THE IMPLEMENTATION OF ICT IN EDUCATION: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Innovation in education through the use of ICT plays a very important role on human evolution. The use of ICT innovation in education breaks up existing barriers and expands knowledge frontiers, opening the possibility of developing a more skilled labour force once students end their studies. For this to take place, the existence of ICT champions, defined as those who actively promote and foster the use of technology in institutions, and competent teacher training programs are essential so that information is transmitted efficiently to students.

The objective of this research is to analyse existing publications related to ICT innovation in education to understand better the impact and benefits on society of the implementation of ICT in education, as well as getting to know the keys to implementing it successfully. The methodology applied is bibliometric analysis, this is a systematic literature review which consists of analysing a large number of papers and extracting relevant conclusions related to the topic. The Web of Science database was used to select the papers to be reviewed. The keywords: Education, Innovation and ICT were combined using the Boolean operator "AND" to conduct the search. Papers which we considered that best fitted the topic were selected from the Web of Science search result conducted previously.

The results of the study show that the authors of the selected papers, agree on the benefits of ICT in education. According to them, the innovative teaching methods implemented by teachers after receiving training allow students to develop ICT-related skills as well as critical thinking skills, as they are forced to think outside the box in some of the activities. Graduates will therefore be able to face a quickly changing working environment in which technology and social interactions are gaining importance. As a consequence, countries will be benefited as a more competent labour force will help them develop further and remain competitive. However, the success of the implementation of ICT in education could be hindered due to certain factors such as, culture, politics or difficulty to access new technologies.

Keywords: ICT champion, training, education.

1 INTRODUCTION

In this paper we will talk about how education has changed throughout the recent years, as well as analysing the role ICT and innovation have in this educational evolution. This topic is of great relevance in the 21st century and even more at the time this paper is being written, in 2020, due to the outbreak of the COVID-19 pandemic. This event has caused the education system to innovate and introduce ICT at a rate never seen before. The main objective of this paper is to analyse the importance of introducing ICT in education to develop student and teacher's knowledge and how this will affect countries' development.

To start with, the theoretical framework will be defined, to comment afterwards on the education system that prevails currently due to the outbreak of the COVID-19 pandemic. Next, we will focus on analysing the benefits of ICT on education as well as analysing the importance of teacher training programs for a successful implementation of new technologies in the classroom. Afterwards, we will introduce some of the key points that will lead to the successful implementation of ICT on education. Finally, we will highlight some possible scenarios in which the benefits of ICT on education may be limited.

2 THEORETICAL FRAMEWORK

Over the past years, society, as well as the way it functions, has experienced a significant change in many aspects, socially, economically and culturally. One of the main factors of this change has been the irruption of ICT in our daily life-improving humanity's standards of living [1] [2] [3].

Technology can be seen everywhere, including schools and universities. The educational system is evolving from an education involving pens, boards, pencils and other tangible objects, to an education involving laptops and other technological devices and software. The latter being focused on the need for learning new teaching methods, which are more suitable for an ICT-based society, through teacher training programs [4] [5]

According to McClintock [6] in order to implement ICT in schools successfully, school models must change from a model focused on teachers, into a new model in which students and knowledge have greater importance [7] [8]. In this new way of learning, students should not only learn knowledge in school through the syllabus' subjects, but they should also learn to use ICT tools which could generate further knowledge development [9] [10] [11].

The outbreak of the COVID-19 pandemic has accelerated even more this process of education evolution. The main reason for this unavoidable acceleration has been the fact that in most of the world's countries all education centres had to remain closed for a certain period time, this period varied in every country depending on the evolution of the pandemic in the country. In some countries like Spain, schools remained closed between March and June, while universities remained closed for students between March and September.

As a consequence, all the teaching had to be switched into an online format. One of the most common teaching methods used during this period has been teaching online classes through video conferencing software such as Microsoft Teams, Zoom, BlackBoard Collaborate or Skype among others. Most of these applications allow teachers to share learning material while teaching in live so that students can follow the lessons.

At the time this paper is being written, November 2020, in Spain not all teachers have returned to their pre-COVID 19 situation, meaning that some teachers still teach all of their classes online and others teach some classes online and the rest in the classroom. We do not know when everything will return to normality and education returns back to be 100% face-to-face.

Training programs are vital in the current situation as teachers must know how to use video conferencing software and other tools to be able to provide students with all the knowledge they need to receive. Also, innovative teaching practices are more than welcomed as they are needed to try and keep students motivated in class and to keep the quality of education high during these hard times.

Figure 1 shows a model which demonstrates the relationships between various concepts involving the effects of training programs. The model shows the importance of teacher training programs related to ICT on education and the correct implementation of them to evolve as a society as a whole by developing new skills and gaining knowledge.

Training is the basis of the introduction of ICT in education and without it, the potential benefits that could be obtained from the introduction of ICT in the education system will not be achieved. In the ICT Competency Framework for Teachers, [9] the importance of technological training for teachers is highlighted, as training will develop teacher's knowledge and skills [12] [1].

As can be seen in Figure 1, when teachers receive ICT training, they develop new knowledge as they learn: new ways of teaching, how to use certain software… among other things. Consequently, training and the acquisition of new knowledge will lead to professional development and ICT Competence development. *"ICT training becomes the main element for teacher professional development in quality education."* [1]. We can build a direct relationship between ICT competence development and professional development, as according to Fernández-Batanero et al [1] *"digital competence is considered a key factor to improve teacher's professional development,"* and as stated by Stuart et al. [13] professional development is of great importance for developing ICT competence.

Once teachers have the knowledge and the resources needed to apply those new and innovative methods of teaching learnt during training, they will apply them in class. Therefore, students will learn the material in a new and innovative way involving ICT, which will expand their knowledge. Not only that but also, they will also develop ICT competence as they will need to learn how to use ICT to receive and understand the information provided by the teacher [14]. For example, [15] analyses different pedagogical practices involving ICT applied in a sample of schools in England. In all of them, students learn how to use new ICT tools such as a wide range of generic software to support their work in different subjects, multimedia resources, email…
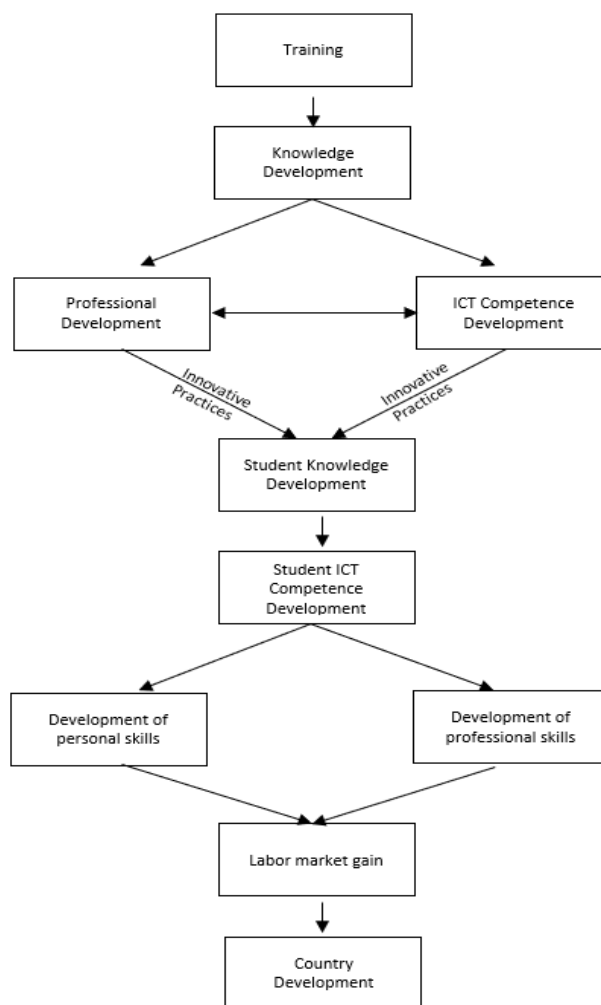
Figure 1. Source: Own elaboration

As stated in [4] *"ICTs, in their role as tools added to pedagogical models, can become valuable resources for learning and for equipping students with appropriate personal and professional skills"* [16]. Therefore, as shown in the diagram, Student ICT Competence Development leads to the development of personal and professional skills.

Improved personal and professional skills will prepare students better for when they finish their studies and become part of the labour market, as they will be more competent and skilled. As stated by Wiseman & Anderson [17] "*ICT-integration throughout education systems has the potential capacity to translate into labour market gains by enabling students' self-directed and flexible acquisition, application and creation of knowledge*" [18]. Finally, with a more skilled and ICT competent labour force and thanks to innovation, the country will be able to develop further as the labour force will be able to meet the market's requirements [19]. Not only that, but also with an ICT competent labour force, some tasks in the workplace will be carried out in a much more efficient way [20].

2.1 Keys to success on the implementation of ICT on education

− Leadership behaviour of school/university leaders [13]

− Existence of champions in the school/university [13]

− Great teacher ability to structure the learning environment [21]

− Successful transition from traditional education to education involving ICT [4]

A school leader is defined as an individual with leadership roles within schools such as principals, deputy principals, assistant/associate principals and head teachers [13]. The leadership behaviour is key to the championing of new technologies as its effectiveness will lead to a correct and satisfactory

implementation of new technology in schools/universities. To be effective in the implementation of ICT, they should have a minimum set of technology skills and be ICT competent [13] [22] [23] [24].

Champions are defined as those who take the initiative in actively promoting and building support for new technology in their organizations. They are confident, persistent, energy and risk-taking [13] [25] and are able to visualize the benefits of the introduction of technology [26]. The existence of champions in a school/university is very important as they will motivate others to use new technologies so as to introduce new and more effective pedagogical methods [27] [28] [29] [30].

In order to succeed, teachers must be able to *"create flexible classroom learning environments. Within these environments, teachers must be able to integrate student-centred activities and flexibly apply technology to support collaboration."* [21].

A transition between traditional education and ICT-involved education is taking place. Along with this, teachers must change their views and roles on education, and become more flexible so as to adapt to the new education system which involves new pedagogical methods involving ICT. For a successful transition between traditional education to an ICT-based education, teachers must think differently regarding education and the physical spaces where students can learn. They should also encourage learning outside the classroom [4].

The introduction of ICT in education can bring more benefits other than just improving the students' ICT competence or ICT skill [31]. In the research made by Harris, [15] she discovered that students who participated in the different projects, not only did they improve their ICT skills, but they also developed other skills such as communication or literacy skills. Furthermore, students who participated in those projects which involved third parties, such as the e-pal project arranged with employees at the nearby Ericsson factory, developed an awareness of other people's commitments and therefore understood that if someone does not reply to your email immediately it could be because they are busy doing something else [32].

2.2 Limitations on ICT in education

It seems that the introduction of ICT in education has a positive effect on student and teacher development. However, it could be that the positive effects are not as great as they are expected to be, as it is the case of the Gulf Cooperation Council countries. The analyses reported in Wiseman & Anderson, [17] indicate that in GCC countries, even though classrooms are well equipped technologically, students do not benefit from the promotion of knowledge that technology provides [33]. An explanation of this, according to the paper, is that this is due to the local culture and beliefs, as well as the vision of teacher's role in GCC countries, not to mention the restrictions on the internet used imposed by these countries.

Besides cultural and political factors another factor that may limit the benefits of ICT in education is wealth. Introducing technology in education can be very costly among other things because of the high cost of certain hardware and software. To keep up-to-date and be well prepared for technological innovations and changes, institutions should purchase new technologies now and then in order to teach students how to use the latest technology, as the previous one may become obsolete [34] [17] [35].

3 METHOD

A bibliometric analysis enables to study the trend on a concrete topic by summarizing the representative results of a range of documents [36]. To this end we have selected the Web of Science and included the topics "education", "innovation" and "ICT". In terms of bibliometric indicators, we use the number of publications and analyse the document types, publication years, organizations-enhanced, the countries, authors, funding entities, meeting titles and source titles.

4 RESULTS

4.1 Document types

When we include the terms Education, Innovation and ICT in the Web of Science, we obtain 1.702 results. In Table 1 we can find that 908 are articles, 763 proceedings paper, 56 book chapter, 23 reviews and the rest are early access, editorial material, book reviews or books. Most publications are scientific articles published in journals.

Table 1: Document types.

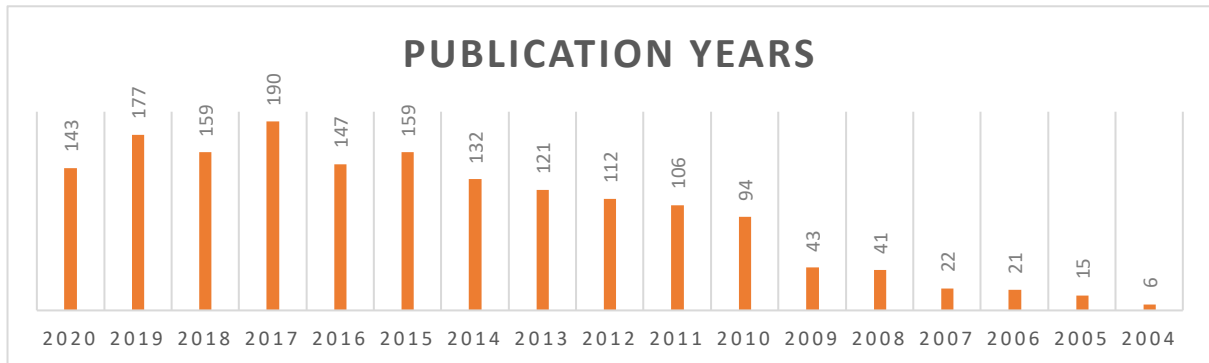| Document Types	Records
ARTICLE	908
PROCEEDINGS PAPER	763
BOOK CHAPTER	56
REVIEW	23
EARLY ACCESS	10
EDITORIAL MATERIAL	8
BOOK REVIEW	3
BOOK	2

4.2 Publication years

Figure 2: Publication years.

The number of publications related to the topics of Education, Innovation and ICT has grown significantly since 2004, reaching its peak in 2017. It is true that since 2017 the number of publications has fallen; however, the numbers are very far away from those previous to 2010. The average number of publications between the years 2004-2009 is approximately 25 publications per year, while the average number of publications of the years, 2015-2020, is approximately 163, which is over 6 times more than in the period 2004-2009. An explanation for this growth is the increased use of technology in our daily life. Technology is probably the fastest-changing movement in the 21st century and it is evolving at exponential rates. The increasing importance and use of ICT in our daily lives has dragged the attention of researchers who are now willing to understand this change in lifestyle and its effect on different aspects of society, such as education.

4.3 Organizations-Enhanced

Table 2: Organizations-Enhanced.

Organizations-Enhanced	Records
UNIVERSITY OF GRANADA	54
UNIVERSITY OF SEVILLA	35
UNIVERSITY OF ZARAGOZA	35
UNIVERSITY OF SALAMANCA	30
UNIVERSITY OF VALENCIA	27
UNIVERSITY OF MURCIA	25
UNIVERSITY OF BARCELONA	21
UOC UNIVERSITAT OBERTA DE CATALUNYA	21
UNIVERSIDAD NACIONAL DE EDUCACION A DISTANCIA UNED	20

University of Granada has been the most productive institution in papers related to the topic we are analysing. This university has a department called "Departamento de Didáctica y Organización Escolar" related to education in which 6 of the 15 most prolific authors work, such as Belmonte JL. Note that from this list of the 25 most productive institutions, 24 of them are Spanish and all of them are from Spanish speaking countries. Among the 24 Spanish institutions only 3 of them are private universities: "UOC Universitat Oberta de Catalunya", "Universidad Internacional de la Rioja UNIR", "Universitat Ramon LLull". A possible explanation for this is that Spanish public universities usually have a greater number of professors and researchers than private universities due to their capacity. As a consequence, researchers have the ability to specialise in and cover a greater number of research areas.

4.4 Countries publishing education, innovation and IC

Figure 3: Countries publishing education, innovation and IC

As can be observed in Fig. 3, the country with most publications on education, innovation and ICT is Spain with 587 records, followed by USA and 71 records, Romania with 60, Italy (59), England (51), Mexico (48), Colombia (47), Czech Republic (46), Portugal (46), Australia (41), South Africa (38), Netherlands (34), Slovakia (34), Brazil (33), Germany (33), India (33) and China (33).
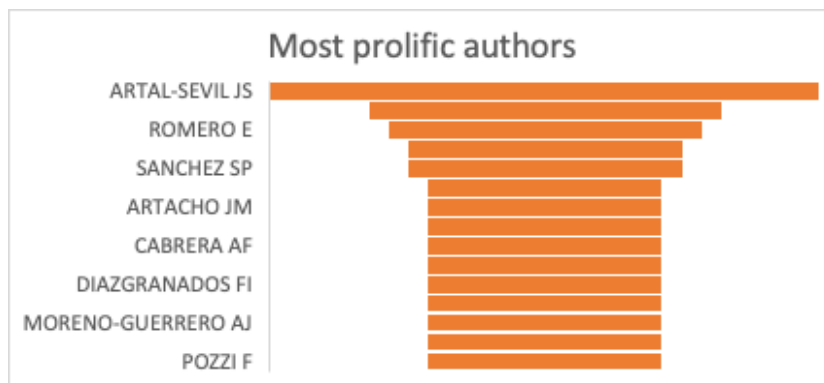
4.5 Most prolific authors

Figure 4: Most prolific authors

Before commenting on Fig. 4 it is important to notice that "Belmonte JL" and "Lopez-Belmonte J" is the same author, therefore he is the most prolific author on the topic with a total of 23 publications. The second and third most prolific authors: Romero E and Artal-Sevil JS, as well as Artacho JM are researchers in the University of Zaragoza and they have published several papers together. The following author Sanchez SP as well as Belmonte JL, Cabrera AF and Moreno-Guerrero AJ are researchers in the University of Granada and they have published several papers together too, the three of them work at the "Departamento de Didáctica y Organización Escolar" mentioned previously.

From the list of the most prolific authors all of them are from Spanish speaking countries except for Pozzi F.

4.6 Funding Agencies

Table 3: Funding agencies.

Funding Agencies	Records
EUROPEAN UNION EU	17
UNIVERSITY OF ZARAGOZA	14
EUROPEAN COMMISSION	11
EUROPEAN COMMISSION JOINT RESEARCH CENTRE	11
EUROPEAN SOCIAL FUND ESF	4
SPANISH GOVERNMENT	4

Regarding the funding agencies which have financed the research on education, innovation and ICT, we find that the European Union counts with 17 records. The University of Zaragoza (14), the European Commission (11), European Commission Joint Research Centre (11). It is highlightable that out of the 100 publications financed by entities, the ones that have financed four or more are from the European region.

4.7 Meeting titles

Out of the 1.702 publications on Education, Innovation and ICT, 348 have been presented in three international conferences. International Conference on Education and New Learning Technologies EDULEARN has published 158 documents, International Conference of Technology Education and Development INTED published 104 documents and Annual International Conference of Education Research and Innovation ICERI, 86.

We can see how those conferences are relevant on the development and discussion of this ground-breaking topic.

4.8 Source titles

Source titles that have published more than 70 documents are EDULEARN proceedings (158), INTED proceedings (112), ICERI proceedings (70). They come from the conferences that we have commented above. Procedia Social and Behavioral Sciences is a book series.

Regarding journals we've find that the most relevant are Revista Latinoamericana de Tecnología Educativa Relatec (24) or Pixel Bit Revista de Medios y Educación (21), which are not indexed in the WOS Core collection.
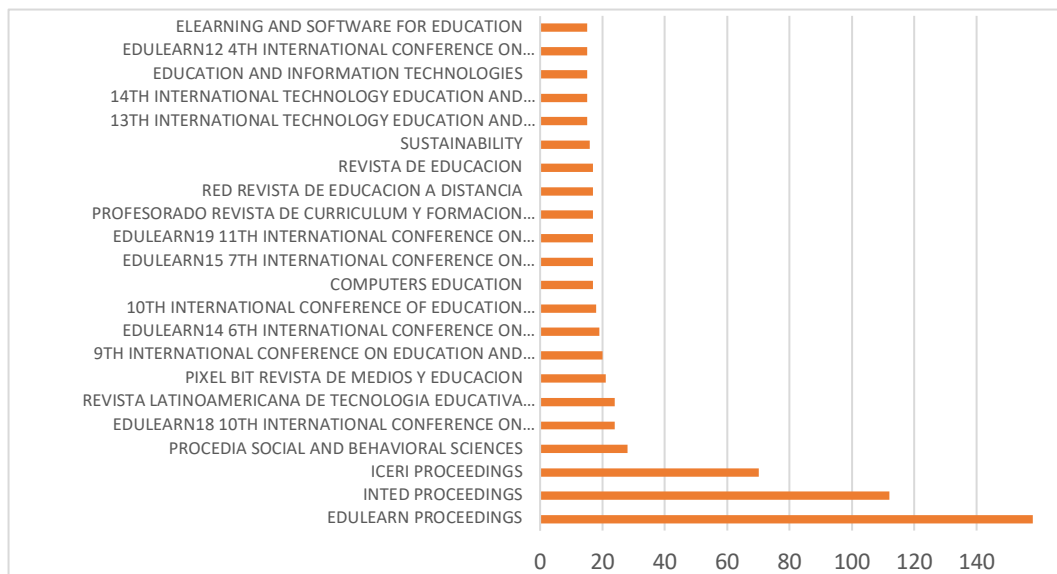

Figure 5: Source titles

5   CONCLUSIONS

We have developed this study due to in the COVID situation, education, innovation and ICT is more prominent than ever. Also, as digitalization occurs and is implemented in education the development of technology is highly relevant. This study presents a bibliometric overview of the leading trends by analysing the documents published in the WOS. The document type with most records is the article, with 908. The year with most publications was 2017, with 190 on the topic. The most prolific organization is University of Granada, counting with 54 documents. The country whose authors research more in the subject is Spain, which published 587 documents. Belmonte is the author with more experience in terms of publications on education, innovation and ICT with 23 records. The funding entity that highlights is the European Union with 17 documents financed. Meetings or conferences which published 158 and 104 are EDULEARN and INTED respectively. Also, the source titles more important correspond to the two conferences previously named.

Relating to the conclusions extracted by the authors of some of the papers we have analysed in this study, it is generally believed that implementing ICT in education is beneficial. New technologies offer teachers an infinite number of innovative and efficient teaching methods which can be useful for the transmission of knowledge and the development of student's skills. Technology is changing every now and then and it cannot be avoided as it is being used in more and more daily life tasks, from driving to even buying groceries in the supermarket. Countries, companies and the society as a whole will benefit from the introduction of ICT in education too, as people will be more skilled. This will lead to a much more competent labour force which will be able to solve problems in a much more efficient manner. However, for this to be done correctly training is vital. Without successful training programmes, teachers will not be able to transmit knowledge efficiently to students, as a consequence those students who are not receiving ICT-based education will fall behind with respect to those who are. Finally, a part from training programmes, governments must get involved too and must reduce the digital divide so that everyone gets the chance to benefit from the advantages that ICT provides.

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