







Mirroring learning ecologies of outstanding teachers to integrate ICTs in the classroom

Ecologías de aprendizaje para usar las TIC inspirándose en docentes referentes

-  Dr. Teresa Romeu-Fontanillas is Professor in the Department of Psychology and Education at the Open University of Catalonia (Spain) (tromeu@uoc.edu) (<https://orcid.org/0000-0002-4866-4389>)
-  Dr. Montse Guitert-Catasús is Professor in the Department of Psychology and Education at the Open University of Catalonia (Spain) (mguitert@uoc.edu) (<https://orcid.org/0000-0001-8144-7629>)
-  Dr. Juliana-E. Raffaghelli is Senior 'Ramon y Cajal' Researcher in the Department Psychology and Education at the Open University of Catalonia (Spain) (jraffaghelli@uoc.edu) (<https://orcid.org/0000-0002-8753-6478>)
-  Dr. Albert Sangrà is Full Professor in the Department of Psychology and Education at the Open University of Catalonia (Spain) (asangra@uoc.edu) (<https://orcid.org/0000-0002-5144-0038>)

ABSTRACT

This paper presents an exploratory study to examine the practices of outstanding primary school teachers in their professional development for ICT integration in teaching and learning, as a means of understanding how their learning ecologies develop and function. Outstanding teachers in the context of this study are teachers who innovate pedagogically and who are influential in the community, having successfully developed their learning ecology. Using a qualitative approach, we explore the concept of learning ecologies as a driver for innovation in the professional development of teachers, using a carefully selected sample of nine outstanding teachers. Drawing from in-depth interviews, specific coding and NVIVO analysis, our results show that these teachers develop organized systems for activities, relationships and resource usage and production, which can be characterized as the components of their professional learning ecology, to continuously keep up to date. We also identified some characteristics of teachers that perform outstandingly and factors that potentially facilitate or hinder their learning ecology development. Further research in the field will enable an improved understanding of the professional learning ecologies of school teachers and support future interventions and recommendations for professional development through the cultivation of emerging professional learning ecologies.

RESUMEN

Este artículo presenta un estudio exploratorio que examina prácticas de docentes referentes de Educación Primaria en su desarrollo profesional sobre la integración de las TIC en la docencia y el aprendizaje como medio para comprender el desarrollo y operación de sus ecologías de aprendizaje. Un docente referente en el contexto de este estudio es aquel que innova pedagógicamente y que influye en la comunidad, habiendo desarrollado con éxito su ecología de aprendizaje. Mediante un enfoque cualitativo, se explora el concepto de ecologías de aprendizaje como motor de la innovación en el desarrollo profesional de los docentes, utilizando una muestra cuidadosamente seleccionada de nueve profesores de Educación Primaria. A partir de entrevistas en profundidad, codificación específica y análisis con NVivo, los resultados muestran que estos docentes desarrollan sistemas organizados de actividades, relaciones y recursos, que pueden ser caracterizados como componentes de sus ecologías de aprendizaje para mantenerse permanentemente actualizados. Se identifican algunas de las características y factores que potencialmente facilitan u obstaculizan el desarrollo de su ecología de aprendizaje. Futuras investigaciones en esta línea permitirán mejorar nuestra comprensión de las ecologías de aprendizaje profesional de los docentes, apoyando nuevas futuras intervenciones y recomendaciones para el desarrollo profesional.

KEYWORDS | PALABRAS CLAVE

Learning ecologies, teachers' professional development, primary school education, outstanding teachers, ICT, case studies, influencing factors, training.

Ecologías de aprendizaje, desarrollo profesional docente, educación primaria, docentes referentes, TIC, casos de estudio, factores influyentes, formación.

1. Introduction

Teachers play a key role in the integration and effective use of technology in education (Uluyol & ahin, 2016), and while most primary school teachers recognize the potential of digital technologies and the internet (Admiraal & al., 2017; Correa & Martínez, 2010; De-Jesús & Lebres, 2013; Potter & Rockinson-Szapkiw, 2012), implementation remains limited (Correa & Martínez, 2010; De-Jesús & Lebres, 2013) and technology at school unused (Potter & Rockinson-Szapkiw, 2012).

A survey of adult skills (OECD, 2016), reveals that 87% of teachers (pre-primary, primary and secondary) consider that they have the computer skills needed in their job. The difficulty, then, lies in the lack of skills to use technologies for educational purposes (De-Jesús & Lebres, 2013). The well-known Technological Pedagogical Content Knowledge (TPACK) theory considers pedagogical and disciplinary knowledge applied to technology to be fundamental, and points to the many ways in which techno-pedagogical knowledge can be developed. This theory arose precisely from research into the difficulties encountered by teachers in applying technology to education (Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2009). The same difficulties led to the development of the Digital Competence for Educators (DigCompEdu) framework (Redecker & Punie, 2017), which attempts to support technology integration in pedagogical practices and in so doing develop the digital competence of students.

Teachers may face difficulties related to insufficient training, the lack of suitable equipment or a lack of flexibility in the curriculum (Nikolopoulou & Gialamas, 2015; Panagiotis & al., 2011; Unal & Ozturk, 2012). Teachers' attitudes towards technology are conditioned by the resources available to them, the support that they receive and the existence of a motivational school culture (Agyei & Voogt, 2014; Uluyol & ahin, 2016).

One of the most important challenges in techno-pedagogical uptake by teachers is promoting effective professional development strategies. The literature suggests that most continuing professional development currently focuses on administrative and institutional aspects, leaving teachers feeling powerless in their own professional development (Jiménez, 2007). A proposed alternative is the empowerment of teachers through a more consensual definition of their professional development (Livingston & Robertson, 2010) and the incorporation of collaborative practices (Kennedy, 2011) and peer-group mentoring (Geeraerts & al., 2015). Another successful innovation is collegial practice transfers, consisting of more experienced teachers instructing less experienced teachers (Lakkala & Ilomäki, 2015). Mentoring has, in fact, been identified as a key factor in the success of in-service teacher training (Dorner & Kárpáti, 2010), as peers can provide both practical and emotional support.

In spite of advances, teachers' professional training is essentially based on (more or less innovative) approaches that are frequently kept separate and that tend to focus on the trainer/coach/coordinator's perspective of learning achievements (Bradshaw, Walsh, & Twining, 2011; Laurillard, 2014; Twining, Raffaghelli, Albion, & Knezek, 2013). However, a more integrated learner-centred perspective is crucial to nurturing teachers' confidence in their own capacity to integrate ICT innovations into teaching (Tondeur, Forkosh-Baruch, Prestridge, Albion, & Edirisinghe, 2016). Below we describe the concept of learning ecologies (LE) as a driver of innovation in the professional development of teachers.

Since the 1990s, ecological approaches to teaching and learning in the digital age have yielded a range of terms and conceptual definitions that have come to be widely used (Sangrà, Raffaghelli, & Guitert, 2019). The term LE has been used in many fields of education, including technologies and gender (Barron, 2004), ICT skills development (Barron, 2006), collaborative learning (Hodgson & Spours, 2009), designs for learning with technologies (Luckin, 2010), learning resources for homeless populations (Strohmayr, Comber, & Balaam, 2015), teachers' professional development (Sangrà, González-Sanmamed & Guitert, 2013; Van-den Beemt & Diepstraten, 2016) as well as personalized learning and lifelong learning (Maina & García, 2016).

Jackson (2011) has further explored the construct of LE, introducing the useful concept of lifewide learning, given that LE embrace many different spaces and types of learning. The concept of LE, therefore, emphasizes a learner-centred and self-determined perspective, which is particularly important for professional development and is particularly applicable to the professional development of teachers. Van-Den-Beemt & Diepstraten (2016) studied the LE of teachers starting to use ICTs, particularly their

assumptions and expectations, and the contexts and key people that encouraged their learning conceived as a horizontal process among a plurality of spaces (Akkerman & Van-Eijck, 2013).

The advent of digital environments has generated another important dimension of analysis for the learning ecology concept, namely, the selection of, and engagement with, more or less digital or analogue/physical learning contexts. While this aspect was envisaged in foundational work by Barron (2004), it emerged sharply in Delphi studies as a lens to characterize LE (González-Sanmamed, Muñoz-Carril, & Santos-Caamaño, 2019).

The above considerations are relevant in recognizing that, while most learning ecology studies attempt to analyse ongoing experiences and practices, few support strategies for professional development (Sangrà, Raffaghelli, & Guitert, 2019). Therefore, and considering the ongoing debate on the need to improve the effectiveness in teachers' professional development, it seemed particularly appropriate to research lifelong LE in primary teachers in an endeavour to support future research, strategies, interventions and recommendations for professional development based on cultivating professional LE.

2. Methodology

Qualitative methods allow deep exploration of emergent discourses and practices. They therefore attempt to grasp the complexity of experiential knowledge, while avoiding the limitations and synthesis required of quantitative methods. Although qualitative methods do not allow the study of causality or the generalization of research results, they do encompass very rich descriptions where emerging new patterns can support further exploration (Ingleby, 2012).

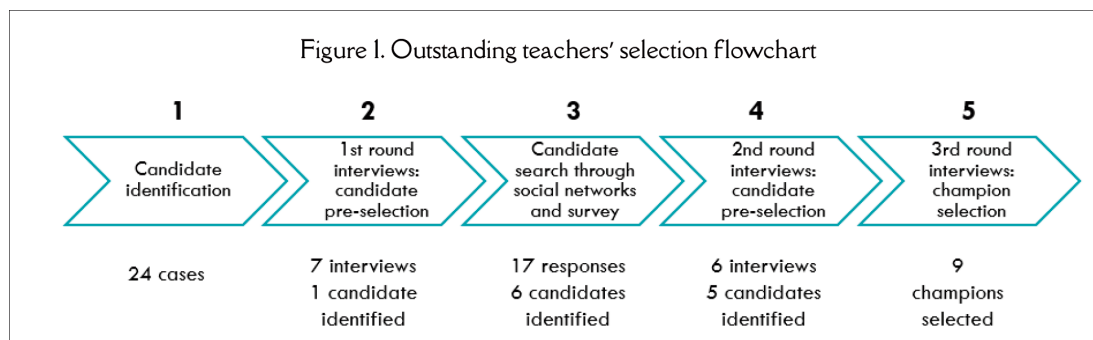
This study aimed to explore outstanding practices in self-directed professional development for ICT integration in teaching and learning, as a means to understanding how successful LE develop and function. In this context, outstanding teachers are understood as those that pioneer pedagogical innovations and are usually influential to others, effectively organizing their self-directed professional development. We conducted an in-depth analysis of a sample of primary school teachers, as a follow-up to an initial phase of expert consultation by means of a Delphi study (Romero, Guàrdia, Guitert, & Sangrà, 2014). The research questions addressed in this study were as follows:

- RQ1: What components shape the professional LE of outstanding primary school teachers?
- RQ2: What other factors influence the development and the maintenance of these teachers' LE?

2.1. Data collection: Case selection and interview structure

The outstanding teachers were teachers who demonstrated on-going technology uptake regarding both their classrooms and their own professional development.

Nine teachers were ultimately selected from an initial sample of 24 candidates, in the five-phase process illustrated in Figure 1.



The sample was drawn from in-service primary school teachers in Catalonia (Spain). The initial criterion for inclusion was varied professional experience. The remaining broad inclusion criteria for outstanding participants were as follows:

- 1) They use a set of reliable relationships and resources that enable them to update continuously.

- 2) They use ICTs to develop their own LE for professional development.
- 3) They have developed a learning ecology that positively impacts their professional practice.

Those broad criteria were further refined to establish more specific characteristics for these teachers, as follows:

- a) They are active in social networks, i.e., they: Participate in two or three social networks; participate in distribution lists; Make frequent use of both networks and lists.
- b) They are interested in innovation, i.e., they: have co-authored a publication: Have received an award; Have participated in an innovation project.
- c) They use ICTs in the classroom, i.e., they: Use ICTs as a support or as a complement; Prepare teaching materials or resources using (reusing) materials found in the Internet.

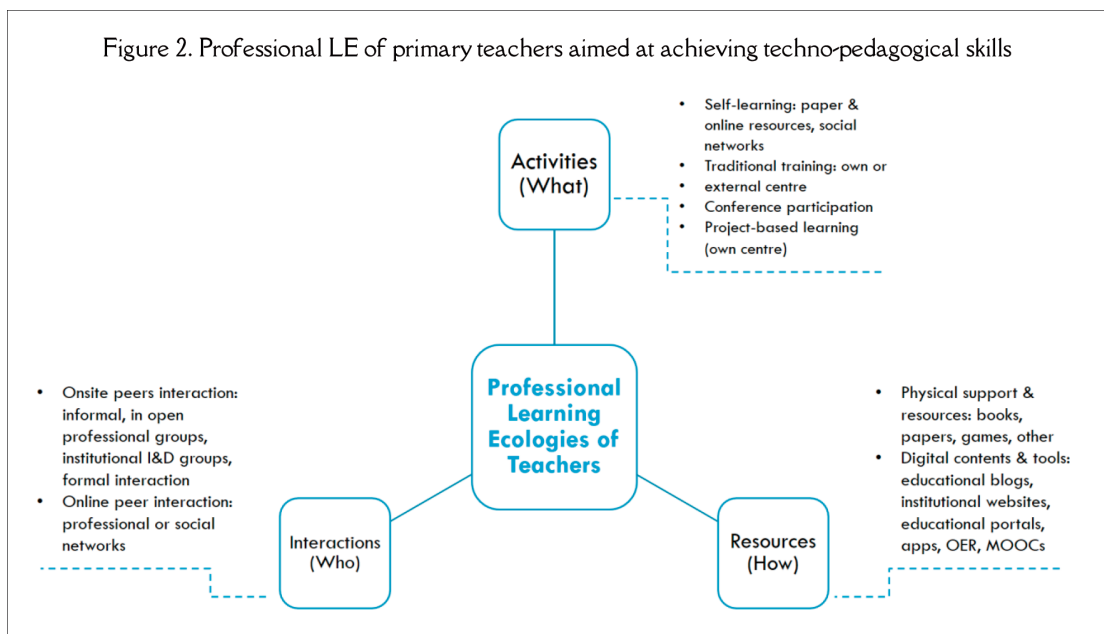
Of the nine selected teachers, three had been teaching for less than 10 years, three between 11 and 20 years, and the last three for more than 20 years.

Three data collection methods were combined: interviews, materials and other products related to the teachers' activities. Our qualitative approach to the analysis of the case studies was based on in-depth interviews as the data collection instrument, using NVIVO software for specific coding and analysis.

2.2. Coding and analysis

Observations of internet and social media practices were triangulated with data collected from interviews, with the resulting textual data constituting our corpus for analysis.

The qualitative analysis was done using NVIVO. The interviews with the nine teachers were coded on the basis of a thematic analysis, with categories and codes theoretically driven by the Delphi study- as shown in the conceptual map depicted in Figure 2: Undertaken in the previous research phase (Romero, Guàrdia, Guitert, & Sangrà, 2014). In this follow-up study we attempted to further elaborate on this map by identifying specific components explaining the drivers motivating teachers to undertake certain activities, strengthen certain interactions and use certain resources in their personal and professional learning contexts.



To obtain a final codebook of axial and basic codes from the inductive research (Table 1), four researchers agreed on the coding strategy and two researchers coded the corpus. The percentage of interrater agreement was 99% for all the codes, for a kappa coefficient of 0.68 (considered an acceptable level of agreement). During the coding process, as well as the three main learning ecology components

of activities, interactions and resources, we detected relevant emerging factors related to drivers behind learning ecology growth and maintenance, which we labelled personal positioning and factors influencing learning ecology development.

Table 1. Codebook resulting from the coding process

Axial code level I	Axial code level II	Basic code (Files, References)	
1. Activities [9-300]	1.1. Formal, self-directed [9-34]	1.1.1. Online (9,34) 1.1.2. a) MOOCs (5,18); b) Other self-directed learning (6,16)	
	1.2. Formal, externally directed [9-106]	1.2.1. Face-to-face or blended (9,106) 1.2.2. a) Courses selected from institutional training (9,36); b) Courses selected from other institutions (9,21); c) Courses externally imposed on the institution (9,49); d) Courses externally imposed in other institutions (0,0)	
	1.3. Informal, self-directed [9-104]	1.3.1. Online (9, 103) 1.3.2. a) Online consultation with experts (9,40); b) Systematic resource/forum/community consultation (9,63); c) Participation in social/cultural projects (0,0)	
		1.3.2. Face-to-face (1,1)	
		1.3.3. Library consultation (1,1)	
1.4 Non-formal, self-directed [9-28]	1.4.1. Face-to-face or blended (0,0) 1.4.2. One-day events and conferences (9,28)		
1.5 Non-formal, externally directed [9-28]	1.5.1. Face-to-face or blended (1,1) 1.5.2. Institutional innovation projects (7,25) 1.5.3. European/interinstitutional innovation projects (2,2)		
2. Interactions [9-221]	2.1. Online interactions [9-116]	2.1.1. Online professional communities (5,23) 2.1.2. Professional networks (7,20) 2.1.3. Social networks (9,73)	
		2.2. Face-to-face interactions [9-105]	2.2.1. Innovation and development institutional groups (4,7) 2.2.2. Formal peer interactions (8,26) 2.2.3. Informal peer interactions (9,55) 2.2.4. Professional groups/memberships (6,17)
			2.2.1. Formal peer interactions (8,26) 2.2.2. Informal peer interactions (9,55) 2.2.3. Professional groups/memberships (6,17)
	3.1. Physical support/content [1-5]	3.1.1. Archives (0,0) 3.1.2. Printed books/magazines/journals (1,5)	
3. Resources [8-88]	3.2. Digital tools/contents [8-83]	3.2.1. Educational blogs (8,42) 3.2.2. Open data (6,6) 3.2.3. Institutional website (5,12) 3.2.4. OER (7,15) 3.2.5. Educational portals/repositories (3,5) 3.2.6. Online books/magazines/journals (1,1) 3.2.7. Personal learning environments (2,2)	
		4.1. Obstacles [7-26]	4.1.1. Historical factors (3,4); 4.1.2 Institutional factors (7,22)
			4.2. Facilitators [7-21]
		5. Personal positioning factors [9-102]	

Note: the "Files" column shows the number of text units for the nine teachers and the "References" column shows the number of mentions in the corpus.

3. Results and analysis

Our results are described considering the three main learning ecology components, namely, activities, interactions and resources, and also considering the two additional factors that emerged during the coding process: personal positioning and factors influencing learning ecology development.

3.1. Characterizing the LE of outstanding teachers

A great diversity of approaches was found throughout the nine cases. As shown on Table 1, there was a great concentration of specific elements across teachers. For example, while all nine teachers participate in formal activities online and face-to-face, only six participate in self-directed activities, and only five have taken massive open online courses (MOOCs). In general, following an established pattern, more diversity is observed for self-directed activities than for externally directed activities proposed at the national or institutional level.

3.1.1. Activities

Regarding which activities the teachers carry out, great discursive density is observed in relation to participation in courses (106 of 302 corpus references), which also offer the opportunity to establish professional networks. The dynamics usually coincide: from face-to-face or online interactions, teachers become followers or friends in social networks. The courses taken vary greatly, from those offered by the centre, MOOCs, etc., but uptake is greater for external and face-to-face courses.

Many teachers opt for formal education, mostly university-based face-to-face or online courses: "I've been looking into TDH courses. And we were looking there the other day and said we should do one. They are courses offered by the centre... We're beginning to get around to it, since we have to start doing this kind of face-to-face thing" (C5, R1_1.2.1b). "One of the reasons for doing the master's in educational innovation was to do that, to learn about and enter the world of people who train and learn how to build training" (C2, R2_1.2.1b).

However, others show a preference for informal and more practical channels: "One of the things I also like to do is to easily access people that I consider referents, without bothering them. I do not have to ask them anything. They are generous in that, once a week or month, they offer their opinions, and I like to hear them, without having to go to where these people give talks" (C1, R1-2_1.3.1a).

Regarding face-to-face activities, it is important to note the attendance to one-day events and conferences as well as informal interactions with colleagues and interns in schools, considered important channels for knowledge updates. Outstanding teachers seem to prefer face-to-face activities, whether formal or informal, that take place in their centre: "Last year together with two other people we presented an innovation project on ideas as to how we could introduce tablets in infants' school, and that took a year, spending just a few hours at a time" (C2, R1-2_1.5.2).

However, specific consideration needs to be given to their participation in informal and self-directed activities. As mentioned above, teachers typically begin with formal activities, and then continue along an informal route that is no longer directed externally but which is managed by the teacher in a process of questioning, demonstrating or sharing professional practices: "That gives you the chance to go to a conference or a talk. Then, of course, you meet people. Through JA, for instance, I found AR, and I had the opportunity to listen to him, he's just something else. And DR came to give us a talk at the school" (C3, R1_1.4.1a).

3.1.2. Interactions

In regard to the personal and professional relationships established by the outstanding teachers, their online interactions focus on seeking information and comparing ideas, knowledge, etc. Social network use is noteworthy, either active (participation) or passive (consultation), and visits to blogs maintained by referents: "I am not into social networks that much, I mean, I'm not very active in social networks, I use them for instance to ask questions, you know? That side I haven't exploited much, I have been more of a passive participant" (C1, R1_2.1.3).

Regarding social networks, Twitter is the most used, for a variety of reasons: to be up-to-date with information from colleagues and referents, to seek specific information, to search, consult and obtain information on a daily basis, to follow referents and colleagues from one's own and other centres, to share resources, information and personal reflections, to draw attention to published works, to request help, information, etc., and to generally keep up to date with both face-to-face and online courses.

Nonetheless, while all the teachers have a Twitter account, they tend to be moderate users in that they

do not post or they only post sporadically. Their use of Twitter is often just for convenience sake and they do not consider themselves to be referents: “Twitter, maybe not, but it’s a great source. If you become a fan of people who are good, for instance, PPL, then many alerts come to you on things that probably you would never have known. Twitter, I think is very handy, you take a look and you say ‘ah, look at that’, and then you search in depth” (C5, R3_2.1.3).

Regarding Facebook, far less popular among these teachers, use is fundamentally personal; typically, the account was initially established for either personal or professional use and, in the latter case, the teacher progressively began to make it more personal and to share information or reflections with and by colleagues: “What happens is that with Facebook I have come to use it in a way that is more personal whereas I’ve used Twitter more professionally. There was a time when I was a ‘100% professional of Facebook’. What happened? Well, of course, there I have friends and, in the end, they give up on you... they get tired. I understand that and I have also stopped to tell myself ‘let me organize my social life’” (C3, R2-3_2.1.3).

Another network that is used sporadically, is LinkedIn (C7, C3), a professional network, for the purpose of posting career resumé online and establishing professional contacts. Less frequently, SlideShare, Keynote and Prezi are adopted to access referents’ presentations (C4, C9) or to share presentations. While these tools are for public use, in some cases the teachers share presentations internally with colleagues (C9), e.g., Ning to monitor forums, Evernote to store information in an orderly way for consultation and analysis, and Pinterest to manage projects and to seek new ideas.

In sum, interactions are distributed homogeneously between face-to-face interactions and online interactions (106 of 302 and 116 of 300 corpus references, respectively). Face-to-face interaction is used for dialogue and collaboration during educational intervention projects or routine practice, whereas online interactions have the advantage of synchrony. All in all, forms of knowledge exchange are established, that allow these teachers to complete, integrate and build their repertoire of professional teaching strategies. Teachers, in this sense, are both receivers and senders, investing, in both cases, cognitive efforts to complete their knowledge through vicarious learning (what others do) and reflective practice (what the teachers themselves do).

3.1.3. Resources

The outstanding teachers are featured by intense online activity, rarely using physical or printed media. Blogs maintained by educational influencers and for educational outreach purposes are the most frequently consulted resource (42 of 82 corpus references). These teachers access these blogs either through Twitter or by subscribing via an RSS feed, in this way, combining social network interactions with access to specific resources: “My usual routine is tracking blogs and Twitter. I have to admit that I did not understand how Twitter worked until a year ago. I’m much more one for blogs” (C1, R1_3.2.1).

However, they are not just passive receivers; some of them are bloggers themselves, whether of a personal blog, group blog or their centre blog. They post and share resources that reinforce specific aspects of educational practice, etc. In these cases, blog post frequency is typically weekly or fortnightly.

There is great variability in the type of resources used in addition to educational blogs, including, specifically, more obvious ones like the institutional website (12 of 83 corpus references), and open educational resources (OER) and open data (which together account for 21 of 83 corpus references).

Finally, in the performance of activities, in interactions and in accessing resources, these teachers mainly use smartphones, tablets and computers. Smartphones and tablets are generally used daily for consultations and for keeping up to date, while computers are reserved for tasks requiring greater interactivity, i.e., reading, research, writing, etc. Most outstanding teachers use commercial software, although some use open software for both their teaching and professional maintenance.

3.2. Factors influencing outstanding teachers’ development of LE

The interviews revealed a number of factors that intervene in how primary teachers configure and update their professional LE in terms of resources, activities and interactions. Two new factors, relating the prior Delphi study (Romero et al., 2014) were identified: personal positioning factors and

factors influencing the learning ecology development, reflecting historical individual development and the institutional context.

3.2.1. Personal positioning factors

The personal positioning of outstanding teachers characterizes their productivity and success in applying technologies in the classroom, reflecting rapid and effective professional learning. Table 2 reproduces some of the comments of the interviewees regarding their personal positioning.

Personal positioning	References
Active searching. For personal and professional guidance.	"What I want is to try to make the leap at a professional level, not so much as a teacher within the school, but more, 'hey people, here I am, we are going to share and to grow together'" (C3, R2_5.1). "So, how can I do that? Well, researching, observing things other people do, surfing the internet in searches, following certain people through Twitter and blogs and doing research in Google, that's how" (C1, R1_5.1).
Curiosity. Exploring interests and resolving doubts and questions.	"At the institutional level, it's not my responsibility because that's what a coordinator is for, but at my own risk, I think I have to know, because it interests me, because I like it and because the ICT and social network issues are important in the school" (C3, R1_5.2).
Innovation. Open, practical and innovative vision of education and ICT use.	"I think everyday you are learning new things, you can't say 'Now, I know everything ...' For example, I haven't used Instagram yet, and it is something I say "maybe you can learn something through Instagram, who knows" (C4, R1_5.2).
Collaboration. Interest elicited by colleagues and in their development.	"What pushes you a lot too is if you have to train other people or if you have to communicate with other people or if you have to share with other people, it all makes you push ahead. I cannot imagine that, without this journey, I would have arrived to where I am. It's not that I've come that far but ... let's say that communicating or passing something on or trying to get others to look here helps you learn a lot" (C2, R1_5.3).
Broad impact. Interest elicited by national and institutional policies and in the centre's development	"I mean, something that started, you know, typically with let's get some good practice using ICTs for the course, that was a long time ago, and now we haven't enough paper to write down all the good practices that are done with ICTs" (C7, R11_5.3).

Evidently personal positioning reflects strong internal motivation to seek resources and establish personal and professional relationships that lead to formal, non-formal and informal learning. In particular, the semantic density in all the nine outstanding teachers' discourse (34 of 102 corpus references) reveals their passion and curiosity, but also their high motivation to search for micro-contexts in their institution that allow the configuration of advanced practices.

3.2.2. Factors influencing learning ecology development

The educational centres act as contexts where negative and positive historical and current aspects become facilitators or obstacles to the development of the learning ecology. Our analysis revealed the existence of training needs that go beyond institutional offerings, which explains why outstanding teachers tend to diversify their own training channels and activities.

The semantic density in relation to this topic would suggest that all the participating outstanding teachers have similar perceptions regarding facilitators and obstacles (20 and 22 of 47 corpus references to facilitating and blocking factors, respectively). Although they mention historical factors, these are less frequent than current, contextual facilitators and obstacles. Negative aspects are generally more related to the national regulatory context than to specific centres, whereas, in relation to positive factors, the concrete actions that centres have set in motion to facilitate the autonomy of their outstanding teachers are noteworthy. Table 3 reproduces some of the comments of the interviewees on this topic.

Table 3. Factors Influencing the Development of the Learning Ecology

Types of Factor	References
Blocking factors	"To begin with, there must be change because it turns out that we evaluate by skills, because we are told that we must have the skills and such, but there are areas. They tell you to work on skills, but the diagnostic test is a memory test of isosceles and equilateral triangles" (C 7, R1_4.1.2). " The training is poor, increasingly badly paid and courses are often cancelled, and I could offer myself to do a course in school X, and this other school could send an expert in another area to come here to give a talk about something else, because the training is very bad now" (C1, R1_4.1.2).
Enabling factors	"They asked me for that and also to be ICT coordinator, doing management. Then I started seeing that there were not only possibilities for technology applied directly in the classroom but also the issue of how we get technology to enter the classroom" (C2, R2_4.2.2). "The truth is that we are very well placed. Two years ago, they started using iPads instead of books in all the secondary schools. We have AppleTV, laptops, digital boards. We have all the resources we need" (C5, R2_4.2.2).

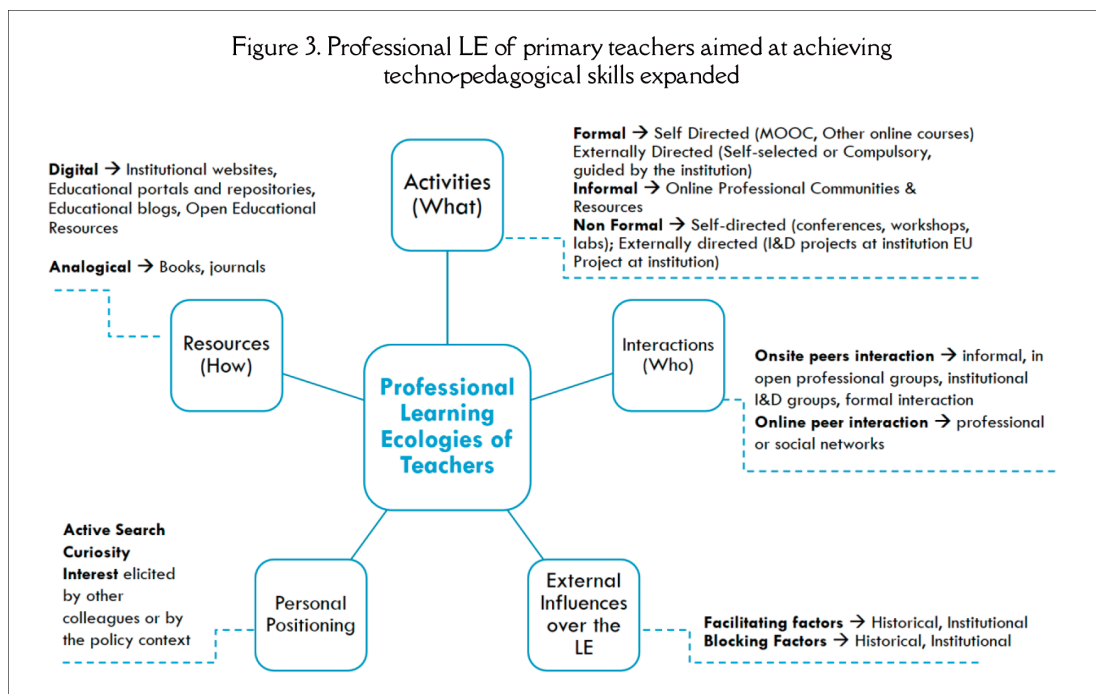
Thus, despite strong historical and contextual constraints, these outstanding teachers generally find support in their centres for their autonomy, in the activation of courses requested by them, time off for training, the facilitation of regular meetings and of ICT projects, the establishment of minimum bases for ICT use, assignment of roles as experts (bring-your-own-device, robotics, programming skills), etc.

In sum, there is a continuous synergy between the characteristics of these teachers and their contexts that stimulate, support and promote their positive and proactive attitudes towards the integration of ICTs in the classroom. Cross-fertilization between teachers of ICTs and other project types (e.g., interdisciplinary approaches, empowered scientific and socio-cultural activities in the community, etc.) generates rich ecosystems in which the specific professional learning ecology finds fertile ground.

4. Discussion

Our results paint a rich picture of the potential LE of teachers within the specific domain of educational technologies in primary schools. However, a number of factors that support the development and maintenance of LE emerged in our analysis that represent a step further in the understanding of professional learning.

Previous learning ecology concepts have emphasized structure (activities, interactions and resources). Emerging from our interviews, however, were two additional factors without which LE could not be sustained: personal positioning factors and the historical and contextual factors influencing learning ecology development. In the first part of our analysis, we observed that professional learning tends to stem from formal activities and is mostly driven throughout on-site relationships with colleagues and participation in institutional projects. External factors, however, evidently function as motivational cues for outstanding teachers to pursue as a pathway to developing their professional skills, for instance, engagement with digital resources and informal online communications as a means for ensuring relationship continuity through social networks. There is an evident inner motivation in these teachers that leads them to connect the external world with an internal ideal picture of how their professional practice should unfold. This hypothesis is further supported by personal positioning factors as supportive of the learning ecology architecture of activities, interactions and resources. If this inner motivation -reflecting the personality and lived experiences of the learner- are in place, then the teacher builds on a spirit of curiosity and passion for innovation, the active search for connections and reflexive practice. Not only do they consult the work of others to shape their own practice, they also have a developmental vision of their own practice context that, in time, implies taking on board national and institutional policies and guidelines. The outline of their LE is represented in Figure 3, where the initial conceptual map (Fig.2) was reorganized and expanded based on the coded discourse of our nine teachers.



5. Conclusions

Our study may advance the re-conceptualization of the constituting components of LE. The qualitative approach through in-depth interviews purported an enriched picture of LE by reorganizing and expanding the semantic nodes within the initial conceptual map obtained through the Delphi study (Romero & al., 2014).

In addition, a further discussion, which sets the stage for future research, outlines the profiling of outstanding teachers. According to our exploration, these teachers are people who:

- Actively seek training opportunities, taking more “traditional” courses as formal face-to-face activities, proposed by the institution, but also following a number of informal, online activities;
- They continue to expand their opportunities to learn through informal interactions in professional communities, where they might play a crucial role as resource developers or curators;
- Not surprisingly, they are active blog readers, with blogs emerging as the main resources selected by them. This aligns with the idea of seeking influential people, whose ideas bring new light to everyday practice.
- As for the new LE components identified in our research, we observed the importance of personal positioning against the context, with teachers that actively engage in innovations, triggered by a high sense of curiosity. Moreover, they understand which facilitating factors exist in their contexts of practice and use them as springboards for their practice, against the deep understanding of reluctant forces in the field of professional practice.

A further inquiry of these outstanding profiles may shed light on micro-factors in the contexts of professional learning (external) or on the personal features which could be mirrored by others in search for positive technological uptake within pedagogical practices.

Our findings have implications for both innovations in professional development and applied research. They suggest the need to identify other potential outstanding teachers in order to explore their creativity as an expression of their personal positioning towards institutional development. The process of discovery and support may be time-consuming, but ultimately, the identification of these teachers could lead to a creative domino process whereby other teachers that are less effective in addressing innovation draw on outstanding teachers’ best practices. This approach could be explored through applied research into school

management strategies, so that a common picture of the learning ecology structure could be generated through participatory meetings and raise awareness of the main components in model LE. Personal positioning and related factors could also be explored since, as has been emphasized in the professional self-regulated learning literature (Littlejohn, Milligan, & Margaryan, 2012), this type of self-awareness could also be the trigger for on-going development of individual professional learning approaches, with each teacher motivated to cultivate and enrich their own professional learning ecology. As for research, analyses of LE could progress to more systematic confirmatory studies using representative samples. Additional research could polish the model further and obtain some predictive insights into the factors influencing the development and configuration of LE. Moreover, design-based research could lead to the development of self-diagnostic tools to raise learners' awareness of how to configure their own LE.

Our study has a number of limitations, the most important of which is that, despite a rigorous snowball sampling procedure, nine teachers represent a small universe of practice. Our configuration of LE could reflect elements that are not representative of primary school teachers. Nonetheless, the findings that characterize our outstanding teachers may help boost changes in their professional development. Therefore, our research, aimed at improving primary teachers' professional development strategies and overall professional learning, can be considered exploratory, contributing to further understanding of lifelong LE.

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