 de Maio de 2011 20:09  
**Para:** pb@campus.ul.pt  
**Cc:** Phil Abrami  
**Assunto:** Re: Question related to the TIQ - Technology Implementation Questionnaire - reque

Hello Pedro - I see no problem with you translating the TIQ - please send us a copy for our records as well as any copies of reports of its use.

Best regards,

Vivek VENKATESH, PhD

P: +1-514-848-2424 ext. 8936  
E: [vivek@education.concordia.ca](mailto:vivek@education.concordia.ca)  
W: <http://education.concordia.ca/~vivek.venkatesh/HomePage/Profile>

"Pedro Brás | IE.UL" <[pb@campus.ul.pt](mailto:pb@campus.ul.pt)> writes:  
Good evening

My name is Pedro Bras and I am a student from the "ICT in Education" Doctoral Program, in Lisbon University.

I am currently conducting my research in the area of the use of ICT in classroom from teachers of the vocational stream of secondary education in Portugal and I am willing to apply the TIQ – Technology Implementation Questionnaire. In fact, I believe that teachers are still not making an extensive use of ICT in classroom, although they consider it highly important.

I'm trying to draw a picture of the ICT use in the vocational stream of secondary education in Portugal, and this investigation has a national scope.

Therefore:

I wonder if your questionnaire is already translated to Portuguese language (and, in that case, who would be the person to contact in order to obtain the authorization to replicate the questionnaire).

If the translation is not done yet, I would like to do it.

Obviously this request applies to my investigation only and I will comply with all the ethical procedures related to it.

I'll be looking forward for your reply...

Best regards  
Pedro Torres Brás  
Doctoral Student of "ICT in Education Doctoral Program"  
Institute of Education – Lisbon University

**Appendix A.2. TPACK Questionnaire (Mishra).****Pedro Brás | IE.UL**

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**De:** Punya Mishra <punya@msu.edu>  
**Enviado:** quinta-feira, 12 de Maio de 2011 19:39  
**Para:** "Pedro Brás | IE.UL"  
**Assunto:** Re: Question related to the TPACK Questionnaire - request of the permission to use it...

Dear Pedro -

Thank you for your note and your interest in the TPACK survey.

We have made the survey freely available for people to use - so you are free to translate and use it in your research. I am not sure if it has already been translated into Portuguese - that is hard to tell.

Our only request is that once you have made the translation you make it freely available (maybe using the TPACK.org website) just as we have done so - so that it can benefit other researchers.

sincerely  
~ punya

-----  
Punya Mishra  
Web: <http://punyamishra.com>  
Blog: <http://punya.educ.msu.edu/blog/>

Pedro Brás | IE.UL wrote:  
Good evening, Professor

My name is Pedro Bras and I am a student from the "ICT in Education" Doctoral Program, in Lisbon University.

I am currently conducting my research in the area of the use of ICT in classroom from teachers of the vocational stream of secondary education in Portugal and I am willing to apply the TIQ – Technology Implementation Questionnaire. In fact, I believe that teachers are still not making an extensive use of ICT in classroom, although they consider it highly important.

I'm trying to draw a picture of the ICT use in the vocational stream of secondary education in Portugal, and this investigation has a national scope.

Therefore:

*I wonder if your questionnaire is already translated to Portuguese language (and, in that case, who would be the person to contact in order to obtain the authorization to replicate the questionnaire).  
If the translation is not done yet, I would like to do it.*

Obviously this request applies to my investigation only and I will comply with all the ethical procedures related to it.

I'll be looking forward for your reply...

Best regards  
**Pedro Torres Brás**  
Doctoral Student of "ICT in Education Doctoral Program"  
Institute of Education – Lisbon University

**Appendix B. emails from the Association that represents the Professional Schools in Portugal (ANESPO) confirming the importance of the investigation to the professional schools and supporting the project**

**Pedro Brás | IE.Ul**

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**De:** ANESPO [mailto:geral@anespo.pt]  
**Enviado:** quinta-feira, 9 de Junho de 2011 11:09  
**Para:** 'PEDRO MANUEL FERREIRA RAPOSO TO BRÁS'  
**Assunto:** FW: As TIC nas Escolas Profissionais em Portugal: Um estudo exploratório sobre atitudes, práticas e necessidades de formação

**Importância:** Alta

Ex.mos(as) Senhores(as)

**Associados(as) da ANESPO**

NOTA INFORMATIVA N° 066/2011

## **AS TIC NAS ESCOLAS PROFISSIONAIS EM PORTUGAL: UM ESTUDO EXPLORATÓRIO SOBRE ATITUDES, PRÁTICAS E NECESSIDADES DE FORMAÇÃO**

Vimos pela presente dar conhecimento e apelar à participação num trabalho de investigação que está em curso de um doutorando da Universidade de Lisboa cujo tema é: As TIC nas Escolas Profissionais em Portugal: Um estudo exploratório sobre atitudes, práticas e necessidades de formação.

O objectivo principal deste estudo é realizar a caracterização da situação actual em termos de atitude e uso das TIC (Tecnologias de Informação e Comunicação) e pretende-se que o estudo possa ter um âmbito nacional.

Numa primeira fase o investigador está a recolher dados empíricos através de um questionário e, numa segunda fase, serão planeadas acções de formação dirigidas ao corpo docente das Escolas Profissionais. Iremos fazer o possível para que estes cursos sejam disponibilizados pelo CEFANESPO e que os custos sejam tão reduzidos quanto possível.

Para que este projecto tenha sucesso é imperioso o envolvimento e empenho de todos nós, desde a ANESPO à Direcção de cada uma das Escolas Profissionais, passando pelas estruturas pedagógica e administrativa de cada escola no sentido de incentivar o corpo docente a participar nesta acção.


Este estudo está a ser conduzido pelo investigador Pedro Brás, uma pessoa que se encontra ligada ao Ensino Profissional desde a sua criação em 1989 e que tem ocupado diversos cargos pedagógicos e de gestão numa escola profissional.

Porque a ANESPO considera de extrema importância que a realidade das Escolas Profissionais seja conhecida e reconhecida em diferentes contextos, nomeadamente Universitário, vimos desta forma apelar à adesão de todas as escolas a este projecto que agora divulgamos.

O inquérito online, disponível em <http://www.pedrobras.pt/quest/index.php?sid=58133>, demora cerca de 15 minutos a responder, sendo o mesmo anónimo e garantindo o investigador a total confidencialidade das respostas dadas (já que as mesmas serão armazenadas num alojamento próprio).

**O inquérito estará disponível até ao dia 21-06-2011 mas apelamos à resposta tão brevemente quanto possível.**

Com os melhores cumprimentos.

  
**José Luis Presa**  
Presidente da Direcção

**ANESPO – Associação Nacional de Escolas Profissionais**  
Avenida 5 de Outubro N.º 176 – 1.ª Esq. \* 1050 – 063 Lisboa  
Telefone 21 781 83 20 \* Fax 21 797 08 24 \* E-Mail: [geral@anespo.pt](mailto:geral@anespo.pt)  
[www.anespo.pt](http://www.anespo.pt)

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**Pedro Brás**

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**De:** Jorge Soares <jorgesoares@epinfante.com>  
**Enviado:** quarta-feira, 4 de Maio de 2011 15:23  
**Para:** pedrotorresbras@gmail.com  
**Assunto:** FW: Proposta de trabalho com a ANESPO

Bom dia Eng. Pedro Brás

Recebido carta a solicitar colaboração da ANESPO para implantar os estudos necessários a tese de Doutoramento, Venho informar que foi aprovado em reunião de Direcção a autorização para a colaboração com o senhor Eng. Já dei instruções aos serviços, nomeadamente ao CEFANESPO, para disponibilizar os serviços.

Cumprimentos,  
O Vice-presidente,  
Jorge Soares

---

**De:** Director Executivo [mailto:directorexecutivo@anespo.pt]  
**Enviada:** quarta-feira, 4 de Maio de 2011 10:12  
**Para:** pedrotorresbras@gmail.com  
**Cc:** 'Jorge Soares'  
**Assunto:** Proposta de trabalho com a ANESPO

Bom dia.

Na sequência do mail enviado ao nosso VP Jorge Soares, manifestamos a nossa disponibilidade para colaborar na realização do seu trabalho.

Estou disponível para agendar nos próximos dias uma reunião para definirmos os contornos concretos.

Com os melhores cumprimentos.

Luis Costa

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## Appendix C. The online questionnaire

The adapted questionnaire was implemented online using LimeSurvey open-source software (Version 1.90+, Build 9642) that is built in PHP programming language (version 5.2.14) over a MySQL database (version 5.0.91). This instrument was installed in an Apache based HTTP server (version 2.2.17) over the Linux operating system, owned by the investigator in a personal Domain Name Server: [www.pedrobras.pt](http://www.pedrobras.pt).

The template was adjusted in terms of image and made available at the following web address: <http://www.pedrobras.pt/quest/index.php?sid=58343&lang=pt>

The instrument has the following questions:



### Questionário Baseline - "Utilização das TIC nas Escolas Profissionais em Portugal"

Olá.

Eu chamo-me Pedro Brás e este questionário insere-se na fase de recolha de dados da minha tese de doutoramento em Tecnologias de Informação e Comunicação na Educação.

Este instrumento encontra-se instalado num servidor próprio (ao qual só eu tenho acesso) e garanto a total confidencialidade dos elementos recolhidos. Assim, quaisquer elementos identificativos e a informação a eles correspondente estão salvaguardados de utilização abusiva por parte de terceiros.

O trabalho de investigação intitula-se "Estratégias para o Desenvolvimento Profissional dos Professores: Factores facilitadores do uso das TIC nas Escolas Profissionais em Portugal" e a recolha de dados decorrerá até 30 de Setembro de 2011.



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#### **Atenção: Normas de consentimento informado**

Este questionário cumpre as normas de consentimento informado (Lei 67/98 de 26 de Outubro - Qualidade dos dados e legitimidade do seu tratamento).

Os dados recolhidos serão unicamente utilizados para a investigação e serão tratados com rigor, honestidade, autenticidade, equidade, respeito pelo anonimato dos participantes, garantindo-se a total confidencialidade das informações prestadas.

---

Obrigado por colaborar...

Sair e limpar inquérito

Carregar inquérito incompleto

Seguinte >>



Questionário Baseline - "Utilização das TIC nas Escolas Profissionais em Portugal"

0%  100%

Parte I - Caracterização  
Caracterização

\*100. Identificação do inquérito: Este inquérito é anónimo. No entanto, podemos necessitar, no futuro, de fazer a correspondência das suas respostas. Por isso necessitamos de um identificador único.

Assim, **insira os 6 últimos dígitos do seu NIF (Número de Identificação Fiscal - N.º contribuinte):**

*Neste campo só se aceitam números*

\*101. Escola onde lecciona

*Escolha uma das seguintes respostas*

\*102. Qual a componente em que lecciona mais aulas?

*Escolha uma das seguintes respostas*

- Sociocultural (excepto TIC)  
 Científica  
 Tecnológica (ou TIC)

\*103. Sexo

- Feminino  Masculino

\*104. Idade

*Neste campo só se aceitam números*

\*105. Anos de serviço como Professor (incluindo o presente ano lectivo)

anos

*Neste campo só se aceitam números*

\*106. Habilitação académica

*Escolha uma das seguintes respostas*

- Doutoramento  
 Mestrado  
 Licenciatura  
 Bacharelato  
 Sem grau superior

\*107. Profissionalizado?

- Sim  Não

\*108. Tipo de Vínculo na Escola Profissional

*Escolha uma das seguintes respostas*





Questionário Baseline - "Utilização das TIC nas Escolas Profissionais em Portugal"

0%  100%

Parte III - Integração da tecnologia

**Importante:**

Quando responder à presente questão tenha em atenção que, sempre que for mencionada a sigla TIC, nos referimos a uma utilização de tecnologia que compreende

- Equipamentos (Computadores, Impressoras, Scanners, Câmaras, Videoprojectores, Quadros interactivos, etc.)
- Software (sistema operativo, processador de texto, folha de cálculo, navegadores de Internet, apresentações electrónicas - ex: powerpoint -, construção de páginas web, produção de áudio, produção de vídeo, etc.) e
- Comunicação - Acesso à Internet, dispositivos móveis, etc. Todas as restantes tecnologias digitais específicas para a sua área de ensino

\*301. Indique com que frequência inclui a utilização das TIC nas suas actividades docentes.

*Escolha uma das seguintes respostas*

Por favor, seleccione...

\*302. Em média, quantas horas por semana gasta na utilização de TIC fora das suas actividades docentes

*Escolha uma das seguintes respostas*

Por favor, seleccione...

\*303. Leia as seguintes descrições acerca do **Nível de Proficiência** (competência, habilidade, capacidade, mestria) relativamente às TIC e seleccione a opção que melhor se ajusta à sua situação actual.

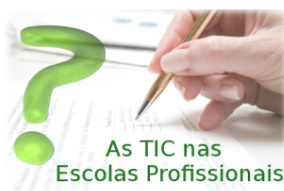
*Escolha uma das seguintes respostas*

- Leigo** - Não tenho experiência nenhuma com as TIC.
- Recém-chegado** - Tenho tentado usar TIC mas preciso frequentemente de ajuda.
- Iniciado** - Sou capaz de utilizar autonomamente um número limitado de tecnologias.
- Utilizador médio** - Disponho das competências mínimas para utilizar autonomamente as TIC mais comuns.
- Utilizador avançado** - Disponho das competências para utilizar autonomamente um largo espectro de TIC.
- Especialista** - Sou extremamente proficiente na utilização autónoma da maioria das TIC. Sou capaz de descobrir como as TIC funcionam mesmo que as não conheça de antemão.

\*304. Leia as descrições abaixo e seleccione a opção que melhor se ajusta à sua situação actual face às TIC

*Escolha uma das seguintes respostas*

- Consciência** - Sei que as TIC existem mas não as tenho utilizado (possivelmente até as tenho evitado). Tenho alguma ansiedade relativamente à utilização das TIC na minha actividade.
- Aprendizagem** - Estou presentemente a tentar aprender o básico. Fico por vezes frustrado(a) ao utilizar as TIC e falta-me a confiança para as utilizar com mais frequência
- Compreensão** - Estou a começar a entender o processo de integração das TIC na minha actividade e consigo perspectivar algumas situações em que isso me pode ser útil.
- Familiaridade** - Estou a ganhar uma sensação de auto-confiança na utilização das TIC para actividades específicas. Estou a começar a sentir-me confortável ao utilizar as TIC
- Adaptação** - Deixei de olhar para as TIC como tecnologia mas como uma ferramenta de trabalho para a minha função de professor. Consigo utilizar várias aplicações das TIC na minha prática docente.
- Aplicação** - Consigo aplicar os meus conhecimentos sobre TIC em sala de aula, concebendo facilmente recursos e actividades, integrando as TIC no curriculum



Questionário Baseline - "Utilização das TIC nas Escolas Profissionais em Portugal"



Parte IV - Utilização das TIC

Importante:

Quando responder à presente questão tenha em atenção que, sempre que for mencionada a sigla TIC, nos referimos a uma utilização de tecnologia que compreende

- Equipamentos (Computadores, Impressoras, Scanners, Câmaras, Videoprojectores, Quadros interactivos, etc.)
- Software (sistema operativo, processador de texto, folha de cálculo, navegadores de Internet, apresentações electrónicas - ex: powerpoint -, construção de páginas web, produção de áudio, produção de vídeo, etc.) e
- Comunicação - Acesso à Internet, dispositivos móveis, etc. Todas as restantes tecnologias digitais específicas para a sua área de ensino

\*Assinale na escala, qual a opção que melhor traduz a sua opinião.

	Nunca uso								Uso sempre
401. Uso as TIC para a preparação de fichas ou testes para as minhas aulas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
402. Uso as TIC para fazer apresentações de audiovisuais nas minhas aulas (ex: Powerpoint)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
403. Uso as TIC para preparação de textos de apoio às minhas aulas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
404. Uso as TIC para pesquisa na Internet de assuntos das minhas disciplinas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
405. Uso as TIC para pesquisa bibliográfica	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
406. Uso as TIC para pesquisa em bases de dados não bibliográficos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
407. Uso as TIC para pesquisa de conteúdos científicos da minha área profissional	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
408. Uso as TIC para pesquisa de outros assuntos que aumentem os meus conhecimentos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
409. Uso as TIC para produção de esquemas (transparências, acetatos)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
410. Uso as TIC para produção de fotografia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
411. Uso as TIC para produção de páginas WEB	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
412. Utilizo as TIC em aplicações de folha de cálculo (Excel ou outro)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
413. Utilizo as TIC em aplicações para elaborar bases de dados (Access ou outro)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
414. Utilizo as TIC em aplicações para tratamento de dados (SPSS ou outro)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
415. Utilizo as TIC em aplicações para digitalizar e compor imagens (scanner ou outro)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
416. Utilizo as TIC em aplicações de processador de texto (word, publisher ou outros)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
417. Uso as TIC para interagir com colegas (professores da minha escola) através de e-mail	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
418. Uso as TIC para interagir com alunos, através de e-mail, para orientação pedagógica	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
419. Uso as TIC para interagir com professores de outras escolas, através de e-mail	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
420. Uso as TIC para interagir com alunos em Fóruns	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
421. Uso as TIC para interagir com os meus colegas em Fóruns	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
422. Uso as TIC para interagir com professores de outras escolas em Fóruns	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
423. Uso as TIC para interacção síncrona com os meus alunos (em tempo real, através de Messenger, ou outros)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
424. Uso as TIC para interacção síncrona com os meus colegas (em tempo real, através de Messenger, ou outros)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
425. Uso as TIC para interacção síncrona com professores de outras escolas (em tempo real, através de Messenger, ou outros)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Questionário Baseline - "Utilização das TIC nas Escolas Profissionais em Portugal"



Parte V - Necessidades de formação  
Diagnóstico das necessidades de formação dos docentes

\*501. Já alguma vez frequentou uma acção de formação sobre TIC?

- Sim  Não

\*502. Estaria disponível para frequentar acções de formação especificamente desenhadas para professores, que visassem melhorar a proficiência na utilização das TIC?

- Sim  Não



Questionário BaseLine - "Utilização das TIC nas Escolas Profissionais em Portugal"

0%  100%

Parte VI - Nível de Proficiência Tecnológica

**\*Importante:**

Quando responder à presente questão tenha em atenção que, sempre que for mencionada a sigla TIC, nos referimos a uma utilização de tecnologia que compreende

- Equipamentos (Computadores, Impressoras, Scanners, Câmaras, Videoprojectores, Quadros Interactivos, etc.)
- Software (sistema operativo, processador de texto, folha de cálculo, navegadores de Internet, apresentações electrónicas - ex: powerpoint -, construção de páginas web, produção de áudio, produção de vídeo, etc.) e
- Comunicação - Acesso à Internet, dispositivos móveis, etc. Todas as restantes tecnologias digitais específicas para a sua área de ensino

	1	2	3	4	5	6
	Totalmente em					Totalmente
	Desacordo					de Acordo
Consigo resolver autonomamente os meus problemas técnicos envolvendo as TIC	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consigo aprender facilmente a trabalhar com as TIC	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consigo manter-me actualizado com as novas tecnologias que surgem diariamente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conheço e sou capaz de trabalhar com bastantes TIC	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disponho das competências técnicas para trabalhar com as TIC	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tenho tido as oportunidades para trabalhar com várias TIC	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Questionário BaseLine - "Utilização das TIC nas Escolas Profissionais em Portugal"

0%  100%

Parte VII - Identificação (opcional)

Obrigado por ter participado.

A informação seguinte é importante para que seja possível o contacto entre nós, caso seja necessário esclarecer alguma dúvida que ocorra.

Ao indicar o seu endereço de email tornará esse o meio privilegiado de contacto.

Caso necessite contactar comigo para assuntos relacionados com o questionário ou com o projecto pode fazê-lo para [pb@pedrobras.pt](mailto:pb@pedrobras.pt)

Se desejar obter informação acerca deste estudo assinala a opção final.

Obrigado.

Nota:

Os pedidos seguintes (**todos de resposta opcional**) têm como intuito permitir o contacto futuro entre o investigador e os respondentes, no sentido de clarificação de alguma informação que se afigure menos clara aquando do processo de tratamento de dados.

De igual modo, ao preencher o seu endereço de email permitir-me-á enviar-lhe informação sobre o estado da investigação (sempre que se atinja um marco importante na mesma) ou o documento final que constitui a minha Tese de Doutoramento.

Assim, permito-me solicitar os seus dados pessoais para viabilizar contactos futuros.

**701. Nome (abreviado):**

**702. Deseja receber informação sobre os resultados deste estudo?**

Sim  Não  Sem resposta

Notes: Some questions are conditional and they were only presented with a specific answer to a previous question, as follows:

1. The questions

- “Qual a modalidade dessa(s) acção(ões) de formação que frequentou?”,
- “Qual o impacto dessa(s) acção(ões) de formação na sua relação com as TIC?”,
- “Deseja acrescentar algum comentário à sua resposta anterior (resposta opcional)?” e
- “Onde realizou as acções de formação? (esta questão não é de resposta obrigatória)”

are only activated when YES was answered to the question:

- “Já alguma vez frequentou uma acção de formação sobre TIC?”

2. The questions

- “Quais as vantagens que antevê na sua possível participação em acções de formação online que o possam ajudar a utilizar as TIC?”,
- “Quais os constrangimentos que antevê relativamente à sua participação numa acção de formação online?” e
- “Entende como imprescindível que as acções de formação sejam acreditadas pelo "Conselho Científico-Pedagógico de Formação Contínua"?”

are only activated when YES was answered to the question:

- “Estaria disponível para frequentar acções de formação ONLINE especificamente desenhadas para professores que visassem incentivar a utilização das TIC?”.

3. The question

- “Endereço de correio electrónico”

are only activated when YES was answered to the question:

- “Deseja receber informação sobre os resultados deste estudo?”





## Appendix D. The online courses

### Appendix D.1. Excel course (advanced).



www.pedrobras.pt/moodle/course/view.php?id=33

Moodle do Pedro Brás

Nome de utilizador: Pedro Brás (Sair)

Brax ► XL

Assumir o cargo de... | Activar modo edição

**Lista de tópicos**

**Utilização da Folha de Cálculo EXCEL**

- Notícias
- Dúvidas e dificuldades gerais
- Vídeo de Boas Vindas
- Vídeo Sumário Excel
- Sumário Excel (PDF)

**1 Básicos do Excel** Sessão 01

- Guião para a Sessão nº 01
- Dúvidas e dificuldades relativamente ao tema "Básicos do Excel"

**Vídeos**

- Vídeo Tutorial - Introdução ao Excel (básicos e configuração)
- Vídeo Tutorial - Inserção de informação
- Vídeo Tutorial - Formatação de informação

**Slides em PDF**

- Slides da sessão 01 - Configuração, inserção e formatação de informação

**Exercícios**

- Exercício prático nº 01 - Proposta de exercício
- Exercício prático nº 01
- Exercício prático nº 01 - Resolução em vídeo
- Exercício prático nº 01 resolvido (em excel)
- Envio da resolução do exercício proposto na sessão 01

**2 Inserção e Cópia de informação** Sessão 02

- Guião para a Sessão nº 02
- Dúvidas e dificuldades relativamente ao tema "Inserção e Cópia de Informação"

**Vídeos**

- Vídeo Tutorial - Cópia de Informação e Endereçamento (absoluto e relativo)

**Slides em PDF**

- Slides da Sessão 02

**Exercícios**

- Exercício prático nº 02 -Pauta de turma
- Envio da resolução do exercício prático 02
- Exercício prático nº 02 - resolvido
- Exercício prático nº 03 - Proposta de exercício
- Ficheiro de base para o exercício 03
- Entrega do Exercício Prático nº 03

**3 Formatação (Estática e dinâmica)** Sessão 03

- Guião para a Sessão nº 03
- Dúvidas relativamente à "Formatação de Informação"

**Vídeos**

- Vídeo Tutorial - Formatação estática
- Vídeo Tutorial - Formatação Condicional

**Slides em PDF**

- Slides da Sessão 03 - Formatação estática
- Slides da Sessão 03 - Formatação condicional

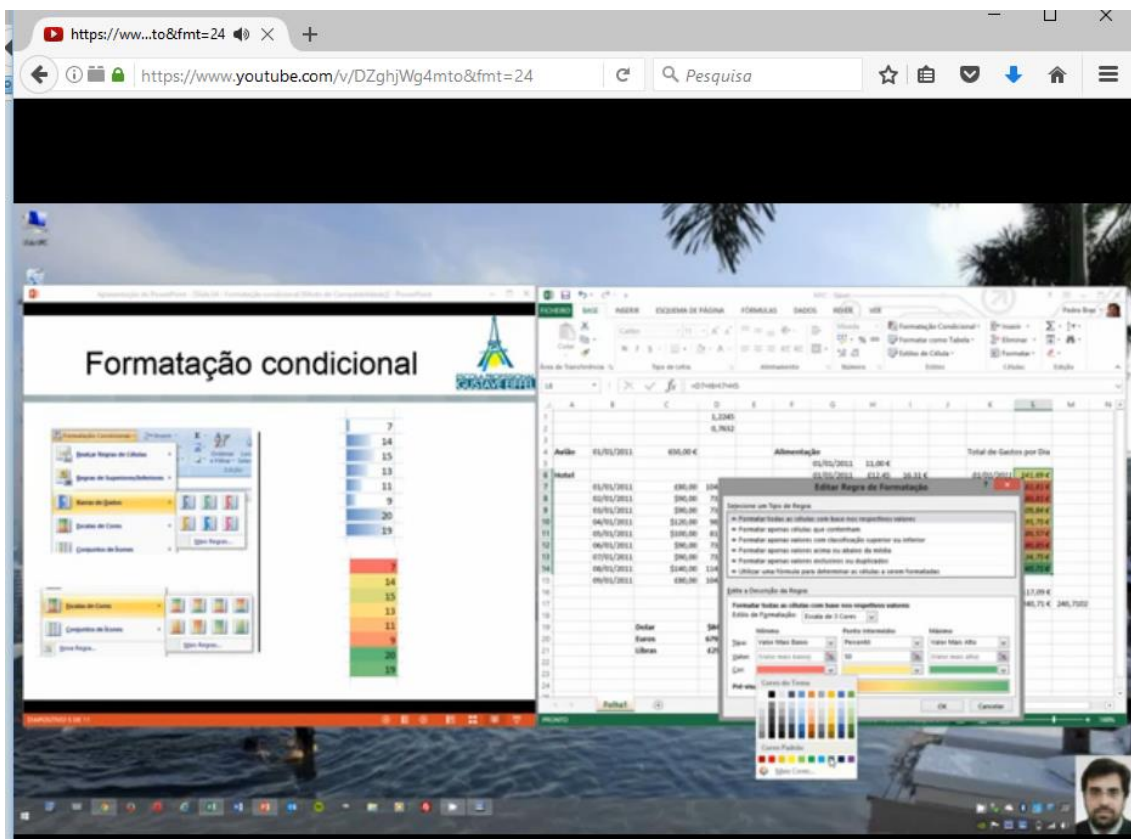
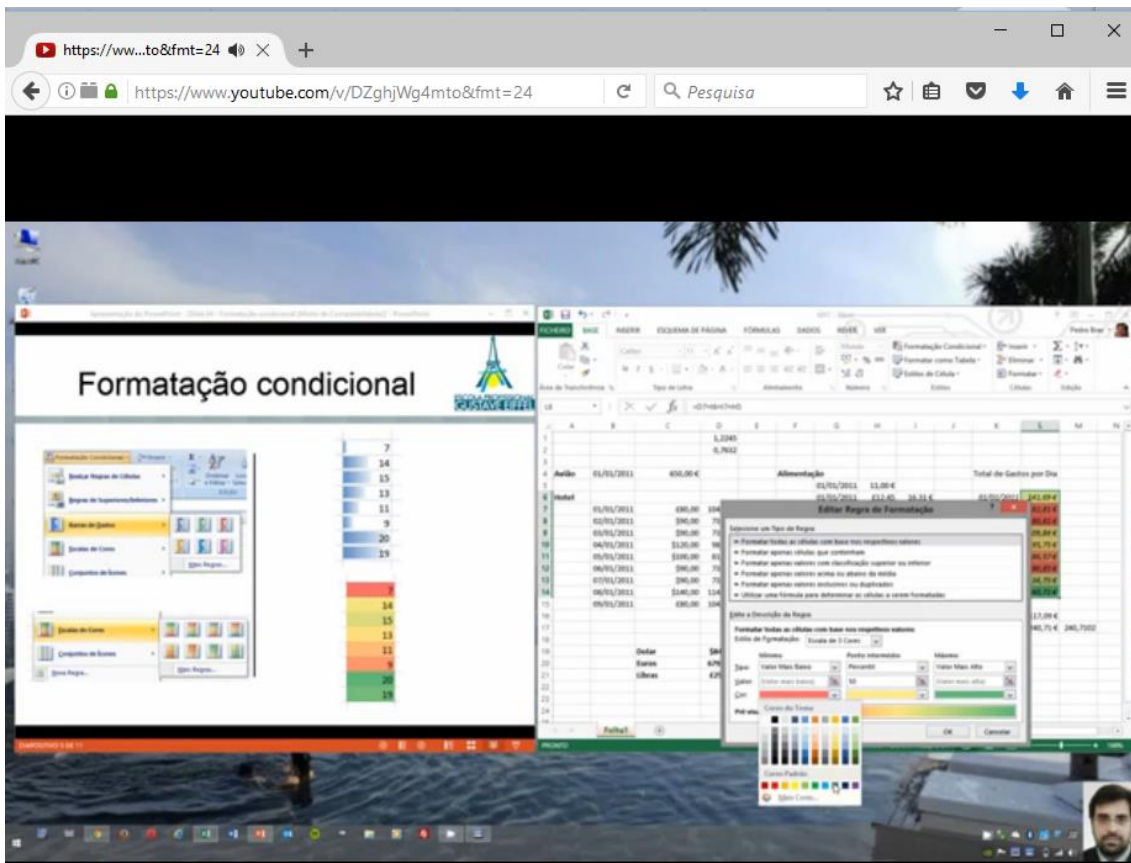
**Exercícios**

- Exercício prático nº 04 - Jogadores de Basquetebol
- Envio da resolução do exercício prático nº 04
- Exercício prático nº 04 - Resolução em vídeo
- Entrega do Exercício Prático nº 05
- Entrega do Exercício Prático nº 05

4	<b>Funções em Excel</b> Guia para a Sessão nº 04 Dúvidas relativamente às "Funções em Excel"	<b>Sessão 04</b>
	<b>Vídeos</b> Vídeo Tutorial - Funções em Excel (Aspetos fundamentais)	
	<b>Slides em PDF</b> Slide 05 - Funções matemáticas Slide 06 - Funções sobre data e texto Slide 07 - Funções condicionais	
	<b>Exercícios</b> Exercício prático nº 06 - Funções em Excel Ficheiro de base para o exercício 06 Entrega do Exercício Prático nº 06 Exercício prático nº 06 - Resolvido (aceda a este ficheiro só depois de tentar resolver o exercício)	
5	<b>Avalio os meus progressos (Teste Intermediário)</b> Enunciado do teste intermédio Ficheiro de base para o Teste Intermédio Entrega do teste intermédio	<b>Sessão 05</b>
6	<b>Impressão em Excel</b> Guia para a Sessão nº 06 Dúvidas relativamente à "Impressão em Excel"	<b>Sessão 06</b>
	<b>Vídeos</b> Vídeo Tutorial - Impressão em Excel	
	<b>Slides em PDF</b> Slide 08 - Impressão	
	<b>Exercícios</b> Exercício prático nº 7 - Vento e Temperatura na Ericeira Ficheiro de base para o exercício 07 Entrega do Exercício Prático nº 07 Resolução do exercício prático nº 07 (parte 1) Resolução do exercício prático nº 07 (parte 2) Exercício prático nº 07 - Resolvido (aceda a este ficheiro só depois de tentar resolver o exercício)	
7	<b>Gráficos em Excel</b> Guia para a Sessão nº 07 Dúvidas e dificuldades relativamente ao tema "Gráficos em Excel"	<b>Sessão 07</b>
	<b>Vídeos</b> Vídeo Tutorial - Gráficos em Excel	
	<b>Slides em PDF</b> Slide 09 - Gráficos	
	<b>Exercícios</b> Exercício prático nº 08 - Gráficos em Excel Ficheiro de base para o exercício 08 Vídeo da resolução do exercício de Gráficos Exercício prático nº 08 - Resolvido (aceda a este ficheiro só depois de tentar resolver o exercício) Entrega do Exercício Prático nº 08	

<b>7</b>	<p><b>Gráficos em Excel</b></p> <p>📄 Guião para a Sessão nº 07</p> <p>🗨️ Dúvidas e dificuldades relativamente ao tema "Gráficos em Excel"</p> <hr/> <p><b>Videos</b></p> <p>📺 Vídeo Tutorial - Gráficos em Excel</p> <hr/> <p><b>Slides em PDF</b></p> <p>📄 Slide 09 - Gráficos</p> <hr/> <p><b>Exercicios</b></p> <p>📄 Exercício prático nº 08 -Gráficos em Excel</p> <p>📄 Ficheiro de base para o exercício 08</p> <hr/> <p>📺 Vídeo da resolução do exercício de Gráficos</p> <p>📄 Exercício prático nº 08 - Resolvido (aceda a este ficheiro só depois de tentar resolver o exercício)</p> <p>📄 Entrega do Exercício Prático nº 08</p>	<b>Sessão 07</b>	☐
<b>8</b>	<p><b>Validação de dados em Excel e procura de informação relacionada</b></p> <p>📄 Guião para a Sessão nº 08</p> <p>🗨️ Dúvidas e dificuldades relativamente ao tema "Proteção e Validação de Informação"</p> <hr/> <p><b>Videos</b></p> <p>📺 Vídeo Tutorial - Proteção e Validação de Informação</p> <hr/> <p><b>Slides em PDF</b></p> <p>📄 Slides da Sessão 08 - Proteção e Validação de Dados</p> <hr/> <p><b>Exercicios</b></p> <p>📄 Exercício prático nº 09 - Validação e Proteção (a par dos assuntos das sessões anteriores)</p> <p>📄 Ficheiro Hoquei sobre Gelo</p> <p>📄 Entrega do Exercício Prático nº 09</p>	<b>Sessão 08</b>	☐
<b>9</b>	<p><b>Avaliação Final</b></p> <p>📄 Teste Final</p> <p>📄 Entrega do teste final</p>	<b>Sessão 09</b>	☐
<b>10</b>	<p><b>Avaliação da Ação (pós-formação)</b></p>	<b>Sessão 10</b>	☐

Screenshots from the videos



Brief list of some of the produced videos, uploaded to youtube in “unlisted mode” (in Portuguese Language).

Tutorial video - Introduction to Excel (basics and configuration):

<https://youtu.be/jvKeKK6Bhr8>

Tutorial video - Inserting information

<https://youtu.be/0lObn0dRI7g>

Tutorial video - information formating (content and format)

<https://youtu.be/k5x-X5-Pfrc>

Tutorial video - Copy and absolute or relative address

<https://youtu.be/0AOXqOGdvjg>

Solved assignment

<https://youtu.be/X5rLxcdPMLs>

Tutorial video - static cell formating

<https://youtu.be/1TwbqolNbuI>

Tutorial video - Conditional cell formating

<https://youtu.be/DZghjWg4mto>

Tutorial video - Funcions in Excel

<https://youtu.be/hUOtTwiwLv8>

Tutorial video - Printing in Excel

<https://youtu.be/y54atDeU56Q>

Tutorial video - Graphics in Excel

<https://youtu.be/Ju2pR1mUggQ>

Solved assignment

<https://youtu.be/4L3vh0EMQ3o>

Tutorial video - Cell protection and validation

<https://youtu.be/72XU7khQz5E>

## Appendix D.2. Image editing advanced course.



The screenshot shows a Moodle course interface for 'Edição de Imagem...'. The course is titled 'Edição de Imagem...' and is managed by Pedro Brás. The course content is organized into two sections: 'Recursos' (Resources) and 'Atividades' (Activities).

**Recursos:**

- Slides Edição de imagem
- Edição de Imagem - Vídeo 01 (Básicos do GIMP)
- Edição de imagem - Vídeo 02 (Camadas)
- Edição de Imagem - Vídeo 03 (Composição de imagens)
- Edição de Imagem - Vídeo 04 ("apanhar" zonas específicas das imagens e composição de imagens")
- Edição de Imagem - Vídeo 05 (Gradientes e composição de imagens)

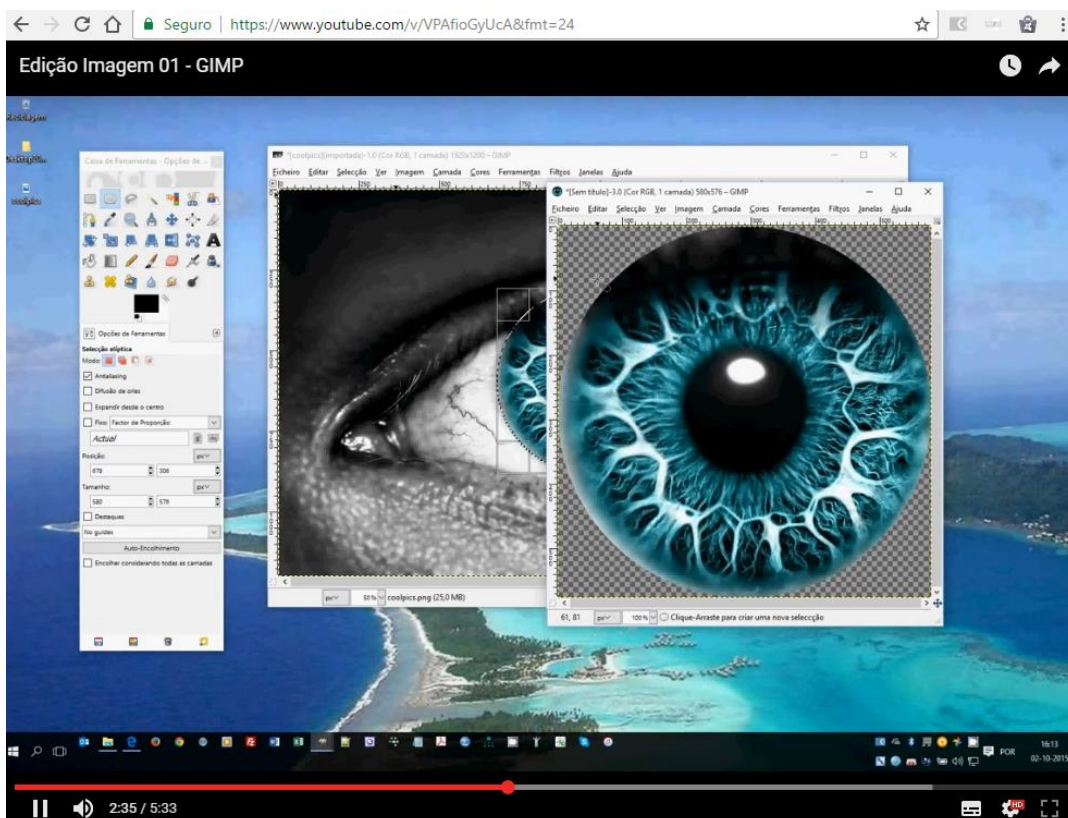
**Atividades:**

- Avestruz Original
- Avestruz - Resultado pretendido
- Entrega do trabalho 1
- Obama Original
- Obama - Resultado Pretendido
- Entrega do trabalho 2

The interface also includes a sidebar with navigation options like 'Pessoas', 'Actividades', 'Procurar nos fóruns', and 'Administração'. A right-hand sidebar shows 'Últimas notícias', 'Próximos eventos', and 'Actividade recente'.

Examples of the videos (screenshots).

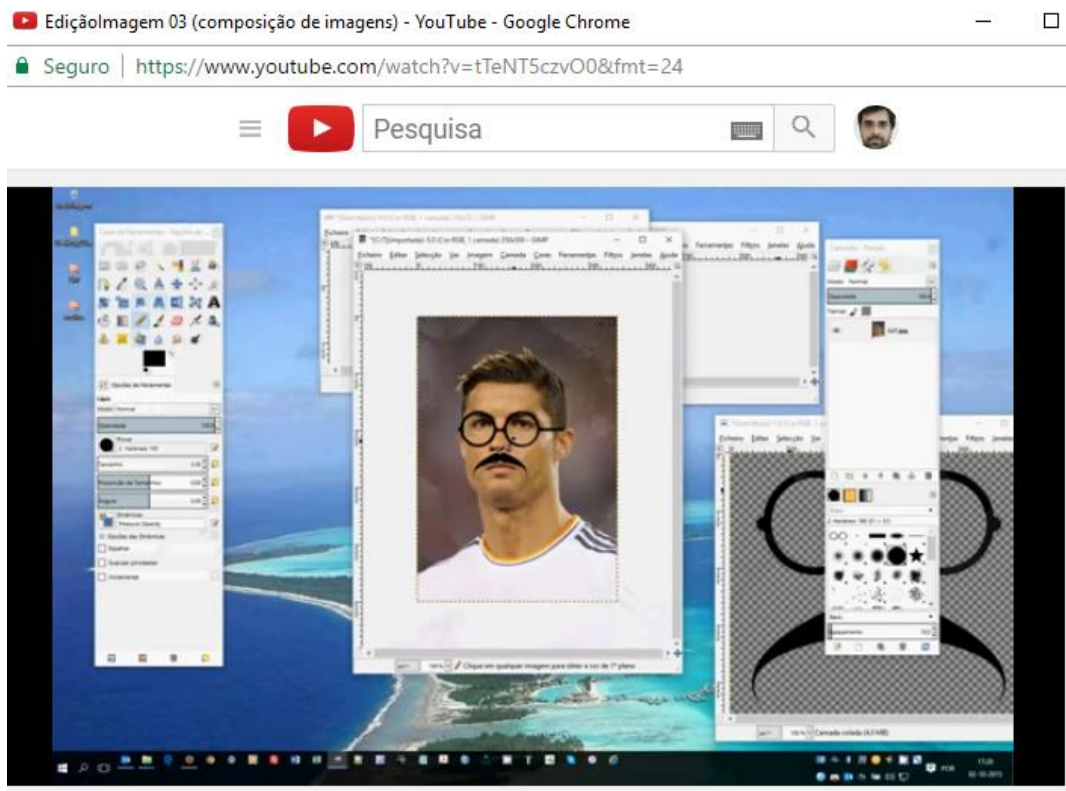
Basics:



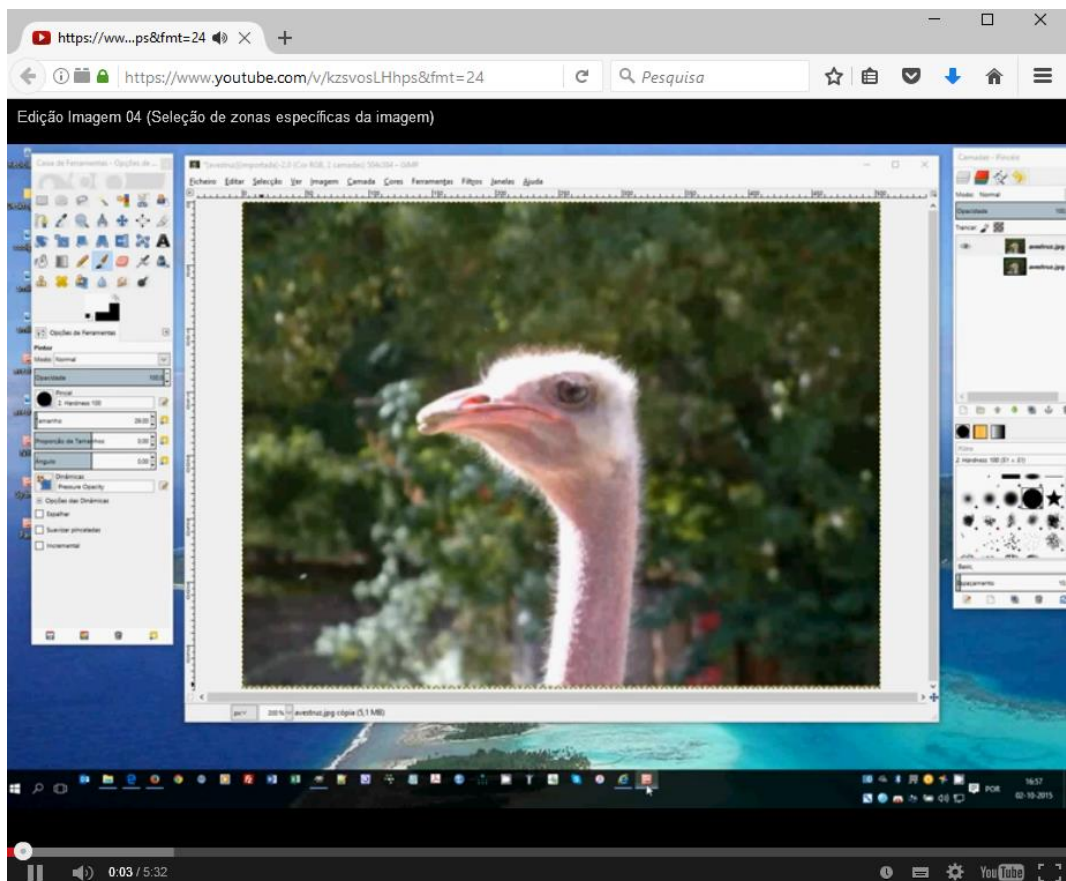
The screenshot shows a YouTube video player displaying a tutorial titled 'Edição Imagem 01 - GIMP'. The video content shows the GIMP software interface with a focus on image editing. The main window displays a close-up of a human eye, which is being edited to have a glowing, blue, crystalline iris. The GIMP interface includes a toolbar on the left, a menu bar at the top, and a status bar at the bottom. The video player controls at the bottom indicate the video is at 2:35 / 5:33.



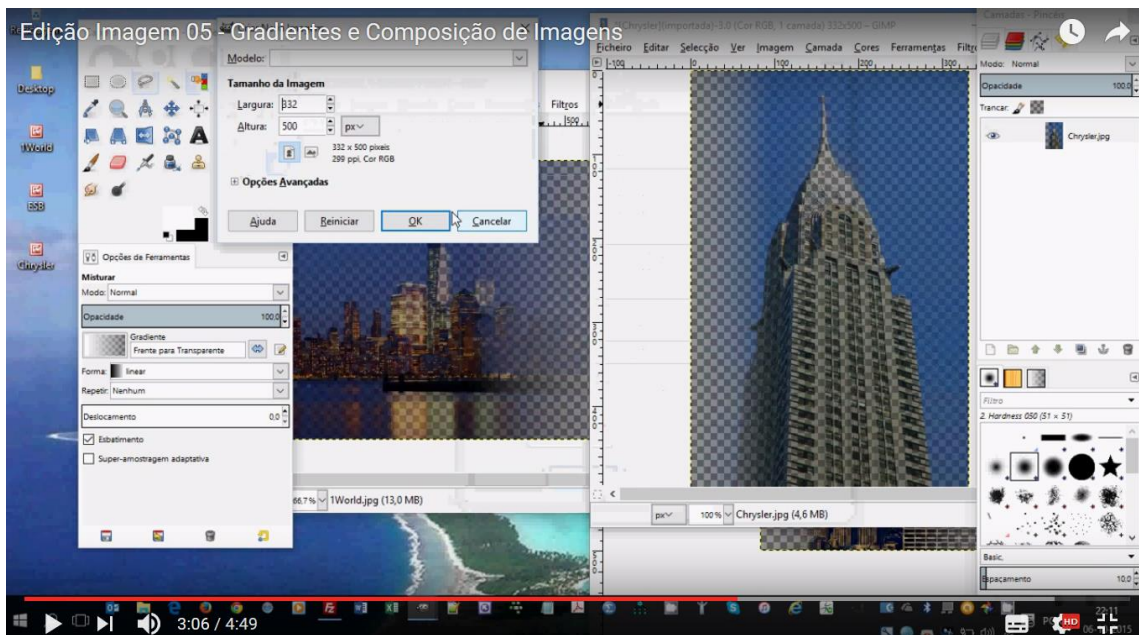
Layers (glasses and a Mexican moustache for Cristiano Ronaldo).



Grabbing selected areas from a picture (extracting the ostrich and clear the rest).



## Gradients and image composition.



Brief list of the produced videos, uploaded to youtube: in unlisted mode (in Portuguese Language).

Image editing - Video 01 (GIMP basics)

<https://youtu.be/VPAfioGyUcA>

Image editing - Video 02 (Layers)

<https://youtu.be/7C9FvFsMZs8>

Image editing - Video 03 (Image composing)

<https://youtu.be/tTeNT5czvO0>

Image editing - Video 04 (grabbing specific areas of an image and use that area in image composing)

<https://youtu.be/kzsvosLHhps>

Image editing - Video 05 (Gradients and image composing)

[https://youtu.be/\\_5S9fSb9J1Y](https://youtu.be/_5S9fSb9J1Y)



### Examples of practical exercises

Image given to students



Intended outcome



## Appendix D.3. Digital Educational Resources production online course.

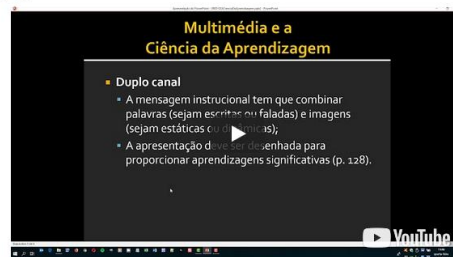
### CRIAÇÃO DE RECURSOS EDUCATIVOS DIGITAIS | 11 DE JUNHO A 1 DE JULHO

🗨️ Questões gerais e dúvidas

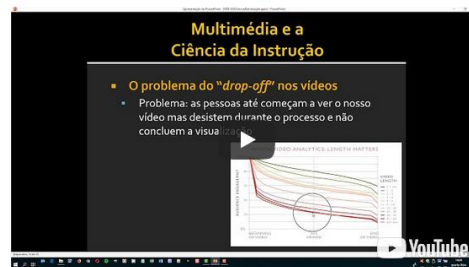
#### ASPETOS FUNDAMENTAIS



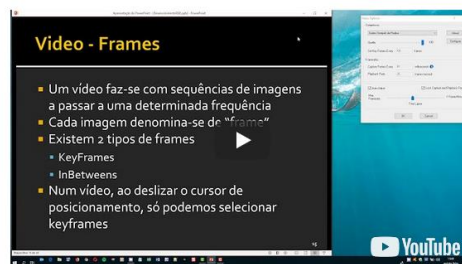
#### MULTIMÉDIA E A CIÊNCIA DA APRENDIZAGEM



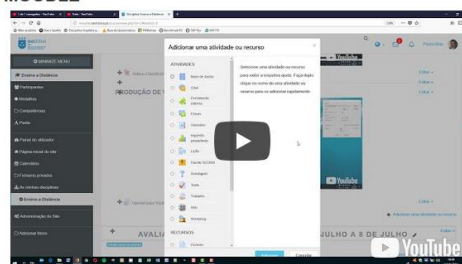
#### MULTIMÉDIA E A CIÊNCIA DA INSTRUÇÃO



#### PRODUÇÃO DE VÍDEO



#### UPLOAD PARA O YOUTUBE PARTILHA NO MOODLE



Links to the produced and YouTube shared video resources (in the unlisted mode):

The basics: <https://youtu.be/3iLLoceDPA0>

Multimedia and the science of learning: <https://youtu.be/kywD0H2QJnk>

Multimedia and the science of instruction: <https://youtu.be/U-HbMzH51VY>

Video Production: <https://youtu.be/nICFGcAhyxc>

YouTube upload and Moodle sharing: <https://youtu.be/G2XOtdPMBVY>