Teacher perspectives on ICT: A learning ecology approach

Antoine van den Beemt [a, *], Isabelle Diepstraten [b, c]

[a] *Eindhoven School of Education, Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands*
[b] *WeltenInstitute, Open University the Netherlands, P.O. Box 2960, 6401 DL Heerlen, The Netherlands*
[c] *Fontys University of Applied Sciences, Child and Education Academy, Eindhoven, The Netherlands*

A R T I C L E   I N F O

A B S T R A C T

This paper aims to contribute to teacher professional development (TPD) on ICT by exploring socio-cultural factors such as places, activities and relevant others, which constitute teachers' complete sets of contexts that provide opportunities for learning. This set of contexts is defined as "learning ecology". An important aspect of learning ecology is the development over time of how people cope with their learning environment. By result, analysing a person's learning ecology entails investigating the start and development of teachers' ICT use, related beliefs and attitudes, and relevant others influencing this development. Our research question reads: What lessons can be learnt for TPD on ICT from knowledge of teachers' learning ecology, with an emphasis on sparks of interest, beliefs, relevant others, and pathways of participation? This question is answered by biographical interviews that in a narrative manner map life trajectories related to ICT. Following existing research we opted for ICT minded and non-ICT minded pre-service and in-service teachers. The results show the importance of a number of TPD aspects: siblings and friends for the ignition and development over time of types of ICT-use, the importance of informal learning approaches and development of bridging social capital, and the creation of ICT rich social environments. The biographical interview may serve as a tool to find elements in the narratives such as reflection on ICT use, learning trajectories and resulting pedagogical beliefs, which foster TPD.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Recently we witness a call for Teacher Professional Development (TPD) on educational use of information and communication technology (ICT) in both research and practice. This call is powered by amongst others, a push of technologies such as tablets, interactive writing boards or online information systems (Twining, Raffaghelli, Albion, & Knezek, 2013). Furthermore, this call is supported by intensive yet diverse use of these technologies among young people (Van den Beemt, Akkerman, & Simons, 2011), and the persisting promise of ICT for education (Laurillard, 2008). This need for TPD goes together with the professional uptake of ICT by teachers lagging behind requirements from everyday practice related to computer technologies (Mumtaz, 2000). The resulting complex demands force teachers to relate to ICT (Twining et al., 2013); a situation they often feel uncomfortable with and that urges TPD on this technology (Kreijns, Van Acker, Vermeulen, & Van Buuren, 2013).

* Corresponding author.
  E-mail addresses: a.a.j.v.d.beemt@tue.nl (A. van den Beemt), i.diepstraten@fontys.nl (I. Diepstraten).

One strain of research in the context of TPD on ICT reveals teachers' pedagogical beliefs and early experiences as factors in the adoption and use of these technologies (Ertmer, 2005). It is argued that those beliefs and experiences are influenced by broader socio-cultural factors (Twining et al., 2013), such as schooling or family structure. This paper is an effort to add to effective ways for TPD by exploring socio-cultural factors that affect teachers' use of ICT. Understanding these socio-cultural factors influencing attitudes and use of ICT is important because it supports (re-)design of work environments that enhance professional learning (Lohman, 2006).

1.1. Teacher professional development on ICT

This paper defines teacher professional development (TPD) as the process by which teachers acquire knowledge, skills, and values (Hoyle & John, 1995) related to a specific domain, in this case educational use of ICT. This often-implicit process (Hoekstra, Beijaard, Brekelmans, & Korthagen, 2007) is influenced by teachers' preferred learning approaches, such as imitation, peer learning or trial and error (Cassidy, 2004). The effectiveness of these learning approaches can be associated with 'social capital', the benefit from connections with others that may provide useful information or emotional support (Putnam, 2000).

Increasingly TPD is seen as an active, lifelong process characterized by informal, practice-based, reciprocal learning (Clarke & Hollingsworth, 2002; Scheerens, 2010). Specifically for TPD on ICT pedagogical beliefs and experiences (Ertmer, 2005), perceptions and attitudes (Twining et al., 2013) play a role. In this context, research shows teachers' uptake of ICT to be related to available resources, rewards, and a supportive and collegial school culture (Agyei & Voogt, 2014; Mumtaz, 2000; Uluyol & Sahin, 2014). Furthermore, other factors influencing ICT uptake are self-efficacy of teachers (e.g. Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Jamieson-Proctor, Burnett, Finger & Watson, 2006; Teo, 2015), and authentic learning experiences outside school (Valtonen et al., 2015). Similar to preferred learning approaches, teachers' ideas about curriculum and instructional practice influence their educational use of ICT (Ertmer, 2005). Teachers appropriate specific types of ICT according to their knowledge and pedagogical beliefs (Pepin, Geudet, & Trouche, 2013). However, this appropriation is not a unidirectional relation since the possibilities and limitations of the applied tools (affordances) shape the teachers behaviour, and in turn, the tools are shaped reciprocally by teachers (Remillard, 2005).

1.2. ICT minded and non-ICT minded teachers

Diversity in teachers' use of learning resources leads to diversity in giving substance to TPD, and to diversity in beliefs and attitudes related to ICT use (Twining et al., 2013). Research shows that teachers who display pedagogical attitudes directed towards lifelong learning, also make intensive educational use of ICT and feel more confident about their ICT competencies compared to other colleagues (Voogt, 2010). Other studies show a relation between, amongst others, high levels of self-efficacy, open-minded and explorative upbringings, positive beliefs and attitudes toward ICT and high innovation mindedness of teachers (Thurlings, Evers, & Vermeulen, 2015). Starting from the idea of a relation between self-efficacy, learning experiences, relevant others, beliefs, attitudes and adoption of ICT, we interpret this characterization of teachers as a difference between ICT mindedness and non-ICT mindedness. We infer that ICT minded teachers show higher levels of open-mindedness, self-efficacy, beliefs and attitudes compared to non-ICT minded teachers.

1.3. Learning ecology

The scope of our exploration includes school and out-of-school places, people and activities. This complete set of contexts found in physical or virtual spaces that provide opportunities for learning, is also defined as 'learning ecology' (Barron, 2006; Bronfenbrenner, 1979). An important aspect of learning ecology as a concept is the development over time of how people make use of learning resources, for example to obtain ICT skills. Bronfenbrenner (1979) while explaining the concept, explicitly refers to the development of competences to make use of those resources. Furthermore, learning ecology allows for a systemic perspective, including all life domains and associated beliefs (Looi, 2001). By result, analysing a person's learning ecology in this context entails investigating the start and development of teachers' ICT use, related beliefs and attitudes, and relevant others influencing this development.

This approach raises the issue of what methods deliver useful insights when analysing a person's learning ecology. How can the sparks that ignite interest for and first use of specific types of ICT, and the subsequent development ('pathways') of this use be mapped? To answer these questions we need to search for ways to chart changes in a person's learning ecology, which could be useful for advancing theories of learning and have practical applications for assessing the productiveness of educational interventions related to TPD (Barron, 2006). Barron (2006) brings the work by Bronfenbrenner (1979) on learning ecologies into the context of ICT use by proposing a research agenda. This research agenda, evolving around first experience, development and learning approaches related to ICT, might be a possible solution to our questions. Could accounts of the three aspects, first experience, development and learning approaches, be a fruitful approach for mapping ignition and pathways of ICT use? Because surveys lead to a snapshot, could for instance stories of life experiences resulting in narratives be a solution? Subsequently, could the difference between teachers in ICT mindedness guide our exploration of narratives of first experiences and development of ICT use?

1.4. Narratives

Narratives of life experiences, for instance related to ICT use, imply telling stories, and interpreting and retelling the past from the perspective of the present (McCormack & Pamphilon, 2004). Narratives thus provide both narrator and audience with an image of a person's learning ecology: Where were you? What resources were available? Moreover, how were you able to use them? Narratives of life experiences show the narrator's social space: the whole of a person's patterns of social relations and forms of participation (Elchardus & Glorieux, 2002; Van den Beemt et al., 2011).

Charting changes in a person's learning ecology requires instruments that do justice to narratives, by showing how social relations and participations structure someone's sense of space to act. Sustaining coherent yet continuously revised biographical narratives is argued to be part of (professional) identity (Giddens, 1991). In our case, this means that reflecting on ICT use is part of teachers' professional identity (Diepstraten & Van den Beemt, 2013; Diepstraten, 2006). The resulting biographical narrative charts a becoming, defined both by and with community and practice. Accordingly, "there is a profound connection between identity and practice" (Wenger, 1998, p.149).

By mapping a person's learning ecology through narratives, we aim to describe and motivate learning trajectories. By result, using narratives ties in with developments in society that require learning in non-school contexts and combining learning from formal, non-formal and informal contexts (Colley, Hodkinson, & Malcolm, 2003). This perspective on learning fits recent changes in learning theory, which reflect a shift to learning as a horizontal process between multiple social spaces (Akkerman & Van Eijck, 2011). Learning as a horizontal process implies crossing boundaries between life domains and social spaces where different meanings and social practices are at work. In our case, this means possible applications of outside school (ICT related) experiences in an educational context. Because the goal is to contribute to TPD on ICT we strive for not only to collect data, yet also to find elements in the narratives that foster TPD. These elements for instance can consist of reflections on the position of ICT in a persons learning ecology, participations and related learning trajectories, and what this position means for professional behaviour.

Our effort to find ways to investigate teachers' ICT use and related beliefs (Voogt, 2010) follows horizontal approaches to learning, perceiving TPD as an active process grounded in social space, with specific attention for storytelling and timeline (Bornat, 2008) and distinguishing between direct/formal and indirect/informal forms of TPD. In line with existing research, we make a distinction between pre-service and in-service teachers (e.g. Teo, 2015; Valtonen et al., 2015) and include out of school ICT use (Meneses, Fabregues, Rodriguez-Gomez, & Ion, 2012). A query of existing empirical research on ICT related TPD in terms of first experiences, development of ICT use, and approaches to learn to use ICT, showed an existing gap of knowledge on the origins of teachers' beliefs, attitudes and adoption of ICT.

2. Research question

Our discussion of existing literature leads to the following research question: What lessons can be learnt for TPD on ICT from knowledge of teachers' learning ecology, with an emphasis on sparks of interest, pathways of participation, and learning approaches?

This research question reflects the research agenda proposed by Barron (2006), which induced the three themes we focused on in the narratives of respondents:

1. *Sparks of interest* — Accounts of the kinds of places, activities and relevant others that influence first experience and that spark and sustain interest in learning about and using ICT,
2. *Pathways of participation* — Accounts of pathways of participation in ICT activities as a result of how learning opportunities are created and developed,
3. *Learning approaches* — Accounts of respondents' approaches to learn to use ICT, with special attention to the formal—informal learning relations, and boundary crossing. Exploring learning approaches at this broader level of analysis may serve as an important design resource and contribute to theories of informal learning.

3. Methodology

3.1. Biographical method

Instruments under the umbrella of the biographical method, such as narratives, allow people to tell their own story, which includes re-telling, changing and providing different meanings (Bornat, 2008). For compiling narratives on ICT use, biographical interviews (Newton, 1995) were held with both pre-service and in-service teachers. The interviews consisted of several steps. First, the respondents were asked to chart their social space (Van den Beemt et al., 2011) by naming important places where they currently use ICT. Examples of these places are home, school, work and sports club. Second, respondents had to name all types of ICT applications used in each of these places. Third, respondents ordered all named ICT applications on a timeline (Sheridan, Chamberlain, & Dupuis, 2011), based on their first use by the respondent. This timeline then was expanded into the past, until the respondent's first encounter with ICT was reached. Fourth, from that point on respondents

were asked to tell about the location and context, and relevant others influencing this first use and subsequent developments (Barron, 2006) into the present. This way, respondents organized objects and events into a meaningful whole, and enabled to see consequences of actions over time (Bruner, 1986). Respondents also explained how they learnt to use the mentioned applications (Van den Beemt, Akkerman, & Simons, 2010). Fifth, respondents were encouraged to narrate about their learning approaches throughout their lives and their educational uses of ICT and beliefs (Voogt, 2010). This resulted in extensive life stories related to ICT use.

Although the biographical interview is an intervention, it allows for respondent's active self-steering. The interview stimulates consciousness and reflection and is a starting point for change (Chase, 2005), which causes respondents to experience agency: a view on their acting options and possibilities for self-development (Eteläpelto, Vähäsantanen, Hökkä, & Paloniemi, 2013). From the perspective of the researcher, biographical instruments are very well applicable for mapping concepts such as agency or boundary crossing between life worlds (Heinz & Krüger, 2001; Hubbard, 2000). Biographical interviews deliver subjective data, which means accounts of life trajectories, biographical meaning of life domains, of past and future, which are coloured by previous experiences and future expectations. Those subjective aspects are inherent to, yet also aim of biographical research.

3.2. Respondents

Biographical interviews were conducted among 18 pre-service teachers of two teacher-training institutes, and 18 in-service teachers in the Netherlands (see Table 1). Of both groups, 10 respondents were active in primary education, and 8 respondents in secondary education. The respondents were selected by means of purposeful sampling. This method implies an active search for cases within categories, with the purpose of a better understanding of behaviour. This means that both groups consisted of nine ICT minded and nine non-ICT minded respondents. It was left to the respondents to determine whether they were ICT minded or not. In line with biographical research, the perception of this characteristic itself was not judged or valued. However, the respondents were encouraged to explain their choice in terms of self-efficacy, learning experiences, beliefs, attitudes and adoption of ICT. These aspects of ICT mindedness were derived from literature (see also par. 1.2) and showed similar responses within all categories of respondents. For the identification of meta-themes in relatively structured qualitative data, at least six participants per homogeneous group have been found to be sufficient (Guest, Bunce, & Johnson, 2006). During the interviews, the respondents' attitude towards ICT was verified by means of questions from an existing instrument (Voogt, 2010) about educational uses of ICT and related beliefs. The respondents group counted 64% females. Teaching experience of in-service teachers varied from 1 to 38 years, with an average of 10.2 years. Teachers were recruited from schools that collaborate with the teacher training institutes and our research institutes.

3.3. Procedure

All interviews were conducted in-person; were audio recorded and lasted on average 60 min.

These interviews were conducted at the pre-service teachers' educational institution and at the in-service teachers' schools. The researcher was aware of the respondents' predisposition towards ICT, which guided the themes to be discussed. The interviews were held in Dutch.

3.4. Data analysis

Quality checks in biographical research are referred to as 'levels of credibility' (Guba & Lincoln, 1998). These quality checks consist of three conditions, which were followed during this study: reaching for transparency, making findings plausible, and feedback from respondents.

The condition transparency refers to archiving all steps in the research process, which in this study consisted of a start document, raw data and field notes, processed data and a process document (Akkerman, Admiraal, Brekelmans, & Oost, 2006). All documents were created by both authors. The start document encompassed the problem, the theoretical perspective, accounts of biographical methods and expected results. The raw data consisted of audio-recorded conversations, transcriptions of interviews and written records. The raw data were then summarised into a content analytic summary matrix (Miles, Huberman, & Saldaña, 2014), consisting of the respondents' answers to questions and probes, and additional remarks.

Table 1
Respondents.

Teachers	N	Gender (female)	Age (means)	Experience (means)
Pre-service teachers	18	13	22.4	—
ICT minded	9	4	22.3	—
Non-ICT minded	9	9	22.4	—
In-service teachers	18	10	39.0	10.2
ICT minded	9	5	37.0	8.9
Non-ICT minded	9	5	41.0	11.6

This matrix was again processed into a second content analytic summary matrix, consisting of codes and themes. The process document covered a systematic report on how data were gathered and analysed.

The second condition is to make the findings plausible for the public by means of inter-researchers triangulation, using explicit concept and theoretical notions to analyse the data that are illustrated with citations of the respondents (Guba & Lincoln, 1998). For this purpose, analyses of the biographical interview data followed an open, explorative research design to identify themes. This design consisted of a combination of content analysis and constant comparison (Leech & Onwuegbuzie, 2007), which implies switching between literature on relevant concepts and empirical explorations of the gathered data. To gain more theoretical insights on (the relation between) concepts and themes, this process continues until sufficient saturation of those concepts and themes is reached. In order to do so, transcription of the audio-recorded interviews was followed by vertical analysis of the data (Strauss & Corbin, 1998). Close reading of all transcribed interviews resulted in indicator profiles and reflectional remarks. The indicator profiles served as input for a horizontal analysis to discover key indicators and the range of variation (subtypes) for concepts such as beliefs, relevant others and participations. Relations between concepts and respondent characteristics, such as age or gender, were explored. Analytic summary tables were reciprocally checked by both authors, which lead to no major inconsistencies in interpretation to be found. This process resulted in a second matrix containing the final data for analysis. This second matrix contained the codes assigned to the cells in the original content analytic summary matrix, thus representing a further condensation of the data. This second matrix was also used for a member debriefing, which involved presenting the results to respondents. This member debriefing is part of the third condition, which implies that respondents have to recognize the results. Furthermore, to satisfy this condition, reflection on the interview and interview context was applied as a communicative validation instrument at the end of all sessions. This resulted in respondents expressing to recognize the value of the exercise, because it made them rethink past experiences and place those experiences in the context of educational use of ICT and TPD.

4. Results

To answer our research question, this section first presents accounts of places, activities and relevant others that spark interest in using ICT (4.1). Second, we focus on the development of pathways of ICT use (4.2), followed by accounts of learning approaches related to ICT (4.3). The results are presented as synthesized findings per theme. Together with transcripts from the data that illustrate the findings, this results in an image of the respondents' narratives. The complete set of 36 respondents consisted of pre-service teachers and in-service teachers, both at primary education level and at secondary education level. These four groups each consisted of ICT minded and non-ICT minded respondents. Where applicable, the results explore differences between these eight sub-groups.

4.1. Sparks of interest for ICT use: place, activity and relevant others

For most respondents, both ICT minded and non-ICT minded, the first ICT experience took place on a (often standalone) desktop computer at home or at a friends place.

> "We had a PC at home, and one day my uncle brought us a video football-game. And from that moment on I played together, with my brother." (T., ICT minded student, male, 21yrs)

Two respondents mentioned school, and one older ICT minded primary education teacher reported the workplace as location for their first ICT experience. This specific teacher named as relevant others ICT minded colleagues and ICT co-ordinators, whom he would meet in the computer shop. Parents, brothers, sisters and friends were mentioned as relevant others for their first ICT experience by the students and the ICT minded teachers of both levels. The non-ICT minded teachers only mentioned males: (older) brothers or a partner. Some ICT minded respondents explicitly named their mothers as significant other: mothers wanted to learn how to use the computer, and by assisting them, these respondents learnt about the technology as well.

> "My mother had to learn how to use the computer for typing. And I helped her, and so we learned together about how it all worked." (D., ICT minded student, male, 24yrs)

Parents acted as facilitators when they had a computer at home. Some respondents reported absence of a computer at home, which influenced the location of their first experience: a friend's home or school. In the stories of all ICT minded students primary education was perceived as stimulating for their ICT use. This contrasts with the non-ICT minded students who reported primary education as inhibiting rather than stimulating ICT use.

> "At home we had a computer that I could use, for example to make a report for school. But […] at school they tried to avoid computers as much as possible, and not, like today, that they want children to use it." (A., non-ICT minded student, female, 23yrs)

Experiencing the "real computer use" is reported to take place together with friends or siblings: for instance playing video games, or learning foreign vocabulary. School was the place to talk with others about these new fascinations, which ignited the spark of interest for ICT use.

"And then friends at school told me about games, such as Commander Keen or Pong, and then I wanted to try that. And asked my parents to buy it." (J., ICT minded teacher, male, 25yrs)

Some students and respondents who considered themselves late in adopting new technologies mentioned social media, such as MSN as their initial applications.

"The teacher at school showed us how to use tools, such as MSN. And then I was allowed [by my parents] to make an account, and from that point it went on using different tools" (C., ICT minded student, female, 22yrs).

All respondents, including the non-ICT minded students of both educational levels, mentioned the first experience as both exciting and frustrating. Excitement flourished when households connected to the Internet. Yet, this also caused frustration because in the early 90's of the previous century, analogue phone lines prohibited simultaneous phone calls and Internet use. This situation made parents limit the online time of their children to prescheduled moments. Negative experiences, such as malfunctioning floppy disks or Internet connections via a slow modem were mentioned as well. However, the narratives showed that these negative experiences were romanticised in a laughing manner.

"And then I was allowed one hour per day, I could play games on the computer or go on the Internet. But that had to be between seven and eight, because then our family knew that they could not call us, because the computer went on the same cable as the phone. It is funny to think about that now." (D., non-ICT minded student, female, 21yrs)

4.2. Pathways of participation: place, activity, relevant others

The students mentioned going into secondary education as a turning point when they enrolled in "computer class", which led to "more serious ICT use". The introduction of the Internet made games more popular, as well as new applications and social media sites, such as MSN and the Dutch equivalent of Facebook named 'Hyves'. In this process adults were explicitly mentioned as facilitators or initiators for ICT use, however their role decreases as the respondents' ICT use developed over time. Peers and informal learning are reported to be the central notions in the development of ICT use, for both ICT minded and non-ICT minded respondents. All female non-ICT minded respondents mentioned males as relevant peers for development in ICT use: fathers, partners or handy brothers.

"My brother got a computer, a Commodore 64, … and he wanted me to learn how to type. And when he convinced me to type something, I often would press the wrong button, and then everything was gone. That was not really motivating for me." (I., non-ICT minded teacher, female, 51yrs)

Especially students reported peer influence as motivation for using new applications. Several respondents felt the risk of losing friends when they would not turn to the newest social media applications. Respondents reported use of the mainstream tools and applications, such as widely popular games (Tetris, Mario), text editors, search engines and web browsers. Their stories revealed a gradual transition from offline to online ICT use, from MSN to social media platform Hyves and then to Facebook and Twitter.

"When I was 7 or so, my father brought home a game for the PC. […] And then when I was 10, we got Internet access, and then I heard of MSN. […] When I went into secondary education I started with social media like Sugababes and Hyves. […] Now I use Facebook, Whatsapp and Twitter." (C., ICT-minded student, female, 22yrs)

Our ICT minded students were not necessarily early adopters. They often mentioned to start using interactive writing boards or social media during the teacher training minor course on learning with ICT. These ICT minded students appear to be early adopters only in comparison to their (non-ICT minded) fellow students and teachers, rather than being really ahead of the majority.

4.3. Learning approaches: awareness of relations and participations

Work related ICT applications, such as text editors, are reported to require more knowledge building and exercise, and are thus associated with formal learning. For this type of tools teachers reported to feel in need of a course or training. Our respondents tried to use educational ICT tools on their own initiative, or because they were inspired by colleagues.

"I learned how to use Gynzy [an interactive learning environment] on the digiboard from a pre-service teacher who did her apprenticeship in my class. She learned about it during teacher training, and inspired me to explore the possibilities myself". (F., ICT-minded teacher, female, 27yrs)

All other accounts of ICT use can be characterised by learning through imitating peers, in combination with individual trial-and-error strategies. This holds for both ICT minded and non-ICT minded respondents.

"I learned to play games just by trial and error. Some levels I've started maybe 100.000 times. And when I was really stuck in a level I would ask friends at school to show me how to do it. And then I would imitate them. I never ever read a manual." (J., ICT-minded teacher, male, 25yrs)

Peer learning with likeminded people alone ('bonding social capital') appears to be insufficient for increasing progress in ICT skills: encounters with *different* people and experiences were found in all stories of ICT minded respondents ('bridging social capital'). For example, for the older ICT minded primary education teacher 'different people' referred to "a network of computer nerds" and early adopters that participate in several networks and thus update each other on new developments. He explained how "in the early days of ICT computers [were] technical", focused on programming tools and setting up in-frastructures. Therefore, he felt to be bound to a subculture of "male computer nerds". Encounters with 'different' people were absent from the non-ICT minded respondents' narratives. They often recited to "wait and see until a tool proved helpful or necessary to do their work", and to only explore new tools with a clear urge to do so.

Among ICT minded respondents the open view on possible uses leads to an informal learning approach of trial and error and asking peers when needed. However, ICT minded respondents used the assistance of peers to develop their knowledge and independent use of ICT. In contrast, non-ICT minded respondents appeared to develop a dependent attitude.

> "When I didn't understand, which was often, I asked my brother to help me. [....] And then I got married. My husband was a computer-nerd, so he could help me quite often. [....] At school when I do not know how to get for instance the beamer or projection board to work, I will call the ICT-assistant." (L., non-ICT minded teacher, female, 52 yrs)

This goes together with non-ICT minded respondents often mentioning possible dangers of ICT-use and expressing fear of students having more knowledge that they could use to their advantage.

> "Well, especially because the children in my class often work with those machines, and I notice that they grasp those tools better or quicker than I do. […] And then I ask them to Google something, and then, you know they end up on sites that you do not want to show in class …. You know, sex sites." (C., non-ICT minded teacher, female, 38yrs).

The lagging attitude of non-ICT minded respondents contrasts with the ICT minded students, whose stories showed more awareness of development, turning points and significant others in both their ICT use and their general life trajectories. This awareness was also found in the accounts of ICT minded teachers, who mentioned to always look for possible educational uses of tools they encounter, even in spare time.

> "Even in my free-time, when I see a new tool, or hear about something, I always think about possible uses in class" (J., ICT-minded teacher, 25yrs)

Mobile devices being present everywhere enhance blurring of life domains (i.e. work versus leisure time). In response to this development, in-service teachers expressed to feel an urge to separate ICT use at work from ICT use for leisure. One way to deal with this situation was a reported sharp distinction on functions, for instance through multiple social media accounts: one Facebook account to communicate with friends, and another one to share photographs of class-experiences with parents and colleagues. Non-ICT minded respondents mentioned two types of functions: social media and smartphones to communicate, relax and share with peers, and "all other tools, such as text editors, spreadsheets and laptops" for work purposes. This contrasts with ICT minded respondents who pointed out the educational value of ICT, and the communication function of social media to inform both parents or friends and students.

> "Social media are for sharing, functional tools are for capturing, editing and a repository" (F., ICT-minded teacher, female, 27 yrs).

At the end or after the interview most respondents mentioned how reciting their life stories related to ICT brought back memories of applications, often games, they used in the past. They talked of renewed inspiration and starting points for relating educational uses of ICT to their own interests.

> "It was good to reflect on my own use, and the way I learn ICT tools. I will talk to my colleagues how they make use of the students' ICT knowledge." (C., non-ICT minded teacher, female, 38 yrs)

> "Funny how I seem to have forgotten that I used to play Simcity a lot. …. I might even give it a try in class." (J., non-ICT minded teacher, female, 50 yrs)

5. Discussion

The sparks of interest for ICT applications ignited outside school for our respondents. By result, their interests are often not school related (see also Van den Beemt et al., 2010). School is reported to be the location for reflection on ICT use and exchanging tips and tricks. The sparks of interest were influenced by the state of art of technology. Age plays a role here, because the older respondents recall pre-Internet times. Students often mentioned their first experiences with the Internet. It appears that ICT minded respondents were able to set the limitations of new technologies aside, such as slow connections on analog lines. For non-ICT minded respondents these limitations might have been the foundation for a lifelong aversion to technology, as is shown by their narratives in which they emphasize negative experiences. The subsequent pathways of participation are influenced by peers and take shape in informal ways, either by trial and error or by "stealing" knowledge (Brown & Duguid, 1996) from friends. The learning approaches among the distinguished groups did not differ much; most often individual cognitive approaches (Putnam & Broko, 2000) could be discerned, rather than collaborative learning.

However, the uptake of ICT differed especially among ICT-minded and non-ICT minded respondents. In terms of the learning ecology perspective, both groups show different ways in which they were able to make use of available resources in their environment (Bronfenbrenner, 1979), such as parents, friends, available technology or other resources.

The interviews served as reflection on the respondents ICT uptake and the ways they learnt how to use these technologies. The results made clear how non-ICT minded teachers struggle to successfully integrate ICT in their lessons (Colwell, Hunt-Barron, & Reinking, 2013). Furthermore, the interviews often relighted forgotten memories, which in turn functioned as a reported inspiration for (renewed) ICT use in class.

Regarding our main question, because of the focused reflection on previous experiences, knowledge, skills and values, the interviews provided elements fostering TPD on ICT. The biographical method thus reveals teachers' fears, missing knowledge or skills in a constructive and non-confronting manner. This in turn relates to the indirect stimulus for TPD because the interview results may provide in jump-off points for (schooling in) educational uses of ICT.

Gathering data about places, activities and people relevant to people's life trajectories by means of biographical interviews is difficult and demanding of respondents (cf. Carmichael, Fox, McCormick, Proctor, & Honour, 2006). This was clearly seen when respondents were asked to recite their life courses related to ICT, and to simultaneously reflect on their development. The synthesized patterns in our respondents narratives were illustrated by means of citations to make visible the broad field of anser patterns. Because of the rather limited number of respondents per category, follow up research should be focused on a larger group of respondents. However, for this study we focused on the complete rich life stories in order to make a 'film' of learning ecologies, which was needed to come to theoretical understandings in a little researched domain. Furthermore, in future research, conducting the same research on students and professionals from other professions would be relevant in order to have different contrast groups to confront our data with. Notwithstanding these limitations, we do an effort to derive lessons to be learnt for effective TPD on ICT from our results.

5.1. Practical implications

The current attention for the informal character of TPD (Twinning et al., 2013), combined with the informal ways in which teachers reported to have learnt to use ICT, raises the question of effectiveness of formal ICT training. Focussing on informal forms of TPD on ICT relates to self-directed learning, which is argued as a means to increase self-efficacy among teachers (Teo, 2015). The importance of peer influence in igniting and sustaining interest in specific applications makes a case for organizing collaborative learning sessions where knowledge and experience are shared. However, collaborative approaches need guidance and structure provided by school management in order to be effective (Vaessen, Van den Beemt, & De Laat, 2014).

The sparks of interest ignited outside school by friends or siblings. Non-ICT minded teachers appeared less prone to transfer their ICT experiences to other domains, such as inside school. TPD on ICT might therefore look into specific sparks within the school domain. Another approach relates to the problematic uptake of ICT among non-ICT minded respondents, which implies that they have problems in making full use of their learning ecology (cd. Bronfenbrenner, 1979). Professional development for this type of teachers should therefore focus on developing skills to recognize and use resources in their learning ecology. This could also result in a change in learning approaches from individual trial and error and dependence on the expertise of others, to developing an understanding of the technology and independent use of ICT.

The reported role of friends and siblings relates to an important notion of educational research, which considers peer learning of increasing relevance for an uptake on ICT and media (Watson & Prestridge, 2003). However, peer learning only with likeminded people ("bonding social capital", Putnam, 2000) is not enough to get ahead of fellow students and colleagues. Crucial are encounters with radically different experiences via people who they did not meet previously ("bridging social capital"), for example, a new partner or a special "mentor" at work. ICT minded respondents appeared to be more open for this type of encounters, and to being engaged in new activities and to learn new things, compared to non-ICT minded respondents. Non-ICT minded respondents could thus be characterised as "followers" who act in response to their environment (Rogers, 1995). Our data showed that the pathways of ICT use in the non-ICT group is more coincidental, depending on what crossed their path and what types of ICT relevant others used. These results suggest the importance of role models as part of TPD. This can be supported with an ICT rich social environment to stimulate ICT development among teachers and students. Research in this context often emphasizes the importance of incentives and support, combined with a stimulating school culture (e.g. Mumtaz, 2000; Agyei & Voogt, 2014).

6. Conclusion

By using biographical interviews, this study explored socio-cultural factors related to beliefs and use of ICT, with the purpose to contribute to effective TPD on ICT. By applying learning ecology as perspective, we asked for places, activities and relevant others that played a role in the uptake of ICT, and examined preferred approaches for learning how to use these technologies.

Because of emerging pathways of ICT use, teachers develop beliefs in a process of enculturation. These early beliefs are the basis for teacher pedagogical beliefs: beliefs about teaching and learning (Ertmer, 2005). The stories of teachers in this study show that these beliefs develop alongside other professional beliefs. For example when teachers develop dependence on others, or when they are not encouraged to use ICT, they appear less open to innovation and less eager to look outside school for possible educational uses of ICT.

The experienced separation between domains, as reported in different functionalities and separation of social media accounts, might enlarge the power of ICT as a boundary object (Star & Griesemer, 1989). Because social media, such as Facebook are used with different functions, they are a means to connect multiple life domains. This is also expressed in ICT minded teachers' response when they come across a tool (in free time), to always look for possibilities to apply that tool in class. By result, these teachers experience a certain level of boundary crossing, because in this situation they interact with other domains (Suchman, 1994). Their tools function as objects that are 'plastic' enough to have multiple meanings in different domains (Star & Griesemer, 1989). For TPD this means that non-ICT minded teachers and students should learn how to deal with the "cognitive conflicts" which make them refrain from boundary crossing behaviour (Van Eijck & Roth, 2013). However, this is nuanced by research showing that people often think negatively about ICT tools associated with non-professional domains being used as learning tools in class (Van den Beemt et al., 2010). Therefore, it is important to show teachers how tools such as social media can be used in both leisure time and at work, thus elucidating their function as boundary objects.

Narration is considered an important means for professional development, for example in the shape of "value creation stories" (Wenger, Trayner, & De Laat, 2011) or, as in our case biographical interviews. The biographical method is fruitful to give an impulse to professional reflection and by result to stimulate professional development (Bornat, 2008). Our students and teachers' responded that the interview made them reflect on their practice, learning and professional behaviour. The biographical interview stimulated reflection on ICT use, learning trajectories and resulting beliefs. This reflection might be a source for belief change (Ertmer, 2005), which is considered an important prerequisite for teachers' uptake of ICT. Ertmer (2005) shows that belief change can be reached in several ways, via personal experience, vicarious experiences or social cultural influence through professional communities. Personal experience is represented by accounts of developing pathways of participation. Vicarious experiences are represented inspiration, imitation and by peers that function as role models. The social cultural influence relates to inspiring ICT rich learning environments. These aspects of belief change resonate with Barron's (2006) research agenda of accounts of ignition of interest and development of pathways, the role of relevant others, and the importance of learning approaches and rich environments. This makes a plea for the use of biographical methods for charting changes in a person's learning ecology and for teacher professional development on ICT.

References

Agyei, D., & Voogt, J. (2014). Examining factors affecting beginning teachers' transfer of learning of ICT-enhanced learning activities in their teaching practice. *Australasian Journal of Educational Technology, 30*(1).

Akkerman, S., Admiraal, W., Brekelmans, M., & Oost, H. (2006). Auditing quality of research in social sciences. *Quality & Quantity, 42*(2), 257–274.

Akkerman, S., & Van Eijck, M. (2011). Re-theorising the student dialogically across and between boundaries of multiple communities. *British Educational Research Journal, 39*(1), 60–72.

Diepstraten, I., & Van den Beemt, A. (2013). *Learning biographies as a means for teacher professionalisation on ICT use. Paper presented at the 2013 EARLI conference*. Munich, Germany.

Barron, B. (2006). Interest and self-sustained learning as catalysts of development: a learning ecologies perspective. *Human Development, 49*, 193–224.

Bornat, J. (2008). Biographical methods. In P. Alasuutari, L. Bickman, & J. Brannen (Eds.), *The Sage Handbook of social research methods* (pp. 344–356). London, UK: Sage.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press.

Brown, J. S., & Duguid, P. (1996). Stolen knowledge. In McL. H (Ed.), *Situated learning perspectives* (pp. 47–56). Englewood Cliffs: NJEducational Technology Publications.

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Carmichael, P., Fox, A., McCormick, R., Proctor, R., & Honour, L. (2006). Teachers' networks in and out of school. *Research Papers in Education, 21*(02), 217–234.

Cassidy, S. (2004). Learning styles: an overview of theories, models, and measures. *Educational Psychology, 24*(4), 419–444.

Chase, S. (2005). Narrative inquiry: multiple lenses, approaches, voices. In N. Denzin, & Y. Lincoln (Eds.), *The Sage Handbook of qualitative research*. Thousand Oaks: Sage Publishing Inc.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*(2002), 947–967.

Colley, H., Hodkinson, Ph, & Malcolm, J. (2003). *Informality and formality in learning*. Leeds: Learning Skills Research Centre.

Colwell, J., Hunt-Barron, S., & Reinking, D. (2013). Obstacles to developing digital literacy on the internet in middle school science instruction. *Journal of Literacy Research, 45*(3), 295–324. September 2013.

Diepstraten, I. (2006). *De nieuwe leerder*. Eindhoven: Fontys Hogescholen.

Elchardus, M., & Glorieux, I. (Eds.). (2002). *De symbolische samenleving. [The symbolic society]*. Tielt: Lannoo.

Ertmer, P. (2005). Teacher pedagogical beliefs: the final frontier in our quest for technology integration? *Educational Technology Research & Development, 53*(4), 25–39.

Ertmer, P., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: a critical relationship. *Computers & Education, 59*, 423–435.

Eteläpelto, A., Vähäsantanen, K., Hökkä, P., & Paloniemi, S. (2013). What is agency? Conceptualizing professional agency at work. *Educational Research Review, 10*, 45–65.

Giddens, A. (1991). *Modernity and self-identity. Self and society in the late modern age*. Cambridge: Polity Press.

Guba, E., & Lincoln, Y. (1998). Competing paradigms in qualitative research. In N. Denzin, & Y. Lincoln (Eds.), *The landscape of qualitative research* (pp. 195–220). London: Sage.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18*, 59–82. http://dx.doi.org/10.1177/1525822X05279903.

Heinz, W. R., & Krüger, H. (2001). The life course. Innovations and challenges for social research. *Current Sociology, 49*(2), 29–53.

Hoekstra, A., Beijaard, D., Brekelmans, M., & Korthagen, F. A. J. (2007). Experienced teachers' informal learning from classroom teaching. *Teachers and Teaching: Theory and Practice, 13*(2), 191–208.

Hoyle, E., & John, P. D. (1995). *Professional knowledge and professional practice*. London, UK: Cassel.

Hubbard, G. (2000). The usefulness of indepth life history interviews for exploring the role of social structure and human agency in youth transitions. *Sociological Research Online, 4*, 4.

Jamieson-Proctor, R., Burnett, P., Finger, G., & Watson, G. (2006). ICT integration and teachers' confidence in using ICT for teaching and learning in Queensland state schools. *Australasian Journal of Educational Technology, 22*(4), 511—530.

Kreijns, K., Van Acker, F., Vermeulen, M., & Van Buuren, H. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? The use of digital learning materials in education. *Computers in Human Behavior, 29*, 217—225.

Laurillard, B. (2008). *Digital technologies and their role in achieving our ambitions for education*. London: London Knowledge Lab Institute of Education, University of London. www.ioe.ac.uk/publications.

Leech, N. L., & Onwuegbuzie, A. J. (2007). An array of qualitative data analysis tools: a call for data analysis triangulation. *School Psychology Quarterly, 22*, 557—584. http://dx.doi.org/10.1037/1045-3830.22.4.557.

Lohman, M. C. (2006). Factors influencing teachers' engagement in informal learning activities. *Journal of Workplace Learning, 18*(3), 141—156. http://dx.doi.org/10.1108/13665620610654577.

Looi, C. (2001). Enhancing learning ecology on the Internet. *Journal of Computer Assisted Learning, 17*, 13—20.

McCormack, C., & Pamphilon, B. (2004). More than a confessional: postmodern groupwork to support postgraduate supervisors' professional development. *Innovations in Education and Teaching International, 41*(1), 23—37.

Meneses, J., Fabregues, S., Rodriguez-Gomez, D., & Ion, G. (2012). Internet in teachers' professional practice outside the classroom: examining supportive and management uses in primary and secondary schools. *Computers & Education, 59*, 915—924.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook*. London, UK: Sage Publications, Ltd.

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of Information Technology for Teacher Education, 9*(3), 319—342.

Newton, P. (1995). Some suggestions for the conduct of biographical research. *Journal of Adult Development, 2*(3).

Pepin, B., Geudet, G., & Trouche, L. (2013). Re-sourcing teachers' work and interactions: a collective perspective on resources, their use and transformation. *ZDM Mathematics Education, 45*, 929—943.

Putnam. (2000). *Bowling alone*. New York: Simon & Schuster.

Putnam, R., & Broko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1).

Remillard, J. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*(2), 211—246.

Rogers, E. (1995). *Diffusion of innovations*. New York: The Free Press.

Scheerens, J. (Ed.). (2010). *Teachers' professional development; Europe in international comparison*. Luxembourg: Office for Official Publications of the European Union.

Sheridan, J., Chamberlain, K., & Dupuis, A. (2011). Timelining: visualising experience. *Qualitative Research, 11*(5), 552—569.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, "translations" and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907—39. *Social Studies of Science, 19*, 387—420.

Strauss, A., & Corbin, J. (Eds.). (1998). *Basics of qualitative research* (2nd ed.). London: Sage.

Suchman, L. (1994). *Plans and situated actions*. Cambridge: Cambridge University Press.

Teo, T. (2015). Comparing pre-service and in-service teachers' acceptance of technology: assessment of measurement invariance and latent mean differences. *Computers & Education, 83*, 22—31.

Thurlings, M., Evers, A., & Vermeulen, M. (2015). Toward a model of explaining teachers' innovative behavior: a literature review. *Review of Educational Research, 85*(3), 430—471. http://dx.doi.org/10.3102/0034654314557949.

Twining, P., Raffaghelli, J., Albion, P., & Knezek, D. (2013). Moving education into the digital age: the contribution of teachers' professional development. *Journal of Computer Assisted Learning, 29*, 426—437.

Uluyol, C., & Sahin, S. (2014). Elementary school teachers' ICT use in the classroom and their motivators for using ICT. *British Journal of Educational Technology*. http://dx.doi.org/10.1111/bjet.12220.

Vaessen, M., Van den Beemt, A., & De Laat, M. (2014). Networked professional learning: relating the formal and the informal. *Frontline Learning Research, 2*(2), 56—71.

Valtonen, T., Kukkonen, J., Kontkanen, S., Sormunen, K., Dillon, P., & Sointu, E. (2015). The impact of authentic learning experiences with ICT on pre-service teachers' intentions to use ICT for teaching and learning. *Computers & Education, 81*, 49—58.

Van Eijck, M., & Roth, W. M. (2013). *Imagination of science in education: From epics to novelization*. Dordrecht: Springer.

Van den Beemt, A., Akkerman, S., & Simons, P. R. J. (2010). Pathways in interactive media practices among young people. *Learning, Media & Technology, 35*(4), 419—434. http://dx.doi.org/10.1080/17439884.2010.531395.

Van den Beemt, A., Akkerman, S., & Simons, P. R. J. (2011). Patterns of interactive media use among contemporary youth. *Journal of Computer Assisted Learning, 27*(2), 103—118.

Voogt, J. (2010). Teacher factors associated with innovative curriculum goals and pedagogical practices: differences between extensive and non-extensive ICT-using science teachers. *Journal of Computer Assisted Learning, 26*, 453—464.

Watson, G., & Prestridge, S. (2003). A networked learning community approach to sustain teacher ICT professional development. *Australasian Journal of Educational Technology, 19*(2), 227—240.

Wenger, E. (1998). *Communities of Practice: Learning, meaning, and identity*. New York: Cambridge University Press.

Wenger, E., Trayner, B., & De Laat, M. (2011). *Telling stories about the value of communities and networks: a toolkit*. Heerlen: Open Universiteit in the Netherlands.