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# Use of ICT by secondary school teachers analyzed using the learning ecology model: a case study in the region of Murcia

Uso de TIC por parte del profesorado de enseñanza secundaria analizado a partir del modelo de ecologías de aprendizaje: estudio de caso en la región de Murcia

使用学习生态模型分析中学教师对信息技术的使用：穆尔西亚地区的案例研究

Анализ использования ИКТ учителями средних школ с использованием модели экологии обучения: тематическое исследование в регионе Мурсия

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## Abstract

Lifelong learning is a key element in the quality of teaching at any level, so in Secondary Education too. Teachers often feel unprepared to teach and need ongoing training. This training does not always take place within a formal framework, but increasingly involves non-formal and informal aspects. In order to better understand the way they learn, the concept of Learning Ecologies (From now on, LE) is used as a starting point in this research and our main objective is to analyze the LE of practicing secondary school teachers, focusing on the influence of the use of ICT. A qualitative methodology was used with a semi-structured interview as an instrument to collect information from 12 teachers selected using previous criteria (a case study design). We have used Nvivo to analyze data and we have used four dimensions of analysis: learning, tools, benefits, and disadvantages. It was found that informal learning has a main role in the in-service training of secondary school teachers and to carry out this training, they use tools such as Twitter, Facebook, or WhatsApp. The main benefit of using ICT for their training is ubiquity and flexibility. Some teachers indicate that the amount of existing information is one of the main disadvantages. Overall, it is concluded that ICT are considered a great resource for teachers within their LE and for their professional development.

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Keywords: Learning Ecologies, ICT, Secondary Education, Teachers, Qualitative Research.

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## Resumen

La formación permanente de los docentes es un elemento clave para la calidad de la enseñanza, también en Enseñanza Secundaria. Esta formación no se realiza siempre de manera formal, sino que cada vez tienen más cabida los aspectos no formales e informales. Para entender mejor las estrategias y herramientas que el profesorado utiliza para su formación permanente, se parte del concepto de Ecologías de Aprendizaje (EA) y se establece como objetivo principal de nuestra investigación analizar la influencia del uso de TIC en las EA del profesorado de Secundaria en ejercicio. Se ha utilizado una metodología cualitativa, con una entrevista semiestructurada como instrumento de recogida de información y un estudio de caso con 12 participantes seleccionados a partir de criterios previos. Hemos usado Nvivo como herramienta para el análisis de los datos y hemos concretado cuatro dimensiones de análisis: aprendizaje, herramientas, beneficios e inconvenientes. Se constata que el aprendizaje informal tiene un papel protagonista en la formación permanente de los docentes de secundaria y para ello utilizan herramientas como Twitter, Facebook o WhatsApp. El principal beneficio del uso de las TIC para su formación es la ubicuidad y flexibilidad. Algunos docentes indican que la cantidad de información existente es uno de los principales inconvenientes. En general, se concluye que las TIC son consideradas un gran recurso para los docentes dentro de sus EA y para su desarrollo profesional.

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Palabras clave: Ecologías de aprendizaje, TIC, Educación Secundaria, profesorado, investigación cualitativa.

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## 概要

教师的长期培训是教学质量,尤其是中学教学质量的关键要素。其中不仅包括正式培训,还包括越来越多的非正式培训。为了更好地了解教师使用的用于持续培训的策略和工具,我们从学习生态 (LE) 的概念出发,主要研究目标是分析中学教师在学习生态中使用信息技术的影响。我们采用定性研究方法和半结构化访谈作为收集信息的工具,并根据已定标准选择 12 名参与者进行案例研究。我们用 Nvivo 作为数据分析工具,并对四个维度进行了分歧,分别是:学习、工具、优点和缺点。研究发现非正式学习在中学教师的持续培

训中发挥着主导作用,为此他们使用Twitter、Facebook 或 WhatsApp 等工具。使用信息技术进行培训的主要好处是其灵活性和不受地点限制。一些教师表示,现有信息数量的缺乏是主要不足之一。总体来说,信息通信技术被认为是教师在其学习生态和职业发展中的重要资源。

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关键词:学习生态,信息通信技术,中学教育,教师,定性研究。

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## АННОТАЦИЯ

Постоянная подготовка учителей является ключевым элементом качества преподавания, в том числе и в средней школе. Это обучение не всегда проводится формально, но все чаще включает неформальные и неофициальные аспекты. Чтобы лучше понять стратегии и инструменты, которые учителя используют для своего непрерывного образования, мы отталкиваемся от концепции Экологии обучения (ЭО), а основная цель нашего исследования - проанализировать влияние использования ИКТ на ЭО практикующих учителей средней школы. Мы использовали качественную методологию, с полуструктурированным интервью в качестве инструмента для сбора информации и тематическое исследование с 12 участниками, отобранными на основе предыдущих критериев. Мы использовали Nvivo в качестве инструмента для анализа данных и указали четыре измерения анализа: обучение, инструменты, преимущества и недостатки. Мы обнаружили, что неформальное обучение играет ведущую роль в непрерывном образовании учителей средних школ, и для этого они используют такие инструменты, как Twitter, Facebook или WhatsApp. Основным преимуществом использования ИКТ для их обучения является повсеместность и гибкость. Некоторые преподаватели отмечают, что количество существующей информации является одним из главных недостатков. В целом, можно сделать вывод, что ИКТ считаются большим ресурсом для учителей в рамках их ЭО и для их профессионального развития.

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КЛЮЧЕВЫЕ СЛОВА: экология обучения, ИКТ, среднее образование, учителя, качественное исследование.

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## Introduction

Secondary school is a key stage in education, not only for its connection with higher education, but also for being the stage which leads to vocational training or, directly, to the labor market. It is a stage during which the high rates of school early leaving and failure (according to official data of the Ministry of Education and Science on ED-UCAbase1, more than 20% of students did not complete their secondary education during the academic year 2018-2019). Secondary education teachers' training, as in the rest of the educational stages, is a key element for the quality of education (Imbernón, 2019; Lorenzo, Muñoz, & Beas, 2015; Vilches & Gil, 2010), and our project on "Learning Ecologies in the Digital Era: new opportunities for secondary education teachers' training (ECO4LEARN-SE)" revolves around it. In this project we focus on secondary school teachers' initial training as well as on their ongoing training, as both are fundamental for the construction of the teachers' identity and professional development (Caballero, 2013).

After the Organic Law on Education (LOE, 2006), secondary education teachers' initial training is organized around the "Master's Degree on Compulsory Secondary Education, Vocational Training and Language Teaching", a certifying degree of 60 ECTS, and

of a compulsory nature to be eligible for teaching during this secondary education stage.

The justification for this master's degree comes from the idea that an education professional, apart from possessing knowledge in their area of specialization, they need to possess knowledge on how to teach and which resources to use for that purpose (Koehler, Mishra, & Cain, 2015). In line with the approach laid out by Hargreaves and Fullan (2014), quality initial training, together with an ongoing training process, make up secondary education teachers' professional capital, and such professional capital must be linked to the analysis of the students' needs, but also to the changes occurring in the social environment.

This article is going to be centered on the analysis of secondary education teachers' ongoing training, based on the data collected on the previously mentioned project (ECO4LEARN-SE). The project employs a mixed methodology, but we have centered on the qualitative information to analyze the Learning Ecologies of the practicing teachers, whereas through quantitative techniques we have analyzed the initial training process, by means of questionnaires for students of the master's degree on secondary education. Through interviews we have tried to delve into the dimensions and aspects that shape the Learning Ecologies in practicing teachers, information which can turn out to be really useful both for redesigning that initial training and for designing ongoing training proposals which allow for the professional development in the scope of Secondary Education.

## Teaching and learning in a digital society

Within the current context of our 21<sup>st</sup> century society, the transformations promoted by technologies are impacting all areas of life (family, leisure, work) and from all perspectives (economy, politics, law, medicine...), also from an educational approach. We live, in the words of Baumann (2003), in a "liquid modernity". He believes that we have to rethink our models of analysis of human behavior considering the context of profound changes influenced by emancipation, individualism, time/space, work, and the community. This leads to the author's analysis of education, suggesting four axes (Baumann, 2005): the syndrome of impatience (minimizing efforts), obsolescence- and, at a great velocity- of knowledge, the contemporary change- permanent and unpredictable-, and the gradually irrelevant memory, in a learning model which entails a continuous revolution for our knowledge. Teaching and learning models of the old times are rendered useless for the new citizens of the liquid society.

Training, be it from a formal or informal perspective, has been transformed by the impact of Information and Communication Technologies (from now on, ICT) and even more so, since Covid-19, the so dreaded pandemic, bursted into our lives (Zubillaga & Gortázar, 2020).

With no time to reflect on how, when or in which way, all the educational systems were forced to implement ICT as a technological solution which would allow them to continue teaching a quarantined population. And from that moment, we have realized about the importance of digital competence in teachers and students, competences which encompass a wide range of indicators which go beyond mere technical competence (Durán, Prendes, & Gutiérrez, 2019; Martinenco, Martín, & García, 2021; Prendes, Gutiérrez, & Martínez, 2018).

ICT in education has implied the arrival of a great number of new models, innovative experiences and transformational pedagogies (virtual teaching, ICT enriched learning, open learning, flipped classroom, MOOC, adaptative learning, intelligent coaching, smart learning environments, connected environments, personalized learning environments- PLE...), and with this, the studies on how we learn in these new environments which connect face-to-face education with virtual learning (Hernández-Sellés, González-Sanmamed, & Muñoz-Carril, 2015; Prendes & Cerdán, 2021). And there is precisely where the construct Learning Ecologies which centers our research leads us to: analyzing and understanding how us teachers construct our learning processes and how ICTs play a fundamental role in the professional development of teachers. In other words, placing our focus on the context of formal training and the personal experience of practicing teachers, we are going to analyze and describe how these learning processes- conditioned by the technological context- are shaping the professional development; this way, technologies are the undisputable protagonist of teaching competency and it is necessary to analyze how teachers integrate them in their ongoing training strategies (Agyei & Voogt, 2014; He & Li, 2019; Koehler, Mishra, & Cain, 2015; Parsons et al., 2019; Van den Meemt & Diepstraten, 2016)

## Learning ecologies

Learning Ecologies (From now on, LE) constitute a valid construct to explain learning from a holistic perspective, which enables us to value the contexts and elements which influence learning, and besides, in parallel, the interrelationship between these elements. The concept has its main precedent in the works of Siemens (2005) about connectivism: how us learners construct our knowledge based on the relationships with the context and on the connections between formal and informal learning, understanding learning as a continuous process in which technologies are a key element in the construction of knowledge.

Both organizations and individuals are learning organisms. Barron (2006) propose a model which helps us comprehend how the learning process is developed through the use of resources, the relationship between peers, the community, work, home, and the academic environment; in short, a multitude of resources, inside and outside the school, or the educational institution, thus creating a model which is originated due to the influence of factors which are internal and external to the learner.

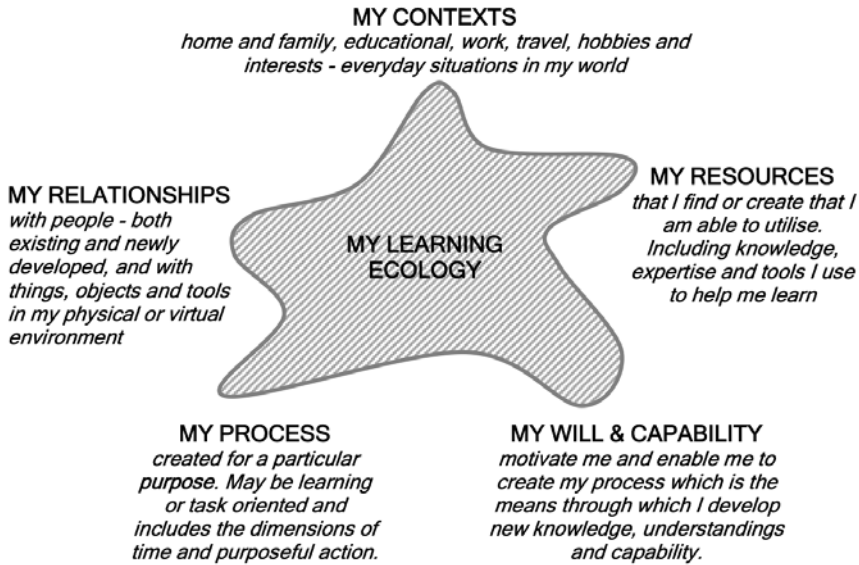
The author describes the elemental level (resources, activities, personal relationships, and interactions); the contextual level (formal or informal learning environments, which can be mediated by technologies) and a superior level which envisions the whole and the interrelationships between elements so as to understand ecology as a whole.

In the same line, Jackson (2013) uses the metaphor of LE to understand the interactions between people and their environments, interactions which make up the framework in which one learns and knowledge is built throughout life, highlighting the idea that these are constructed in a social environment and a specific context with the key influence of aspects such as: the potential of action in time and space; personality characteristics; reflection and capacity of decision making; self-regulation and capacity of execution; knowledge and construction of meanings; and, as important as all of the former elements, the interaction between all the components of the system (Figure 1).

The author sketches four scenarios in which learning ecologies are developed: formal contexts of traditional education, active education (inquiry, problem, or project-based learning), self-directed learning in loosely structured formative contexts (communities, family, social situations) and, lastly, independent self-directed learning (free and without external guidance).

Figure 1

*Individual Learning Ecologies*



Note. Adapted from “The concept of learning ecologies”, por N. J. Jackson, *Lifewide learning, education & personal development* (p. 14), 2013.

Ultimately, the concept of LE “enhances the possibilities of having a framework of analysis to understand how we learn and which contexts and/or elements we utilize to educate ourselves, with the purpose of providing ourselves with new learning opportunities”, thus becoming “an integral perspective of the catalysts for the metamorphosis of learning” of every individual, with their decisions and their interactions, in each context, each time and each space (González-Sanmamed et al., 2018, p. 37).

This approach reinforces the links and interactions built between the learning processes in formal contexts and those in informal ones (Harvey, Coulson, & McMaugh, 2016), constructed by means of personal relationships, networking, experiences, culture... our personal daily routines.

The relevance which this construct of LE has had in research is evidenced in a variety of empirical studies, such as the ones by González-Sanmamed et al. (2019, 2020), who point out that teachers make, on the whole, a moderate use of ICT. On the other hand, Van de Beemt, & Diiepstraten (2016) hint at certain fears existing among teachers in relation to the possibility of their students being more skilled with technology than themselves. Both these works (González-Sanmamed et al., 2020; Van den Beemt

& Diiepstraten, 2016) as well as that of Caballero (2013), reveal differences resulting from the age factor in teachers.

## Objectives

Using the data of previous studies (González-Sanmamed et al., 2020; Harvey, Coulson, & McMaugh, 2016; Van den Beemt & Diiepstraten, 2016), we depart from the idea that LE shaped with the integration of ICT enhance the professional practice of secondary education teachers, under the assumption that professional practice is linked to the teachers' professional development. Our general objective is to analyze LE in practicing secondary school teachers, focusing on the influence of the use of ICT. We intend to comprehend the how and why of their own learning processes linked to the use of ICT in the framework of their professional performance. The specific research objectives, framed within the geographical context of the Region of Murcia, are the following:

- Analyzing the LE in relation to the teaching professional development in practicing secondary education teachers.
- Analyzing the contribution of ICT in the LE of these teachers.
- Proposing improvement initiatives which, on the whole, can enhance the LE of secondary school teachers.

## Methodology

### Approach and method

Our research is framed within an interpretative paradigm and a qualitative methodology (Cubo, Martín, & Ramos, 2011; Silverman, 2016), an appropriate one when analyzing and understanding how LE of secondary school teachers are constructed and which role ICTs play in that construction. The qualitative approach echoes the tradition of studies on the teacher's thinking processes- from an analysis of their expertise- and inquiry techniques about life stories (Huchim & Reyes, 2013). Cortés-González et al. (2016) also remark that "narrative work by means of stories and life experiences is allowing us to visualize and understand part of that hidden learning of people's experiences" (p. 626).

We utilize in a first stage a hypothetical-deductive model, as we have based for the interview on categories of analysis elaborated in relation to the previously explained theoretical construct of LE (Hernández, 2014). In a second stage we work with an inductive model as, in line with the research on teachers' LE carried out by Harvey, Coulson, & McMaugh (2016) and also using as references their previous works with students (Coulson & Harvey, 2013), in this case we opt for a model of reflection about the practice which will allow us to find the teachers' learning ecologies through the analysis of their thoughts, assumptions, concepts, and personal experiences. We have also relied on Van den Beemt and Diepstraten (2016), who analyze teachers' professional development from the perspective of the LE by means of bibliographic interviews which put the focus on the use of ICT, as we have done in our research.

The design consists in a multiple-case study organized by geographical areas with 8 research groups responsible for each of the areas assigned. In this article, we analyze the data corresponding to the work carried out by the research team of the University of Murcia.

## Participants

The interviews have been conducted with practicing secondary school teachers chosen with a non-probabilistic convenience sampling technique (Cubo, Martín, & Ramos, 2011). The previous criteria established as necessary prerequisites were the following: a minimum of 5 years' experience as secondary education teachers; choosing teachers of different subjects; standing out for their use of ICT in the context of their professional experience as teachers. As complementary requirements, the following criteria were established: having received any previous recognition or prize which allow us to classify them as examples of good practices with ICT; having information shared online; being active users of relevant social networks and having certain following on those. With those criteria being established, a search was carried out and the cases were selected. 12 interviews were conducted, being 10 of the subjects men, and 2 women (see Table 1).

Table 1

*List of the participants, sorted by their attributes*

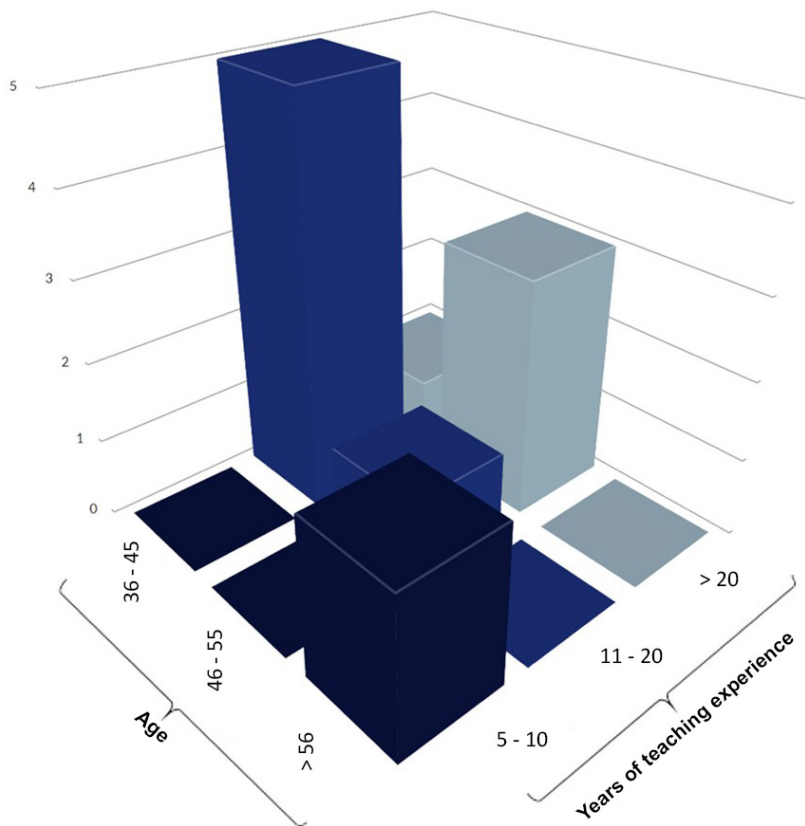
Attribute	Number of cases	
Sex	Male	10
	Female	2
Age	36 - 45	6
	46 - 55	4
	> 56	2
Teaching experience	5 - 10	2
	11 – 20	6
	> 20	4
Subject	Technical drawing	1
	Economy	1
	Physical education	1
	History	1
	English	2
	Spanish language	1
	Mathematics	2
	Language	1
Technology	2	



The larger number of participants, specifically 6, represents teachers with professional experience between 11 and 20 years and within the 36-45 age range. It is worth noting that the two teachers who are older than 56 are also the ones who have the shortest teaching experience (5-10 years), as can be seen in Figure 2.

Figure 2

*Relationship between the attributes of the participants: years of teaching experience and age*



## Instrument

In the present study both individual and semi-structured interviews of a biographical-narrative nature were conducted (Bolívar, 2002), an instrument which turns out to be especially optimal for educational research centered on teachers (Huchim & Reyes, 2013). We have concluded that this technique is ideal for our research because interviews allow us to “analyze the individuals’ experiences, linking them with every day or professional practices, putting the focus on the access to the practices and interactions in their natural context” (Hernández, 2014, p. 188). This type of interviews makes possible the analysis of the nature of a subjective phenomenon, incorporating factors of the actual context and helping to understand, by means of narration and reflection, the “why” and “how” of the processes (Silverman, 2016).

Two scripts were elaborated for the interview:

1. An initial biographic script, to collect the teachers' personal data, their professional career, and their expectations about their training in line with the life-stories technique. It included 5 blocks: four about their life story during their formal education (2 questions about early childhood education; 2 about primary education; 3 about secondary education; and 4 about their academic training at university) and one last block about their professional experience (13 questions).
2. The second interview, dealing with learning strategies and professional updating, is centered on the resources, and learning processes which contribute to professional development and the teachers' ongoing training. That is, this is the interview where we will be able to delve into the construction of LE and the role of ICT. It was organized in three blocks: ongoing training (14 questions), ICT (6 questions) and reflections about teachers' professional learning (8 questions).

These scripts have been elaborated using the already validated instruments, which have been used in previous projects (ECO4LEARN and ECO4LE RN-HE), as they were instruments specially designed for teachers pertaining to other levels of formal education.

The necessary adaptations for their application to secondary education teachers were made, including a new process of validation, using the expert judgment technique to guarantee the construct validity.

Table 2

*Categories of information collected by the interviews*

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<b>Biographical interview</b>
Life story (Early childhood education)
Life story (Primary education)
Life story (Secondary education)
Life story (University)
Professional experience

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<b>Learning and professional updating strategies</b>
Ongoing training
USE OF ICT:
1. How has your knowledge about ICT evolved? have you done any kind of formal training on the issue, or have you acquired such knowledge through informal and/or non-formal training?
2. What benefits do ICT offer you as a teacher in your training process? And what inconveniences have they brought about?
3. What role do ICT play in your learning and professional development process as a teacher? Which are the ICT tools that you use the most to carry out your training? What do you use them for, specifically?
4. How has your learning style changed in the digital era thanks to technology?
5. What is your opinion about social media? Do you have a profile page on any of them? On which one(s)? What role do you think they play in your professional updating as a secondary school teacher?
6. On the whole, how do you assess the contributions made by technological tools with respect to facilitating professional learning in secondary school teachers?
Teacher professional learning

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## Procedure

The interviews were conducted using videoconferencing tools, given the situation of quarantine caused by the Covid-19 pandemic. The time allotted for the interviews was not exceeded and their duration ranged from 35 minutes (the briefest one) and 130 minutes (the longest). The interviewers were researchers from the project's working team and a standardized protocol with instructions on how to contact interviewees and how to conduct the interviews was utilized, guaranteeing this way the same procedure in all the cases and similar conditions in the conducting of the interviews for everyone.

For the informed consent, before the interview, the objective of the interviews was explained to the participants, the script was sent to them by email, and they were informed about the anonymous use of data, respecting at all times the ethical principles of research (Salazar et al., 2018). Different tools (Skype, Teams or Zoom), depending on the preferences of the interviewees, were used and the Videoconferencing session was recorded together with the complementary recording of the audio, using for such purpose an auxiliary device as a backup copy. The audio was then transcribed with the conversion tool Nvivo. As the transcriptions tend to feature mistakes, they were manually revised, contrasting the recording with the text file obtained. All the interviews were conducted in Spanish, between May and June 2020.

In line with the principles of bibliographic research (Bolívar, 2002; Huchim & Reyes, 2013; Silverman, 2016), the answers provided by the interviewees are not judged or assessed; instead, the interviewers collect the information, and the interviewees are encouraged to explain their ideas freely.

## Data analysis

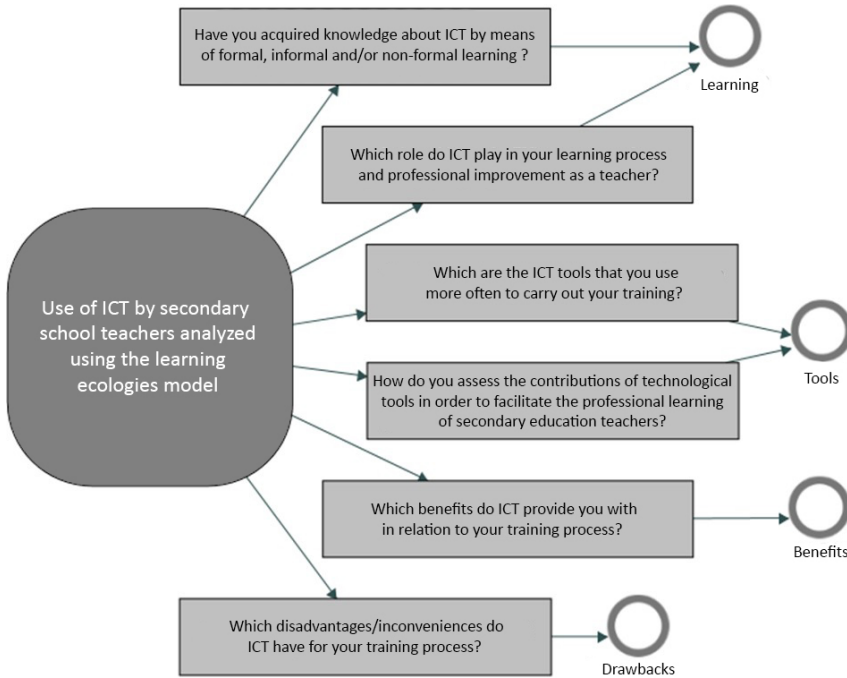
To carry out the data analysis we have utilized Nvivo, a tool recommended by Hernández (2014) for the analysis of interviews in qualitative research, by means of a systematic strategy sequenced in different stages. This process starts with the preparation of the interview's script, its validation (by means of expert judgment), its application to the participants, and its recording. In the next stage the automatic transcription was carried out with the further manual revision of the anonymous files, so as to preserve the identity of the participants, making it possible to identify each file with a case, to which the attributes of sex, age and years of teaching experience are assigned. Preserving the identification of the cases has facilitated analysis and grouping according to socio-demographic variables as well as further revisions.

Next, we have performed data analysis based on the dimensions of the construct detailed in the interview script, including the analysis of the information using creation of nodes, and a process of definition and reorganization of categories according to the content resulting from the interviews. That is, we have followed a process of mixed categorization, based on a "theoretical conceptual categorization and following with a process of emerging theoretical categorization" (Trigueros, Rivera, & Rivera, 2018, p. 22). This way, an axial coding tree, whose relationships are subsequently analyzed by means of intersection matrices or cross-references is created (Palacios, Gutiérrez, & Sánchez, 2013).

## Analysis and results

The phase of approach to the object of study by means of theoretical conceptual categorization has allowed us to gather four dimensions or categories which are depicted in Figure 3. These are related to the learning style or paths of secondary school teachers who use ICT; with the available tools which exist for those training processes; with the benefits that ICT bring about for their ongoing training processes, as well as the drawbacks that these can entail.

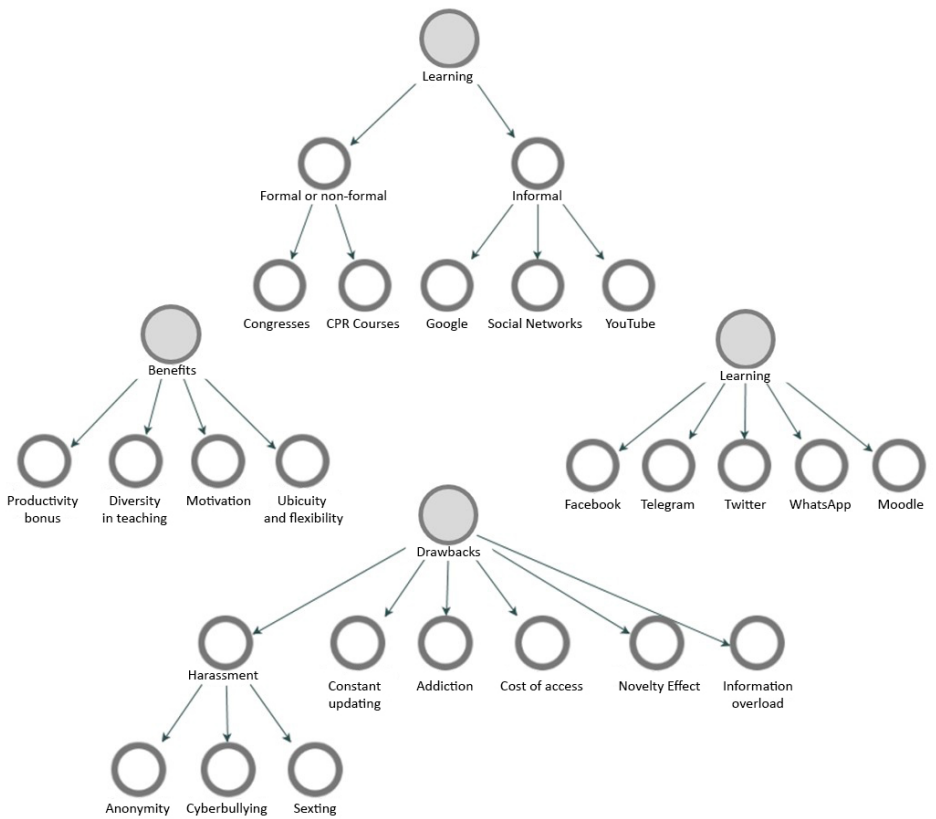
Figure 3  
*Conceptual map for the approach to the object of study*



Using these four dimensions, we have carried out the phase of information production based on the creation of nodes which result from the personal and experiential information provided by the participants in the interviews, resulting in the previously mentioned axial coding, graphically represented in Figure 4.

Figura 4

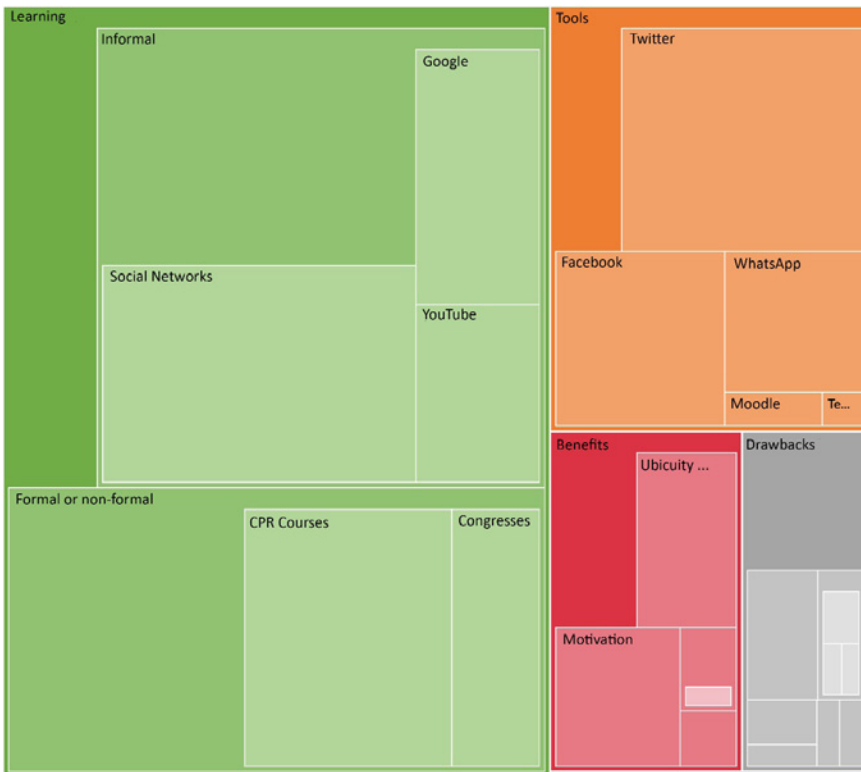
*Axial coding of the four dimensions in the study*



The percentage weight that each of these nodes has over the total of the coding performed on the information obtained in the interviews is represented in Figure 5.

Figure 5

Hierarchical map with the combination of dimensions and analysis nodes



## Learning

When asked about their training in ICT- be it formal, informal or non formal- the majority of the participants (10; 83%) answered that they do “a huge number of courses at the CPR”; “it is constant, by doing courses at the CPR”. This is how the Teachers’ and Resources Center of the Region of Murcia is called. If we segment by “years of teaching experience” (Table 3), we observe a decreasing tendency as said variable increases. This way, 100% of teachers with less than 10 years mention the CPR courses as part of their training processes, decreasing up to 83% for teachers with 11 to 20 years of experience, and to 75% to teachers with 20 or more years of experience.

Apart from these courses, a number of teachers (41%) also refer to their training in ICT through congresses, or university workshops and, thus, “maybe the principal source of training courses is the CPR, but also the training offered institutionally by the University of Murcia”. Besides, 75% of the teachers with more than 20 years of teaching experience mention self-directed learning on YouTube through the “viewing of tutorials; videos with educational experiences; tips or technical instructions in the use of digital resources”.

Table 3

*ICT Learning paths of teachers according to their years of experience*

	Years of teaching experience= Between 5 and 10 (2)	Years of teaching experience= Between 11 and 20(6)	Years of teaching experience= More than 20 (4)	Total (12)
Congresses	50%	33.33%	50%	41.67%
CPR courses	100%	83.33%	75%	83.33%
Google	0%	66.67%	25%	41.67%
Social networks	50%	66.67%	50%	58.33%
YouTube	50%	33.33%	75%	50%

On the other hand, when we segment the population according to their age (Table 4), between those younger than 45 years old (6 participants) and those older than 45 (another 6 participants), we can observe different behaviors regarding their attendance to congresses or training workshops (16% and 66%, respectively), or in relation to the use of social networking sites or virtual learning communities (83% and 33%, respectively).

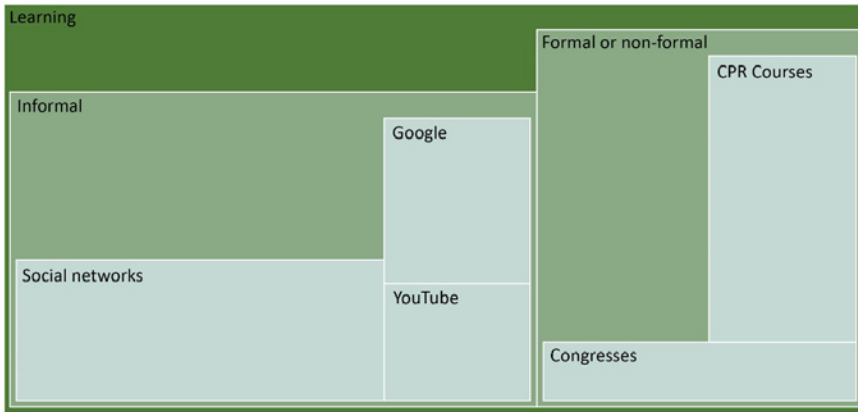
Table 4

*ICT Learning paths of teachers according to their age*

	Age= Younger than 45 (6)	Age= Older than 45 (6)	Total (12)
Congresses	16.67%	66.67%	41.67%
CPR Courses	83.33%	83.33%	83.33%
Google	66.67%	16.67%	41.67%
Social Networks	83.33%	33.33%	58.33%
YouTube	50%	50%	50%

We can graphically and easily observe the percentage weight which each element has within the dimension "learning" thanks to the following hierarchical map (Figure 6).

Figure 6  
 Hierarchical map of results of the dimension “learning”



## Tools

The priority tools for ICT-related learning for secondary school teachers are social networking sites, such as Twitter or Facebook (8; 66%), on which virtual learning communities with open and informal participation, and which are really far-reaching are created. In the same line, we find the use of other instant messaging networks such as WhatsApp and Telegram for the private interaction between teachers, who share some interests “in a group where we exchange a huge number of resources, ideas, and it is really dynamic, with other teachers that, in general, we have previously met in other school centers”. These social networks are used as spaces for ongoing training more often by older teachers (Table 5). This way, among those younger than 45, only 16% mention WhatsApp, and no one even considers Telegram, while among those older than 45, half of them (50%) state that they use WhatsApp as a tool for learning and up to 16% mention Telegram. The analysis of this dimension in relation to the years of teaching experience is not significant.

Table 5  
 Use of ICT tools for ongoing training according to “age”

	Age= Younger than 45 (6)	Age= Older than 45 (6)	Total (12)
Facebook	66.67%	66.67%	66.67%
Moodle	16.67%	16.67%	16.67%
Telegram	0%	16.67%	8.33%
Twitter	66.67%	66.67%	66.67%
WhatsApp	16.67%	50%	33.33%

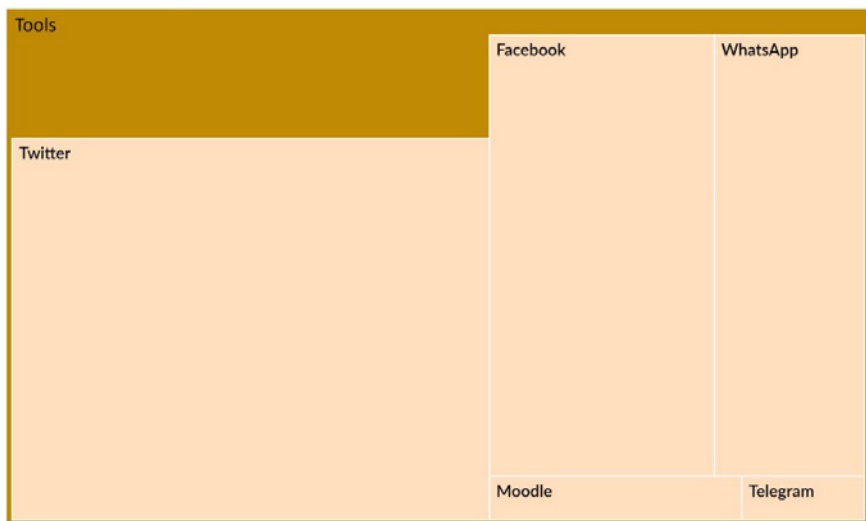


Another tool which is mentioned by some teachers (16% of them) is the teaching platform Moodle as “a virtual classroom”, principally for their formal or non-formal learning processes on which *“the contents or topics which we have to work with are planned and organized”*. In any case, for the participants on the whole, the most useful tools for their training in ICT are the virtual spaces of informal communication *“especially on Twitter or Facebook, where I try to keep up with everything which deals with education, and which is published regularly”*. There, groups or learning communities can be created, for instance, *“through Twitter I have met users who are part of a type of virtual faculty, with an enormous generosity, who share a great deal of really valuable content and who are willing not only to share their continuous work, but also to solve some specific questions”*.

The total distribution of the different tools can be observed according to their percentage weight in the following figure.

Figure 7

*Hierarchical map of the dimension “tools” and the categories therein included*



## Benefits

In relation to the benefits of the use of ICT for teachers’ training, the ubiquity and flexibility of the digital means and resources utilized stand out, with testimonials such as *“you can learn for one hour, another day, three, in groups, individually, from your smart-phone, TV or the tablet”*; *“its flexibility means being able to choose contents from different levels, different duration, even from mobile devices”*; *“not having to go anywhere, but comfortably, using the computer at home”*: *“whenever you want and however you want”*, appreciating thus the individualization of the learning process and the adaptability to the space and time of each one of them, especially in those processes of self-directed learning. This way, 58% of the participants regard this element as a priority, being those older than 45 (66%) the ones who give more importance to it (Table 6).

Table 6

*Benefits of the use of ICT in teacher's training, according to "age"*

	Age= Younger than 45 (6)	Age= Older than 45 (6)	Total (12)
Greater productivity	33.33%	0%	16.67%
Diversity in teaching	16.67%	16.67%	16.67%
Motivation	100%	33.33%	66.67%
Ubiquity and flexibility	50%	66.67%	58.33%

This characteristic of ICT is linked to high levels of motivation in relation to training processes. This is a benefit highlighted by 66% of all the teachers and by 100% of those younger than 45, who regard ICT as "endowed with the capacity of facilitating motivational activities"; *"increasing the interest or motivation, also related to the fact of being able to plan with its flexibility and adapt to your interests, using tools and resources which can be more attractive than the traditional ones"*. It is during this age period when another important benefit is considered: the capacity of ICT tools to complement the daily teaching duties, as when used effectively, they hugely increase working productivity. This implies that *"ICTs complement our activity in the classroom, and make it more efficient, for instance, by having a virtual classroom where we upload materials, videos, and have self-assessment tests"; "they complement our work really well... by saving us time so face-to-face work is more effective"*. Said circumstance has not been considered by any teacher older than 45. The analysis of this dimension in relation to the years of experience of the teachers is not significant.

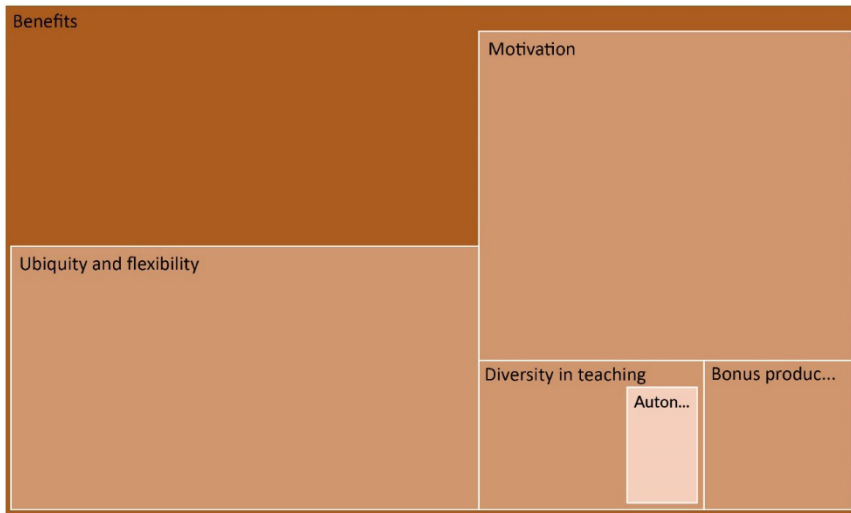
Another characteristic of the use of ICT for the teachers' training processes is the amount of information available online, the diversity of learning opportunities, and amount of knowledge- which has been deemed an inconvenience by some, as it will be detailed later-

It is described as a benefit by two teachers (16%), for offering the possibility of catering to the individual preferences and necessities, facilitating the individual and intrinsic construction of knowledge and *"deciding in an autonomous way which is your itinerary, because the offer is really varied"*, which makes possible the diversity in teaching.

In any case, about ICT, they highlight- above any other benefit- the possibilities of ubiquity and flexibility, as well as the motivation when they realize that ICTs effectively facilitate their ongoing training processes. This can be observed graphically in Figure 8.

Figure 8

Hierarchical Map of the dimension “benefits” and the categories it includes



## Drawbacks

The drawbacks that the use of digital resources and ICT tools bring about for secondary school teachers' ongoing training are varied- although outnumbered by the benefits- according to the teachers' answers.

Two of the teachers (16%), both older than 45, refer to risks and problems of cyber-security and harassment related to the anonymous component on the Internet which can increase the possibility of *“problematic behavior such as cyberbullying or sexting”*.

They are the same who also call attention to the danger of *“addiction to the use of digital devices due to their overuse”* for all types of daily actions, related to either work or leisure.

Four of the participants believe that there is an excessive amount of information online which hinders the process of construction of learning itself, being this aspect stressed by those older than 45 (Table 7). This disadvantage, related to the “overwhelming amount of contents, knowledge and resources”, is in line with the problem that the constant updating and permanent effort entails when trying to keep up with the innovations and possibilities of the use of ICT, something which is expressed by two of the teachers, although this is magnified among those younger than 45. The analysis of this dimension in relation to the years of experience of teachers is not significant.

Another drawback pointed out by one of the teachers is the novelty effect which digital resources have, by which “motivation eventually declines” the more these resources are being used and they do not spark as much interest- regardless of the content- as they used to do at the beginning.

Another teacher brings up the disadvantages of the high economic cost which the use of these resources entails- *“even more so when one intends to be at the forefront of technology”*-, impairing its accessibility by all the teachers and hindering the democratization of training.

Table 7

*Disadvantages of the use of ICT in teachers’ training according to “age”*

	Age= Younger than 45 (6)	Age= Older than 45 (6)	Total (12)
Anonymity	0%	16.67%	8.33%
Ciberbullying	0%	16.67%	8.33%
Sexting	0%	16.67%	8.33%
Constant updating	33.33%	0%	16.67%
Addiction	0%	16.67%	8.33%
Cost of access	16.67%	0%	8.33%
Novelty effect	16.67%	0%	8.33%
Information overload	16.67%	50%	33.33%

## Discussion and conclusions

If we focus on teachers’ training, the Tails report (2018) reveals that teachers regard their initial training as scarce, and we learn that 52% of teachers do not consider themselves qualified enough in relation to the content, nor with regard to pedagogy or classroom practice, which leads to the implementation of models by mimicking the way they have been taught.

This information contrasts with the data collected by Lorenzo, Muñoz, and Beas (2015). These authors found that 90% of secondary school teachers felt they were qualified enough to teach their subject, which the authors conclude “is not congruent with the teachers’ real training” (p. 747). This lack of initial training which the teachers mention and the reality regarding their actual expertise make the teachers continue their training process once they start carrying out their teaching practice. In these circumstances, the range of possibilities for teachers, specifically in secondary schools, is a wide one in all contexts- be they formal, non-formal and informal-, especially in the digital age.

Based on the interviews conducted with the participants, and regarding the learning dimension, it is remarkable that teachers tend to construct an informal framework as the main element of their LE to carry on with their training and enhance their professional development. Self-directed learning supported on ICT stands out as an essential aspect of their ongoing training process. More specifically, it seems that teachers use a diversity of tools which allow them to access learning by being connected with others, or by viewing videos, together with the autonomous search of information. This

aspect is directly linked to the elemental level which Barron (2006) refers to, in which he mentions the resources, tools and relationships.

Regarding the formal or non-formal training carried out, it seems like the CPR is the most habitual option. However, this type of training becomes gradually less interesting for teachers the more years of experience they have, whereas congresses or training workshops organized by university institutions or private companies are preferred by these older teachers.

Younger teachers tend to be more concerned about their training, showing a greater interest in carrying out training activities and, consequently, they would make a more intense use of resources aimed at promoting their updating process, which corroborates the data revealed by other authors (Caballero, 2013; González-Sanmamed et al., 2020).

Considering the informal character of these teachers' training, it is not surprising that the two tools they declare to use most often to train themselves are Facebook and Twitter, two social networks which allow teachers to be in touch with others and create opportunities for learning.

In the same line, we find the use of instant messaging tools, such as WhatsApp or Telegram: the participants say they get in touch with other teachers with similar interests and who they have previously met, by means of these tools. It is striking that in the results of the interviews conducted, those older teachers show a greater preference for the use of WhatsApp, tool which incidentally is the most used among secondary school students too, in the work of Martineco et al. (2021), above other social networks; Instagram and Youtube come immediately after; Twitter is in fourth position, while Facebook does not even appear in the list. However, some of these participants actually have fewer years of experience.

The use of all of these resources helps confirm the different levels detailed by Barron (2006) in relation to LE, observing components of the elemental and contextual level, and the relationship with those which are regarded as a superior level.

These data contrast with the results of González-Sanmamed et al. (2020), who confirm that the use of technological resources by teachers in Spain was moderate, although in their study is carried out with university professors. Our data, on the other hand, show a different reality and reveal an important use of technology by our interviewees, matching the results of other authors, such as Flores-Tena et al. (2021) in their study carried out in Portugal, with 100 surveyed subjects, and also those of Escofet et al. (2019) in their study with 847 teachers, 333 of them from secondary education. Nevertheless, it is important to highlight that in the work of González-Sanmamed et al. (2020) a quantitative method was used, based on this survey, whereas our research is centered on a specific population characterized by the inclusion criteria.

The benefits that the participant teachers observe in the use of ICT for their training are varied, although the ubiquity and flexibility that ICTs offer when constructing their LE stand out above the rest. These tools allow the individualization of their learning process and enable them to have the maximum adaptability in relation to the space and time they have, especially in self-directed learning processes. These data confirm those of previous studies about the use of ICT for teachers' training, which also highlight their flexibility and the personalization of training processes (Bernacki et al., 2020; Flores-Tena, Ortega-Navas, & Sousa-Reis, 2021).

These benefits mentioned by the interviewees go hand in hand with the high levels of motivation and autonomy in the construction of knowledge itself. When linking it with age, we observe that those younger than 45 refer to motivation as a greater benefit, while those who are older than 45 mention ubiquity and flexibility more often. This also goes in line with research on Learning Ecologies of secondary school students, as in the work of Martinenco et al. (2021), which reveals that secondary school students do use these tools very often in their Learning Ecologies, and especially when it comes to searching for information, just like university students do, according to the data provided by Prendes & Román (2017).

Finally, and regarding the benefits, they also highlight the great amount of information which one has access to, and which offers the teachers the individual construction of learning, leading to diversity in teaching because of this characteristic.

However, this benefit stressed by different teachers turns into a liability for other teachers, who agree in this sense, with the opinion expressed by the participants surveyed in the study of Flores-Tena et al. (2021). This information overload impairs the construction of learning according to one's interests, by complicating the searches.

Along with this inconvenience, we find the impossibility of being constantly updated, which is something that those participants older than 45 highlight. Van den Beemt and Diiespstraten (2016) stress among their conclusions the relevance of age, as older teachers tend to remember what their education was like before the arrival of ICT and in general they all allude to their fears regarding the digital competency of their students, which they assume is more advanced than that of their own.

They make use of trial-and-error or ask their colleagues when they need help to use ICT, but in general they tackle their self-directed learning processes on their own, more than in collaboration with their peers.

Another drawback they highlight is the possibility of being harassed and other cybersecurity risks, the novelty effect of the media, and the high cost of certain technologies, all of which are ironically found in the models of teachers' digital competence, as specific indicators of its level of development (González, Román, & Prendes, 2018; Prendes, Gutiérrez, & Martínez, 2018).

The LE patterns which are observed are diverse, in relation to different aspects. This way, while teachers with more years of experience tend to show a greater interest in the education by means of attending congresses, the younger ones are more centered on the use of those ICT tools which allow to create online learning communities, such as social networks. That is, teachers are more focused on the so-called independent self-directed learning environments and self-directed learning in loosely structured educational contexts pointed out by Jackson (2013), relegating all the so-called formal contexts of traditional teaching to a secondary role. Rainieri, Giampaolo, and Bruni (2019) compile data from university professors (85 participants between 28 and 58 years), but apart from the differences inherent to this education stage, we believe that one of its conclusions can be extrapolated to the secondary school stage, and it is related to the relationship which could be established between the different professional identity patterns or models and the different LE found. We need more research to analyze this potential relationship.

In general, we could conclude based on the data collected in the interviews that teachers highlight the role of ICTs within Learning Ecologies to access their training, be it formal, non-formal, or informal; our results match, this way, those of the work by

Hernández-Sellés et al. (2015). For this, teachers use different technologies, and they acknowledge certain benefits related to their use, but also some disadvantages. The importance of ongoing training, beyond their initial training, is key for teachers, and ICTs have become their principal tool of professional development in the framework of their informal learning process, as they are described by Rogoff et al. (2016). Consequently, echoing Caballero (2013) in their work with university teachers, we can state that, quite possibly, ongoing training is more important than initial training in the teachers' professional development.

## Future implications and recommendations

In this study, a qualitative method was used to analyze how secondary school teachers cope with the use of ICT to carry out learning processes in relation to their own training. With the content analysis carried out, we have prioritized the personalization of the research, and not merely turning the information into numerical data. This way, the results can be extrapolated to other contexts, although they cannot be generalised (Trigueros, Rivera, & Rivera, 2018).

Therefore, our research reinforces the approach laid out by Cortés-González et al. (2016) or that of Harvey, Coulson, and McMaugh (2016) about the importance of promoting reflective thinking in teachers, as a strategy to understand LE, as well as the line developed by Van den Beemt and Diiepstraten (2016) in which the biographic interview is favored as the most appropriate technique to look into the Learning Ecologies.

We agree with these authors about pointing out the value of these qualitative methods, even though we believe that the triangulation with future quantitative data which could be collected in the project will also provide conclusions of unquestionable value. In this sense Rainieri, Giampaolo, and Bruni's mixed method (2019), by means of a digital portfolio (e-portfolio) can be an interesting option to consider in future studies.

We believe that the qualitative method approached with the biographic interview is a powerful strategy to gain deeper understanding of LE, integrating not only objective aspects or evidence, but also the subjective world of beliefs, attitudes and opinions which undoubtedly enrich the personal vision of teachers' professional development. Additionally, the LE model offers us a theoretical framework whereby we interpret the obtained information from a multi relational and complex perspective, which allows us to reach interesting conclusions.

As recommendations created using the analysis of results, we detail the following:

- Make the most of the possibilities offered by non-formal and informal learning, as not always formal training seems to be the most useful tool to promote digital competence and the development of Learning Ecologies. This way, we recommend participating in virtual professional communities and teachers' collaboration networks, as well as promoting open digital education resources (both regarding their production and their use).
- Understanding that ICTs are not just the content matter of digital competence training, but essentially tools for self-education and professional development in 21st century societies.

- Promoting the collaboration with students, who can participate actively in collaborative spaces and in the elaboration of digital devices, as well as constructing virtual communities for education and learning with those students.
- Identifying one's own shortcomings or difficulties by questionnaires of self-perception in digital competence and teachers' digital competence, to be able to address with greater insight the processes of professional enhancement and development.

The research we are presenting intends to be an exploratory analysis which allows us to carry out future research to contrast the information herein obtained. It would be interesting to replicate the study with more numerous samples which could even make possible carrying out comparative studies, by areas of knowledge, or regarding age, gender, or work environment.

## Limitations

It is necessary, however, to acknowledge certain limitations in the present study. One of them is the sample size utilized, which could be regarded as non-representative. Nevertheless, we should bear in mind that qualitative research is more focused on searching for certain meanings, or reflecting a variety of realities in depth, more than on the generalization and extrapolation of the results, more akin to other types of research (Martín-Crespo & Salamanca, 2007). Another of the possible limitations is not having been able to compare the analysis of the above-mentioned reality in relation to the different specialties, in other autonomous communities. These are aspects which allow us to consider future lines of research.

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