International Journal of E-Learning & Distance Education
La Revue internationale de l'apprentissage en ligne et de l'enseignement à distance

ISSN: 2292-8588 **Vol. 36, No. 1, 2021**

Exploring Teachers' Cognitive Processes and Web-Based Actions During a Series of Self-Directed Online Learning Sessions

Pamela Beach, Elena Favret, and Alexandra Minuk

Abstract: This case study used screen-capture technology and a cued retrospective think aloud called the "virtual revisit think aloud" to understand teachers' self-directed online learning (SDOL) experiences. Three elementary teachers were involved in a series of in-depth, one-on-one SDOL sessions where they informally used the Internet for their professional learning. Nine think aloud transcripts and three interview transcripts were analyzed using qualitative methods. Additionally, nine 20-minute screen-capture recordings were analyzed using a time sampling observation analysis in which participants' web-based actions were tallied in 10-second intervals. The analyses led to four main themes related to participants' cognitive processes as well as overall trends of participants' web-based actions. Findings from this study provide preliminary insight into the feasibility and value of SDOL over time.

Keywords: online learning, teacher professional development, self-directed learning

Attribution 3.0 Unported (CC BY 3.0)

This work is licensed under a Creative Commons Attribution 3.0 Unported License

Explorer les Processus Cognitifs et les Actions sur le Web des Enseignants Pendant une Série de Sessions d'Apprentissage en Ligne Autodirigé

Résumé: Cette étude de cas a utilisé la technologie de capture d'écran et une réflexion rétrospective à voix haute, guidée, appelée "réflexion à voix haute lors de revisite virtuelle" pour comprendre les expériences d'apprentissage en ligne autodirigé (EALA) des enseignants. Trois enseignants du primaire ont participé à une série de séances individuelles approfondies de EALA au cours desquelles ils ont utilisé Internet de manière informelle pour leur apprentissage professionnel. Neuf transcriptions de réflexions à voix haute et trois transcriptions d'entretiens ont été analysées à l'aide de méthodes qualitatives. En outre, neuf captures d'écran de 20 minutes ont été analysées à l'aide d'une analyse d'observation par échantillonnage temporel, dans laquelle les actions des participants sur le Web ont été notées à intervalles de 10 secondes. Les analyses ont permis de dégager quatre thèmes principaux liés aux processus cognitifs des participants ainsi que les tendances générales des actions des participants sur le Web. Les résultats de cette étude fournissent un aperçu préliminaire de la faisabilité et de la valeur du EALA dans le temps.

Mots-clés : apprentissage en ligne, développement professionnel des enseignants, apprentissage autodirigé

Introduction

Online resources and learning opportunities have become a predominant mode of professional development (PD) for teachers (Parsons et al., 2019). The Internet is a space where teachers can informally engage with teaching material and collaborate globally to gain insight into educational issues and best practices (Marcià & García, 2016). While teachers report using social media, online learning platforms, and other Internet-based networks multiple times per week to obtain up-to-date information directly related to their professional practice (van Bommel et al., 2020; Visser et al., 2014), less is known about their decision-making processes and learning behaviors *during* their informal online navigations. This is particularly true in the Canadian context (Beach et al., 2020). Given the impact professional learning can have on a teacher's beliefs and practices, it is critically important to the teaching profession to understand how and why teachers select and use online resources and websites to inform their PD. The purpose of this exploratory study was to gain insight into the value of informal online PD by examining elementary teachers' cognitive processes and web-based actions as they engaged in a series of self-directed online learning (SDOL) sessions. As described in the literature review, the think aloud method generates direct data about the ongoing cognitive processes that occur during a task (Ericsson & Simon, 1984; 1993). Cognitive processes underlying decisions and behaviours are usually unobservable; however, the think aloud method makes monitoring these processes possible. The SDOL sessions were documented using screen-capture technology and the virtual revisit think aloud. The goal of the virtual revisit think aloud is to aid recall of original events and thought processes by using a screen-capture recording of participants' navigational experiences (Beach & Willows, 2017).

We begin this article with a discussion of the theory that frames this research: self-directed learning. We then turn to the literature on teacher professional development. We also discuss how think alouds, the study's main data source, can be used as a method for understanding teacher learning. The article continues with a discussion of the methodology followed by a discussion of the findings, including research and educational implications.

Theoretical Framework: Self-Directed Learning

This study is framed around theories related to self-directed learning (SDL). As a component of adult learning theory (Knowles, 1975; Tough, 1971), SDL is a complex process of independently seeking out and acquiring knowledge (Garrison, 1997). SDL is a highly individualized process with underlying supports in constructivism, an educational theory that emphasizes knowledge and understanding based on a learner's own experiences; the learner constructs and reconstructs knowledge based on their own interpretations of information (Simons, 2000). Individuals take responsibility for their own learning by choosing "what and how they use information in the process of meaning-making" (Morris, 2019, p. 638). SDL involves a range of cognitive activities and decision-making strategies, and fosters autonomy, choice, and self-initiative — essential characteristics of the successful adult learner (Knowles, 1975).

Garrison (1997) considers self-directed leaning "as an approach where learners are motivated to assume personal responsibility and collaborative control of the cognitive and contextual processes in constructing and confirming meaningful and worthwhile learning outcomes" (p. 18). In the context of online learning, a teacher who decides to view a demonstration video, for example, self-monitors their learning by being aware of their instructional goals while concurrently modifying and planning for their own classroom. Additionally, teachers take control of their learning by continuously

assessing and evaluating web-based information, including source features (e.g., website author) and the mode of information delivery (e.g., text, video). Teachers must critically evaluate information through their unique teaching lenses. Self-management, in turn, will help teachers determine whether a website is worth using and returning to again.

Online environments are conducive to SDL as they remove time and situational barriers. They provide opportunities for learners to interact with technologies in personally meaningful ways (Moore, 2016). Teachers' SDL is often intertwined with their instruction, making it "likely that what they learn will indeed influence and support their teaching practice in meaningful ways" (Putnam & Borko, 2000, p. 6). This situative perspective on cognition suggests knowing and learning is situated in physical and social contexts; learning is directly linked to real life situations (Putnam & Borko, 2000). Classrooms are situated in unique contexts that only the teacher and students know how to navigate (Trust, 2016). When provided the opportunity, teachers may seek out information and material online that directly relates to their classroom context (de Vries et al., 2014).

Literature Review

Teacher Professional Development and Learning

Teachers continuously engage in professional development (PD) throughout their career (Campbell et al., 2017; Canadian Teachers' Federation, 2014; Desimone, 2009). This is not surprising given that teaching is a highly complex professional responsibility and requires continuous learning to support diverse student needs across subject areas. Like their students, teachers need access to multiple and varied learning opportunities to become meaningfully engaged in their learning; there is not a "one-size-fits-all

approach" to PD and nor should there be (Campbell et al., 2017). Generally, professional learning activities can fall under two main categories: formal and informal PD. Formal PD has been described as "top-down professional development endeavors, initiated by schools, districts and government agencies" (Lantz-Andersson et al., 2018, p. 304); formal PD is often guided by a facilitator and usually revolves around a community of teachers who all share a common goal (Jurasaite-Harbison & Rex, 2010). Informal PD, on the other hand, is unique to each teacher; learning opportunities are more personalized since they are chosen by an individual with a particular goal in mind (Callanan et al., 2011). Lantz-Andersson et al. (2018) describe informal PD as a bottom-up initiative, often involving a group of practitioners or individuals who choose to seek out, share information, and delve into personally meaningful topics that are directly relevant to their teaching practice. Whether formal or informal, there is a general agreement on the key features of effective PD—learning opportunities incorporate research-based content; learning is collaborative and job-embedded; and learning is supported, sustained, and self-directed (Campbell et al., 2017; Darling-Hammond & Richardson, 2009).

These key features of PD align with the five stages of teacher learning proposed by Shulman and Shulman (2004) where the quality of the PD can provide a strong foundation for the process of learning. Vision, motivation, understanding, practice, and reflection are aspects that Shulman and Shulman (2004) describe as essential to the process of teacher learning. When PD incorporates these key features, teachers can more effectively move through the learning process. For example, as teachers use the Internet for their professional learning they might initiate their search for research-informed pedagogical information with a *vision* about their current students, teaching context, and instructional methods; their vision is intertwined and embedded within

their current practice. A teacher's vision is enhanced by their willingness to learn—an internal *motivation* drives a teacher's self-directed learning forward. The construction of knowledge and development of deep *understanding* via research-informed online resources contributes to meaningful *practice* that is uniquely connected to a teacher's experiences and learning goals. As teachers *reflect* on their learning and practice, new visions arise, and the cycle of professional learning is sustained and continuous.

According to Shulman and Shulman (2004), a teacher's practice is set upon a foundation of vision, motivation, and understanding. When this foundation has been established, a teacher can more easily consider a range of ongoing factors related to their practice, such as the design and adaptation of curriculum, classroom management, formal and informal assessments, and student diversity (Shulman & Shulman, 2004). A teacher's practice develops and has the potential to transform through ongoing reflection. As such, when teachers are conscious of their own understanding, performances, and dispositions, their capacity to learn is enhanced (Shulman & Shulman, 2004).

Informal Online Professional Development

Responses from a pan-Canadian survey by the Canadian Teachers' Federation (CTF) reported 64% of teachers were somewhat (34%) or significantly (30%) stressed by imposed PD activities (CTF, 2014). Barriers to formal PD were also reported, including lack of funds to cover costs and insufficient time to attend face-to-face PD. In this same survey, the majority of teachers (55.5%) reported having significant ability to exercise their professional judgment with regard to PD. Thus, it is critically important to provide teachers with opportunities to create their own learning experiences and take the lead in their professional learning.

Online environments provide a major source of informal PD (Marcià & García, 2016) where access to "just-in-time" learning resources and participation in local and global online networks during or outside their workday has the potential to expand opportunities for teachers' PD (Learning Forward, 2017). In their review of 52 studies that examined online teacher professional communities, Lantz-Andersson et al. (2018) found that informally-developed PD initiatives often involve accessible spaces for sharing and seeking out new ideas. Teachers are often motivated to use these informal online spaces because they are personally meaningful. Yurkofsky et al. (2019) echo this finding in their study, which examined teachers' perceptions of the value of online PD. The authors found that the teachers they interviewed valued new ways of interacting with others for resource sharing and ongoing professional support. Additionally, in a survey study conducted by Parsons et al. (2019) practicing teachers reported the main benefit of online PD was that it was personally relevant and accessible—online PD allowed teachers to work at their own pace and access materials at any time.

Along with teacher reports about their online PD experiences, researchers have examined how specific environments have impacted teachers' informal professional learning. Social media is one area of research that has gained attention in recent years. For instance, van Bommel et al. (2020) explored teachers' interactions and knowledge sharing in six established Facebook groups. The authors analyzed several hundred discussion threads through a coding technique and found two main types of knowledge exchange: transformation and transaction. Transformations involved sharing information and new understanding whereas transactions only included sharing information without any new understanding on the receiver's end. While new understanding and thereby learning were only found in some of the discussion threads, the authors concluded that social network sites like Facebook have the potential to be a

vehicle for organizing informal PD. This finding has been found by researchers investigating the effects of social media and other informal PD sites on teacher learning (Carpenter & Krutka, 2015; Krutka, Capenter, & Trust, 2016; Tour, 2017; Visser et al., 2014). Along with Facebook, Twitter (Carpenter & Krutka, 2015; Mullins & Hicks, 2019) and Pinterest (Shapiro et al., 2019) have become increasingly popular modes of informal professional learning for teachers.

Additionally, studies have examined how blogs and PD websites are used by practicing teachers as a source of their professional learning (Hall, 2018; Heo & Lee, 2013; Upitis & Brook, 2017). Blogs written by teachers can be trusted learning spaces where ideas and practices have been tried and tested by the authors themselves. Heo and Lee (2013) found that when teachers became blog writers, they had ongoing opportunities to share information based on their personal experiences, opinions, and knowledge. In turn, blog readers were able to construct new knowledge, reflect on ideas, and expand understanding (Heo & Lee, 2013). Hall (2018) explored how blogging worked to support teacher learning. Findings echo those of Heo and Lee where teachers in Hall's study were able to reflect on their shifting views of learning and instruction.

Think Alouds as a Method for Understanding Teacher Learning

Thinking aloud is a method for generating direct data about the ongoing cognitive processes that occur during learning (Ericsson, 2002). Based on the techniques of protocol analysis by Ericsson and Simon (1984; 1993), thinking aloud captures cognitive processes in real time and provides verbal reports of participants' underlying decisions during task performances (Ericsson, 2003). The think aloud method makes monitoring cognitive processes possible and provides useful information about online learning (Olmsted-Hawala et al., 2010).

Researchers have used several types of think aloud methods over the past several decades, including the concurrent and retrospective think alouds (e.g., Barzilai & Zohar, 2012; Damico & Balidon, 2007; Kuusela & Paul, 2000). During the concurrent think aloud, participants verbalize their thoughts aloud while they simultaneously complete a task. The retrospective think aloud, on the other hand, requires participants to think aloud after a task has been completed. While these two types of think alouds have been widely used, both have serious limitations: the concurrent think aloud increases cognitive load since two tasks occur at the same time resulting in a potential compromise to the task completion or the act of thinking aloud; the retrospective think aloud relies on the ability to recall decisions after a task has been completed resulting in lost or omitted data (Beach & Willows, 2017). As a result of these limitations, variations of the think aloud have been developed, including the virtual revisit. The goal of the virtual revisit think aloud is to allow participants to verbalize their thoughts by using a screen-capture recording of their navigations (Beach & Willows, 2014; 2017). Participants think aloud while viewing a recording of their online navigation immediately following a given task, thus avoiding the limitations of the concurrent and retrospective procedures. In the current study, the virtual revisit method allowed participants to think aloud about their teaching practices and learning strategies and provided comprehensive reasons for their judgements and decisions.

While studies indicate that teachers are using the Internet to seek out information for their practice (Kyndt et al., 2016), less is known about the value of this type of informal learning. This is particularly true in the Canadian context. This exploratory study, therefore, used screen-capture technology and the virtual revisit think aloud to capture Canadian teachers' SDOL experiences as they occurred. Through three in-depth, one-on-one SDOL sessions, we documented the moment-to-moment learning experiences of

three elementary teachers as they informally used the Internet for their professional learning. Our aim is to provide insight into the value of SDOL as an informal approach to PD by tracking the cognitive processes and behavioral patterns of the teachers who participated in this study.

The following research questions guided this study:

1. What are elementary teachers' cognitive processes during a series of SDOL sessions?

2. What web-based actions are performed by elementary teachers during a series of SDOL sessions?

Methods

Research Design

This study employed a case study research design. As described by Yin (2012), case study research provides a close and in-depth understanding of a case (an individual, group, or phenomenon) in a real-world context. This closeness, Yin (2012) states, "aims to produce an invaluable but complex understanding—an insightful appreciation of the "case(s)"—hopefully resulting in new learning about real-world behavior" (p. 142). Aligned with Yin's perspective on case study research, our study aimed to provide insight into the complexities of teachers' cognitive processes and web-based actions during a series of three SDOL sessions. Thus, we deemed the case study as an appropriate approach for our research.

Yin proposed three conditions for case study research: conditions over time, in-depth inquiry, and contextual conditions. In our study, participants met with a member of the research team three times over the course of three months (conditions over time), the

focus of our study was on participants' cognitive processes and online bahaviours (in-depth inquiry), and the study was bounded by the context of two literacy-oriented websites (contextual condition). Given that no studies have examined SDOL over several learning sessions using the virtual revisit think aloud method, our study was also exploratory in nature. Yin (2012) suggests that case studies can assume an exploratory mode, where the researchers collect data to determine whether a topic is worthy of further investigation. Our study is a pilot study and exploratory in nature, as we will leverage the results for future studies on teachers' SDOL.

Our case study involved both a qualitative and quantitative component. The qualitative component included a comprehensive examination of participants' cognitive processes during SDOL while the quantitative component involved participants' web-based behaviors. Both the qualitative and quantitative approaches converged during the interpretive phase contributing to our overall aim of determining the value of SDOL as an informal approach to PD. A secondary goal was to leverage the results from this pilot study for future research examining a more representative sample of teachers across Canada.

Participants

Three elementary teachers from Ontario, Canada volunteered to participate in this study and all participants provided informed consent (see Table 1 for demographic characteristics). These teachers responded to a call for participants on social media and were interested in using the study time to enhance their own professional learning. Participant recruitment and consent followed university ethics board approval. While a limitation of this study is that the participants were similar with respect to years of teaching experience and age range, they differed with respect to frequency of Internet use and comfort level with the Internet for their professional learning. We acknowledge

that participants' level of teaching experience as well as the small sample size are study limitations. However, given the exploratory nature of this study, we offer preliminary insights into teachers' SDOL.

Table 1

Demographic Characteristics

Characteristic	Participant 1	Participant 2	Participant 3
Currently Teaching at Public or Private School	Public	Private	Public
Years of Teaching Experience	3	2	3
Age Range	25–29 years	25–29 years	25–29 years
Frequency of Internet Use for Professional Learning	Once a day	Once a week	More than once a day
Comfort Level of Using Internet for Professional Learning	Somewhat comfortable	Somewhat comfortable	Very comfortable

Study Context

Our study focused on literacy education at the elementary level. Given that literacy is a subject area that occurs daily in elementary classrooms, the focus on literacy provided the teacher participants with opportunities to target particular goals related to their literacy program. Prior to each session, participants were provided with the URLs of two multimedia literacy-oriented PD websites: *The Balanced Literacy Diet: Putting Research into Practice in the Classroom* (www.LitDiet.org) and *Reading Rockets: Launching*

Young Readers (www.readingrockets.org). We selected these websites as starting points for the SDOL sessions because of their popularity among elementary teachers, research-informed content, and freely accessible resources. Participants were free to navigate these websites, select hyperlinks to additional sites, or use sites with which they were familiar. The participants spent the majority of their 20-minute navigations perusing these two sites. The total amount of time spent on these sites as well as additional websites is presented in Tables 3 and 4.

Procedure

Participants met for three monthly one-on-one SDOL sessions with a member of the research team. All sessions were remote using Zoom and took place between November 2019 and February 2020. Participants completed a short online demographic questionnaire prior to their first meeting. Each meeting began with the participant sharing their professional goal as it related to their current practice. This was followed by a 20-minute open-ended task to use the Internet as they normally do when seeking information related to their teaching practice.

Participants shared their screen via Zoom and as they navigated the Internet, their actions were captured using Camtasia Studio (techsmith.com/video-editor.html), a screen recording computer software program developed by TechSmith® (techsmith.com). Immediately following participants' 20-minute navigation, the recording of their navigation was shared with them via Zoom and the virtual revisit think aloud was conducted; as participants viewed their online choices virtually, they verbalized their thoughts aloud. Following the last SDOL session, a semi-structured interview was conducted.

Data Sources

Multiple sources of data were obtained for triangulation, contributing credibility to the findings by converging more than one source of information (Golafshani, 2003).

Demographic Questionnaire

A demographic questionnaire was administered to participants to obtain data on a range of relevant factors. Questions included information about age, teaching experience, Internet frequency, and comfort with using the Internet for PD.

Virtual Revisit Think Aloud

Audio recordings captured participants' verbalizations ("thinking aloud") as they viewed their navigational recordings.

Screen-Capture Recordings

Camtasia Studio was used to record the computer screen during the participants' online navigation. Recordings were shared with participants via Zoom for the virtual revisit think aloud procedure.

Semi-Structured Interviews

A semi-structured interview followed the participants' explorations. Sample questions included: What were your general feelings during your navigations?; What did you find challenging while over the three sessions?; Were there any websites/resources that stood out to you?; and Do you feel that you gained information about your literacy program during these sessions?

Data Analysis

The qualitative data was analyzed using an inductive approach in which the data from the think alouds and interviews were reduced to themes as a result of open coding,

comparisons, and categorizations (Creswell, 2007). Audio recordings were first transcribed verbatim resulting in nine think aloud transcripts and three interview transcripts. The think aloud and interview transcripts were first read reflectively to gain a general sense of the participants' thought processes. Phrases were then unitized based on meaningful pieces of information that were "interpretable in the absence of any additional information" (Lincoln & Guba, 1985, p. 345). The process of unitizing the transcripts prior to open coding provided consistency with respect to how the thought units would be separated.

The members of the research team then independently used NVivo (qsrinternational.com/nvivo-qualitative-data-analysis-software), a qualitative software program used to organize data and support qualitative analyses, to code the same two think aloud transcripts. An open coding technique was used by each team member, in which each thought unit was described using a word or short sequence of words. The research team then met to discuss how they coded each thought unit. While word choice differed slightly across the research team members, the codes given to each thought unit were quite similar. After discussing and comparing the codes, a 98% agreement rate was reached. Inter-rater reliability, as described below, helped to establish connections between the thought units leading to four main themes. A coding scheme was finalized as a result of this open coding process and included 18 codes. The research team discussed four broader themes under which the codes were categorized: Self-managing, monitoring learning, evaluating, and increases in self-efficacy (see Appendix A). Due to the high agreement rate, two of the research team members divided up the remaining transcripts and continued the coding process using the established coding scheme.

The quantitative data were analyzed using a time-sampling observation analysis where participants' web-based actions were counted and recorded in 10-second intervals (Beach & Willows, 2017). Specifically, while viewing the 20-minute screen recordings, members of the research team documented each web-action exhibited by the participant every 10 seconds using an excel spreadsheet. Prior to this analysis, a list of actions was created based on the two main websites used in this study. Observations of the screen recordings also led to a list of websites used by the participants as well as the time spent on the websites. Actions included *entering a search term* and *viewing a video*. The full list of actions used to analyze the screen recordings is presented in Table 2.

Ensuring Trustworthiness of the Findings

The study generated data in three ways: think aloud transcripts, interview transcripts, and screen-capture recordings. During analysis, each data set was considered separately then cross-referenced thereby using triangulation to ensure reliability in data interpretation (Golafshani, 2003). Analyzing the interview and think aloud transcripts helped establish the consistency and frequency of categories. Furthermore, the interview allowed participants to expand upon their think aloud and answer direct questions about their website navigation. Because prompts, questions, and redirections were limited during the think aloud, the post-think aloud interview provided opportunities for participants to expand upon their ideas and follow up on their decision-making strategies. This study also used inter-rater reliability during initial coding. The research team members coded approximately 10% of the same transcripts then met to discuss agreements and discrepancies. Disagreements were discussed and resolved until an inter-rater agreement of 98% was reached. The transcripts were then divided up amongst the research team members for continued analysis using the coding scheme that was established during the team meeting.

Findings and Discussion

Below, we provide a summary of the findings according to the research questions. We decided to include the findings and discussion sections together to offer a more integrative story—the reader can use participant quotes and the authors' interpretations as well as the relevant literature to create a representation of how the teachers from this study self-directed their learning during their SDOL sessions. In this section we also share case profiles of our participants. The profiles provide an in-depth representation of each participant's SDOL experience. Finally, we discuss implications for research and teacher education and offer three main aspects to consider for successful SDOL experiences.

What are Elementary Teachers' Cognitive Processes During a Series of SDOL Sessions?

Four main themes resulted from the qualitative analysis: Self-managing, monitoring learning, evaluating, and increases in self-efficacy. These main themes were found to be interconnected and iterative across all three SDOL sessions. They did not appear to progress in a linear way but rather overlapped and influenced each other. As we discuss below, the cognitive processes at play during teachers' SDOL are complex and involve an iterative cycle of cognitive strategies.

Self-Managing

Across the three sessions, participants were metacognitively aware of their learning (Garrison, 1997); they were self-managing their navigations by noticing relevant tools and resources, describing their web behaviors, problem-solving when encountering distracting or confusing information, and reflecting on their learning process. For instance, one participant noted that she "went to the homepage to see maybe if there was something new or something that jumped out and I noticed right away that game

kind of stood out to me." In a similar way, another participant noticed several teaching resources with which she was familiar: "I clicked this resource kit…I actually used it at the school I was at last year"; "it suggested using a graphic organizer, which is something I had already done with these students." Participants also reflected on their learning during the final moments of their last SDOL or when discussing their experience during the interview. For instance, once participant stated how the sessions "really made me more aware of what I'm putting up [in the classroom]. I'm kind of a minimalist and I don't like a lot of things in the classroom because it's too overwhelming."

Self-management is a component of self-directed learning that focuses on the cognitive management of learning and the construction of meaning through critical reflection (Garrison, 1997). The participants in this study seemed to employ strategies to manage the breadth of knowledge they encountered and the source variability. Additionally, the participants determined whether pages and resources they happened upon were worth continued exploration. By managing their navigations and thinking critically about their choices, it can be suggested that the participants demonstrated themselves as successful adult learners (Knowles, 1975); they were able to construct knowledge and develop new understanding via the online resources they encountered.

Monitoring Learning

Participants also verbalized thought units related to self-monitoring, which requires acute attention to personal goals and an ability to think about our thinking (Garrison, 1997). This metacognitive component can lead to knowledge construction in which newly acquired information is connected to existing understanding. In the context of this study, participants demonstrated self-monitoring by making connections to their current practice, saving information for future retrieval, skimming through information

to determine its value and relatedness, and reading information for a deeper understanding when it was deemed relevant.

Monitoring learning most often related to participants' connections to their practice. Throughout all three sessions, participants made direct connections to their students as well as their current literacy practices and literacy-related goals. For instance, one participant stated: "Right now we are working on procedural writing as well as doing a read-aloud in the class and we're reading Fish in a Tree, and so those were some things I was keeping in mind while I was exploring here." Similarly, as another participant opened a new page on one of the given websites, she stated: "I wanted to see if I could come up with some more activities or gain more insight into letter-writing so I could help plan my mini-unit going on."

Participants also saved information for future reference by bookmarking relevant material or taking notes in a word document. For instance, one participant noted how she "saved an activity under 'lesson plans' because it seems like something I can do in a language lesson immediately." Participants also kept tabs open because they wanted to explore the ideas later. They also saved information, including content, websites, and web pages "because it seemed to have a lot of information that might be useful." As we discuss next, one participant spent time taking notes in a word document. These notes combined ideas that could immediately be put into practice as well as thoughts related to future units of study.

Finally, regardless of the session number, participants often skimmed through information prior to reading for greater depth. Participants' thoughts related to skimming included: "I just skim… I was looking for key words because I wasn't going to read all that"; "I looked at all of the main headings"; "I was just skimming to see if it

was relevant"; and "When I filtered through the recipes, I started to look at the different things that jumped out at me that I found interesting." Once participants felt the information was relevant, they found themselves "diving deeper" and reading through "to [see] if there's any added knowledge I can gain from this."

Monitoring learning is a particularly useful cognitive strategy to enact during informal learning. When seeking out and delving into personally meaningful topics, a teacher engaged in SDOL must make quick decisions about whether the material is relevant to their teaching practice. Consistent with how Lantz-Andersson et al. (2018) perceive the processes involved in informal learning, the teachers in this study were able to experience more personalized learning opportunities since the online resources and platforms they selected were chosen with a particular goal in mind (Callanan et al., 2011).

Evaluating

When participants opened a new web page or resource, they often *evaluated* the presentation of information, which included the website usability and readability. Often the website's architecture and text density seemed to determine whether participants would continue navigating a particular resource or turn their attention to a new search. Teachers must critically evaluate information through their unique teaching lenses. They are continuously sifting through a plethora of information while at the same time dealing with the website's architecture.

For instance, upon opening a link from one of the given websites, one participant thought about the readability of the page: "when it's too busy I kind of just avoid it so that I didn't even approach reading, to be honest. It was a link from the other page, and it was a little overwhelming, so I decided to close it." All three participants were also

interested in the background information of the websites they perused. For instance, one participant who was already familiar with Reading Rockets, one of the given websites, noted how they would trust the content from this site: "I would have to watch it first, but if I saw it on Reading Rockets I thought, okay, it should be okay for [my students]."

The fact that the participants spent time evaluating the material and the overall usability of the online resources demonstrates their use of a critical lens when considering the direction of their SDOL. As Darling-Hammond and Richardson (2009) have suggested, successful PD opportunities must include research-based content. While there is no one way of knowing the credibility of all the online educational resources available to teachers for their professional learning, it is encouraging that the teachers in this study viewed the selected online learning environments with a critical lens, potentially contributing to this crucial aspect of effective PD.

Increases in Self-Efficacy

Finally, across the three sessions there were moments where participants noticed increases in their self-efficacy for teaching literacy. These moments specifically seemed to relate to enhancing knowledge and vicarious learning. For instance, when one participant viewed a classroom demonstration video they stated: "[watching this video] was kind of nice to reaffirm what I'm doing and it makes me feel as though I've been on the right track, which is great." As participants selected meaningfully relevant material online, it is possible that they experienced vicarious learning. Through indirect sources of viewing a teacher's practice, participants gained confidence in their own teaching. Another participant demonstrated this when they stated: "it's interesting to read about things and realize that's what I'm doing in my classroom and there's a purpose for it and there's a validation in that sense." The information that this participant viewed

provided them with a sense of confidence knowing the value in their teaching practices. This feeling was echoed by another participant who noted:

> It was kind of cool to see it there after discussing it with someone else and kind of feeling more reaffirmed in what I'm doing, thinking okay, this actually makes sense and I'm actually changing something and there's a purpose behind it.

Self-efficacy for teaching literacy can be described as a teacher's self-perceptions of their competence with the activities of literacy teaching (Tschannen-Moran & Johnson, 2011). This highly relevant aspect can be viewed as a contributing factor for a teacher's motivation and feelings of support. Shulman and Shulman (2004) suggest that motivation contributes to a teacher's willingness to learn; motivation drives a teacher's self-directed learning forward. After seeing lessons they had implemented be successful with other educators, the teachers in this study felt reaffirmed with their own teaching practices, potentially increasing their motivation to continue viewing the online resources. These affirmations can also be viewed as informal support; support being one of the key features of effective PD (Darling-Hammond & Richardson, 2009).

What Web-Based Actions are Performed by Elementary Teachers During a Series of SDOL Sessions?

Frequency counts of the observed actions across each session as well as overall frequency counts are presented in Table 2. Below, we highlight key observations that resulted from the time-sampling analysis. We also list the websites used by the three participants in our study (see Table 3), and the total time spent on the two given websites in comparison to all other websites (see Table 4).

Table 2

Web-Based Actions

Action	Session 1 Total N (%)	Session 2 Total N (%)	Session 3 Total N (%)	Overall Total N (%)
Enters a search term	5 (1.1)	3 (0.7)	5 (1.1)	13 (1.0)
Selects an interactive feature	0 (0.0)	8 (1.9)	3 (0.6)	11 (0.8)
Uses interactive feature	2 (0.5)	25 (5.7)	22 (4.7)	49 (3.6)
Opens content page	26 (5.9)	4 (0.9)	7 (1.5)	37 (2.8)
Opens page about background	11 (2.5)	22 (5.0)	16 (3.4)	49 (3.6)
Opens homepage	4 (0.9)	6 (1.4)	3 (0.6)	13 (1.0)
Opens a video	2 (0.5)	0 (0.0)	2 (0.4)	4 (0.3)
Starts a video	9 (2.0)	1 (0.3)	9 (1.9)	19 (1.4)
Views a video	107 (24.2)	0 (0.0)	24 (5.2)	131 (9.8)
Stops video before the end	3 (0.7)	1 (0.3)	1 (0.2)	5 (0.4)
Opens external link	4 (0.9)	3 (0.7)	5 (1.1)	12 (0.9)
Opens lesson plan	9 (2.0)	1 (0.3)	4 (0.9)	14 (1.1)
Selects filter option	4 (0.9)	0 (0.0)	1 (0.2)	5 (0.4)
Takes a note	0 (0.0)	74 (17.0)	85 (18.3)	159 (11.8)
Highlights text	17 (3.8)	17 (3.9)	16 (3.4)	50 (3.7)
Views a photograph	5 (1.1)	0 (0.0)	16 (3.4)	21 (1.6)
Saves information	16 (3.6)	3 (0.7)	12 (2.6)	31 (2.3)
Opens new tab	13 (2.9)	16 (3.7)	1 (0.2)	30 (2.2)
Switches tab	22 (5.0)	33 (7.6)	18 (3.9)	73 (5.4)
Closes tab	6 (1.4)	3 (0.7)	8 (1.7)	17 (1.7)

Action	Session 1 Total N (%)	Session 2 Total N (%)	Session 3 Total N (%)	Overall Total N (%)
Scrolling	170 (38.5)	181 (41.5)	186 (40)	537 (40.0)
Opens a pop-up window	0 (0.0)	5 (1.1)	1 (0.2)	6 (0.5)
Waits for page to load	4 (0.9)	1 (0.3)	6 (1.3)	11 (0.8)
Uses navigation feature	0 (0.0)	29 (6.7)	11 (2.4)	40 (2.8)
Selects back button	2 (0.5)	0 (0.0)	0 (0.0)	2 (0.1)
Opens internal link	1 (0.23)	0 (0.0)	0 (0.0)	1 (0.07)
Skips ahead in video	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.07)
Uses search function	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.1)

As noted in Table 2, the actions most often observed were scrolling, taking a note, and viewing a video. All participants spent time watching videos with the amount of time totalling 21 minutes 50 seconds across the nine SDOL sessions. An important observation is that the most time spent viewing a video was during the first session, with one participant viewing 12 minutes of video. None of the participants viewed a video during the second session. Also noteworthy is the amount of time one participant spent taking notes (26 minutes 30 seconds) and that the act of note-taking increased across the sessions. While all three participants saved information by using the bookmarking feature at least once during each session, only one participant took notes using a Word document. The fact that participants were interested in saving information for future retrieval suggests that the material they were seeking out was connected to their practice. Moreover, it is possible that the participant who took notes was constructing and processing new information at a deeper level. The time scrolling

through information was found to be the highest across the sessions with similar frequencies for each session. Other noteworthy actions demonstrated by participants include highlighting text, using interactive features (e.g., virtual classroom tours), and opening pages related to a website's background information.

As presented in Tables 3 and 4, participants used a range of websites during their 20-minute navigations. While participants used the two given websites most often, it is worth noting the other websites, even if participants used them for a limited amount of time. Other notable observations are that only four of the listed websites specifically target literacy, and participants spent more than twice as much time on Reading Rockets than on The Balanced Literacy Diet website. The websites used by participants in this study warrant further examination. Given the focus of this article, we do not address the quality of these websites or why the participants opened these sites. However, we do acknowledge that this is a future area of research that can contribute to our understanding of teachers' SDOL and should therefore be further examined.

Table 3

Websites Used by Participants

Website URL	Website Name
https://arpdc.ab.ca/	Alberta Regional Consortia
www.LitDiet.org	The Balanced Literacy Diet
www.edu.gov.on.ca	Ontario Ministry of Education
www.education.com	Education.com
www.funin5thgrade.com	Fun in 5th Grade
www.jigsaw.org	Jigsaw Classroom
www.lincs.ed.gov	LINCS
www.nationalgeographic.org	National Geographic

Website URL	Website Name
www.pbs.org	PBS
www.pinterest.com	Pinterest
www.readingrockets.org	Reading Rockets
www.readwritethink.org	Read Write Think
www.teachervision.com	Teacher Vision
www.tolerance.org	Teaching Tolerance
www.twowritingteachers.org	Two Writing Teachers
www.writingfix.com	Writing Fix

Table 4

Time Spent on Websites

Website Title	Session 1 *(min + s)*	Session 2 *(min + s)*	Session 3 *(min + s)*	Total Time *(min + s)*
The Balanced Literacy Diet	16 min 5 s	17 min 29 s	15 min 52 s	49 min 26 s
Reading Rockets	35 min 8 s	39 min 13 s	39 min 41 s	114 min 2 s
Other	5 min 10 s	4 min 54 s	18 min 38 s	28 min 42 s

Case Profiles

Below we offer a brief description of three case profiles based on each participant's data. Once the profiles were written, we recognized the emergence of Shulman and Shulman's (2004) five key aspects of teacher learning in each participant's SDOL experience. As a result, we have identified potential points of the participant's SDOL where vision, motivation, understanding, practice, and reflection occurred. All names are pseudonyms.

Marie. Throughout the first session, Marie kept her current curriculum in mind, searching for ways to engage her students in procedure writing (*vision*). As she watched a video of a teacher demonstrating how to give detailed instructions, Marie exclaimed, "Oh my goodness, yes! You do have to give every single little detail." Marie described these moments as validating her practice, which is important to her as a new teacher (*motivation*). "It's interesting to read about things and realize that's what I'm doing in my classroom and there's a purpose for it, and there's a validation in the sense." As Marie moved through the sessions, her goals evolved (*understanding*). During her second session, Marie stated that she wanted to focus on how she structures her literacy block in her class (*practice*). Marie reflected on the purpose of silent reading before searching for information on this topic. During her final session a few weeks later, Marie continued to reflect on her current practice, commenting on her students' reliance on technology. When asked at the end of the three sessions if she gained information for her literacy practice over the course of the study, without hesitation, Marie responded, "Yes, definitely because this process made me reflect on my teaching, the students, and the information that I'm gathering." She stated:

> It's made me a more reflective teacher. I think that it's provided lots of great ideas and it's actually encouraged me to explore the Internet some

> more because I've seen how effective it has been during even these short sessions, so I know that it can be effective in the rest of my career (*reflection*).

Emily. Throughout her sessions, Emily consistently made cross-curricular connections between the subjects she teaches (*vision*). When Emily found a resource called Reader's Theatre, for instance, she stated:

> I'm teaching drama, so I thought, what better way for me to kind of turn this into a cross-curricular activity? And Reader's Theatre is actually what we're doing right now in class, and I don't know why I didn't have the realization that I could tie it to language rather than just it being solely drama.

As she moved through the sessions, Emily continued to capitalize on the opportunity to turn resources into cross-curricular activities for her class (*motivation, understanding, practice*), carefully considering the purpose of each resource. At the end of the three sessions, Emily reflected on her experience in the study, stating:

> It really makes me think about what I'm doing and sometimes it's a nice reassurance [...] I really like this because it reaffirms that you know what you're doing, you're okay. You're going to make mistakes, but it's not the end of the world and you're on the right track (*reflection*).

Katrina. During her initial session, Katrina discussed how Pinterest was the most common way she saves information for her professional learning and described her preference for websites and resources that are "methodical, like a recipe to follow." When she found a recipe card on how to start literacy centers, she was excited at the prospect of introducing the activities in her classroom (*vision, motivation, understanding*). Katrina arrived at her second session with several goals in mind. With report cards approaching, Katrina was hoping to use the navigation as an opportunity to find

information related to assessment (*motivation*). To start the session, Katrina explained her website choice: "So I made an intentional choice to just start on Reading Rockets because I find it easier to navigate and more straightforward" compared to websites that are more text-heavy. When we met Katrina for the third and final time, she was interested in searching for lessons and ideas that she could implement immediately (*practice*). This approach illustrated the usefulness of the Internet for just-in-time learning for teachers. At the end of her final session, Katrina expressed a desire for websites that are more concise and visually appealing. Images like the ones on Reading Rockets seemed to help Katrina make connections between the content and her own classroom (*reflection*).

Key Findings and Implications

Our findings suggest that SDOL is a valuable source of informal PD regardless of how often it occurs. As Callanan et al. (2011) describe, informal PD is unique to each teacher where learning opportunities are more personalized since they are chosen by an individual with a particular goal in mind. Additionally, Lantz-Andersson et al. (2018) emphasize informal PD as a bottom-up initiative. The teachers in our study individually chose to seek out personally meaningful literacy topics in order to support their current teaching practice and literacy program. As such, SDOL was a successful form of informal PD for the teachers in our study. Indeed, future research should assess teachers' knowledge before and after a series of SDOL sessions as well as examine the influence of SDOL on classroom practice to fully determine the value of SDOL.

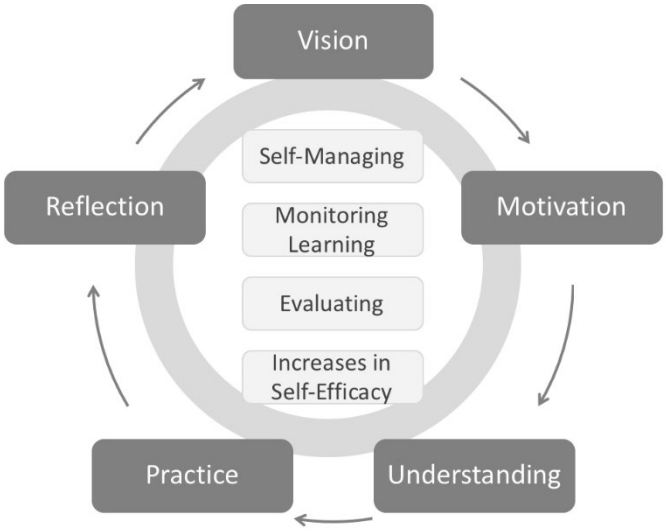
Based on our findings it appears that SDOL fosters self-management and self-monitoring. As Garrison (1997), Knowles (1975) and others have identified, these are key components of successful self-directed learners. While SDL has long been studied as a successful approach to learning when learners are able to self-manage and self-

monitor their learning, few studies have examined how teachers self-direct their learning in online environments, and whether components of SDL are enacted during SDOL. Moreover, no studies, to the awareness of the authors, have examined SDOL over a series of several learning sessions. Thus, our study makes an empirical contribution to the literature: the teachers in our study enacted cognitive processes involved in SDL suggesting that they too were successful in their learning.

The teachers in our study also critically evaluated the content and architecture of the online environments, which seemed to lead to an efficient use of their time, allowing them to read for depth, and potentially construct new knowledge, when they determined relevant and user-friendly material. Based on the participants' experiences, SDOL also appears to foster vicarious learning which can contribute to increases in self-efficacy for teaching, as well as motivation and feelings of support (Darling-Hammond & Richardson, 2009; Shulman & Shulman, 2004). These components of a successful self-directed learner also align with Shulman and Shulman's (2004) stages of teacher learning. The iterative nature of self-managing, self-monitoring, evaluating, and self-efficacy occurred as the participants moved through the stages of vision, motivation, understanding, practice, and reflection. Figure 1 offers a visual representation of SDOL that incorporates these two notions.

Figure 1

A Representation of Teachers' Self-Directed Online Learning



© Beach, 2020

This representation of teachers' self-directed online learning makes a theoretical contribution to the literature, building onto previous models of teachers' online navigational experiences (Beach, 2017). Specifically, by combining the cognitive processes involved during SDOL and Shulman and Shulman's (2004) stages of learning, our model presented in Figure 1 demonstrates how cognitive processes essential to any successful self-directed learner are enacted over time.

Our findings also provide context-specific and broader contributions to the online learning literature. Specifically, by tracking teachers' moment-to-moment decisions during learning we can understand how and why teachers use the Internet for their PD. In turn, this can facilitate better decisions about and increased quality of online professional learning opportunities for teachers; online spaces can be more conducive to teacher learning. More broadly, our findings have implications for researchers across domains in education. Rather than relying on self-reported measures, such as post-task

interviews and surveys, researchers across educational fields can use the virtual revisit think aloud in combination with screen-capture recordings to document online learning as it occurs.

We offer implications for teacher education and specifically propose three main aspects to consider for teachers to have successful SDOL experiences. First, our study occurred in the context of literacy education and the teachers were asked to hone their navigations on topic-oriented goals prior to each session. These goals appeared to help the participants narrow their searches and build onto their practice. In line with Shulman and Shulman's (2004) work on teacher learning, the teachers in this study based their navigations on a vision they had about their current students; their goals aligned with their current context and programming. Second, even though participants were able to click on and use external hyperlinks, they spent most of their time navigating the two websites that were offered to them and returned to these familiar websites for their subsequent sessions. It is possible that they were motivated to use these websites because they were relatively easy to navigate, and the information could be trusted. This internal motivation often drives a teacher's self-directed learning forward (Garrison, 1997). Third, the participants appeared to read for depth on the two given websites that are research-informed. Thus, they were constructing knowledge and developing deeper understanding via research-informed online resources. This in turn, prompted the teachers to reflect on their learning and practice.

Setting targeted goals, using familiar websites, and accessing research-informed online environments can potentially enhance teachers' informal online learning experiences, a type of learning that has potential value and is indeed desirable. By using screen-capture technology and the virtual revisit think aloud we were able to capture three teachers' SDOL experiences resulting in a more comprehension picture of how and why

teachers self-direct their learning in online environments. Documenting moment-to-moment learning experiences over time provides insight into the value of SDOL as an informal approach to PD.

Conclusion

It is well known that teacher learning is multifaceted; there is not a one-size-fits-all approach to PD and nor should there be. Although there is ample research about teacher PD by means of formal learning activities, research examining informal learning, and specifically SDOL is limited. Understanding online resources and websites, and accurately tracking their usage, facilitates better decisions about and increased quality of SDOL opportunities for teachers. Feedback from this study provides preliminary insight into the value of SDOL. The use of the virtual revisit think aloud over a series of SDOL sessions, in combination with screen-capture technology, contributes new knowledge about informal PD in online environments.

References

Ayyildiz, Y., & Tarhan, L. (2015). Development of the self-directed learning skills scale. *International Journal of Lifelong Education, 24*(6), 663–679. https://doi.org/10.1080/02601370.2015.1091393

Barzilai, S. & Zohar, A. (2012). Epistemic thinking in action: Evaluating and integrating online sources. *Cognition and Instruction, 30*(1), 39–85. https://doi.org/10.1080/07370008.2011.636495

Beach, P., & Willows, D. (2014). Investigating teachers' exploration of a professional development website: An innovative approach to understanding the factors that motivate teachers to use Internet-based resources. *Canadian Journal of Learning and Technology, 40*(3). http://dx.doi.org/10.21432/T2RP47

Beach, P. (2017). Self-directed online learning: A theoretical model for understanding elementary teachers' online learning experiences. *Teaching and Teacher Education, 61,* 60-72. https://doi.org/10.1016/j.tate.2016.10.007

Beach, P., & Willows, D. (2017). Understanding teachers' cognitive processes during online professional learning: A methodological comparison. *Online Learning, 21*(1), 60-84. http://dx.doi.org/10.24059/olj.v21i1.949

Beach, P., Minuk, A., & Favret, E. (2020). Online teacher professional development in Canada: A review of the literature. *Manuscript submitted for publication.*

Bullock, S. M. (2013). Using digital technologies to support self-directed learning for preservice teacher education. *The Curriculum Journal, 24*(1), 103–120. https://doi.org/10.1080/09585176.2012.744695

Callanan, M., Cervantes, C., & Loomis, M. (2011). Informal learning. *Wiley Interdisciplinary Reviews: Cognitive Science, 2*(6), 646–655. https://doi.org/10.1002/wcs.143

Campbell, C., Osmond-Johnson, P., Faubert, B., Zeichner, K., & Hobbs-Johnson, A. (with Brown, S., DaCosta, P., Hales, A., Kuehn, L., Sohn, J., & Steffensen, K.). (2016). *The state of educators' professional learning in Canada.* Learning Forward. https://learningforward.org/wp-content/uploads/2017/08/state-of-educators-professional-learning-in-canada.pdf

Canadian Teachers' Federation. (2014). *Highlights of CTF survey on the quest for teacher work-life balance.* Canadian Teachers' Federation. https://files.eric.ed.gov/fulltext/ED546884.pdf

Carpenter, J. P., & Krutka, D. G. (2015). Engagement through microblogging: Educator professional development via Twitter. *Professional Development in Education*, *41*(4), 707–728. https://doi.org/10.1080/19415257.2014.939294

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five traditions* (2nd Ed.). Sage Publications.

Damico, J., & Balidon, M. (2007). Examining ways readers engage with websites during think-aloud sessions. *Journal of Adolescent and Adult Literacy*, *51*(3), 254–263. https://doi.org/10.1598/JAAL.51.3.5

Darling-Hammond, L., & Richardson, N. (2009). Research review/teacher learning: What matters. *Educational leadership: Journal of the Department of Supervision and Curriculum Development*, *N.E.A* , *66*(5), 46–53. https://www.researchgate.net/publication/287590851_Teacher_Learning_What_Matters

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199. https://doi.org/10.3102/0013189X08331140

De Vries, S., van de Grift, W. J., & Jansen, E. P. (2014). How teachers' beliefs about learning and teaching relate to their continuing professional development. *Teachers and Teaching*, *20*(3), 338–357. https://doi.org/10.1080/13540602.2013.848521

Ericsson, K. (2002). Towards a procedure for eliciting verbal expression of non-verbal experience without reactivity: Interpreting the verbal overshadowing effect within the theoretical framework for protocol analysis. *Applied Cognitive Psychology, 16*(8), 981–987. https://doi.org/10.1002/acp.925

Ericsson, K. (2003). Valid and non-reactive verbalization of thoughts during performance of tasks: Towards a solution to the central problems of introspection as a source of scientific data. *Journal of Consciousness Studies, 10*(9-10), 1–18.

Ericsson, K. A., & Simon H. (1984). *Protocol analysis: Verbal reports as data*. The MIT Press.

Ericsson, K. A., & Simon, H. (1993). *Protocol analysis: Verbal reports as data* (Rev. ed.). The MIT Press.

Garrison, D. R. (1997). Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly, 48*(1), 18–33. https://doi.org/10.1177/074171369704800103

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report, 8*(4), 597–607. https://doi.org/10.46743/2160-3715/2003.1870

Hall, L. A. (2018). Using blogs to support reflection in teacher education. *Literacy Research and Instruction*, *57*(1), 26–43. https://doi.org/10.1080/19388071.2017.1367055

Heo, G. M., & Lee, R. (2013). Blogs and social network sites as activity systems: Exploring adult informal learning process through activity theory framework. *Journal of Educational Technology & Society*, *16*(4), 133–145. https://www.researchgate.net/publication/258515553

Hursen, C. (2016). The impact of curriculum developed in line with authentic learning on the teacher candidates' success, attitude and self-directed learning skills. *Asia Pacific Educational Review, 17*, 73–86. https://doi.org/10.1007/s12564-015-9409-2

Jurasaite-Harbison, E., & Rex, L. A. (2010). School cultures as contexts for informal teacher learning. *Teaching and Teacher Education*, *26*(2), 267–277. https://doi.org/10.1016/j.tate.2009.03.012

Knowles, M. (1975). *Self-directed learning: A guide for learners and teachers.* Association Press. https://eric.ed.gov/?id=ED114653

Krutka, D. G., Carpenter, J. P., & Trust, T. (2016). Elements of engagement: A model of teacher interactions via professional learning networks. *Journal of Digital Learning in Teacher Education*, *32*(4), 150–158. https://doi.org/10.1080/21532974.2016.1206492

Kuusela, H., & Paul, P. (2000). A comparison of concurrent and retrospective verbal protocol analysis. American Journal of Psychology, 113 (3), 387–404. https://doi.org/10.2307/1423365

Kyndt, E., Gijbels, D., Grosemans, I., & Donche, V. (2016). Teachers' everyday professional development: Mapping informal learning activities, antecedents, and learning outcomes. *Review of Educational Research*, *86*(4), 1111–1150. https://doi.org/10.3102/0034654315627864

Lantz-Andersson, A., Lundin, M., & Selwyn, N. (2018). Twenty years of online teacher communities: A systematic review of formally-organized and informally-developed professional learning groups. *Teaching and Teacher Education*, *75*, 302–315. https://doi.org/10.1016/j.tate.2018.07.008

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Marcià, M., & García, I. (2016). Informal online communities and networks as a source of teacher professional development: A review. *Teaching and Teacher Education, 55*, 291–307. https://doi.org/10.1016/j.tate.2016.01.021

McCartney, R., Boustedt, J., Eckerdal, A., Sanders, K., Thomas, L., & Zander, C. (2016). Why computing students learn on their own: Motivation for self-directed learning of computing. *ACM Transactions of Computing Education, 16*(1), Article 2, 1–18. http://dx.doi.org/10.1145/2747008

Mello, L. V. (2016). Fostering postgraduate student engagement: Online resources supporting self-directed learning in a diverse cohort. *Research in Learning Technology, 24*. https://doi.org/10.3402/rlt.v24.29366

Moore, M. G. (2016). Thirty years later: Self-directed learning and distance education—In retrospect. *International Journal of E-Learning & Distance Education, 31*(2). http://www.ijede.ca/index.php/jde/article/view/1000

Morris, T. H. (2019). Self-directed learning: A fundamental competence in a rapidly changing world. *International Review of Education*, *65*(4), 633–653. https://doi.org/10.1007/s11159-019-09793-2

Mullins, R., & Hicks, D. (2019). "So I feel like we were just theoretical, whereas they actually do it": Navigating twitter chats for teacher education. *Contemporary Issues in Technology and Teacher Education*, *19*(2), 218–239. https://citejournal.org/volume-19/issue-2-19/social-studies/so-i-feel-like-we-were-just-theoretical-whereas-they-actually-do-it-navigating-twitter-chats-for-teacher-education

Olmsted-Hawala, E., Murphy, E., & Hawala, S. (2010). Think-aloud protocols: Analyzing three different think-aloud protocols with counts of verbalized frustrations in a usability study of an information-rich website. *2010 IEEE International Professional Communication Conference*, 60–66. https://doi.org/10.1109/IPCC.2010.5529815

Parsons, S. A., Hutchison, A. C., Hall, L. A., Parsons, A. W., Ives, S. T., & Leggett, A. B. (2019). US teachers' perceptions of online professional development. *Teaching and Teacher Education: An International Journal of Research and Studies*, *82*(1), 33–42. https://doi.org/10.1016/j.tate.2019.03.006

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, *29*(1), 4–15. https://doi.org/10.3102/0013189X029001004

Shapiro, E. J., Sawyer, A. G., Dick, L. K., & Wismer, T. (2019). Just what online resources are elementary mathematics teachers using? *Contemporary Issues in Technology and Teacher Education*, *19*(4), 670–686. https://citejournal.org/volume-19/issue-4-19/mathematics/just-what-online-resources-are-elementary-mathematics-teachers-using/

Shulman, L. S., & Shulman, J. H. (2004). How and what teachers learn: A shifting perspective. *Journal of Curriculum Studies*, *36*(2), 257–271. https://doi.org/10.1080/0022027032000148298

Simons, P. R. J. (2000). Towards a constructivistic theory of self-directed learning. *Self-Learning*, 1–12. https://dspace.library.uu.nl/handle/1874/6994

Tour, E. (2017). Teachers' self-initiated professional learning through personal learning networks. *Technology, Pedagogy and Education*, *26*(2), 179–192. https://doi.org/10.1080/1475939X.2016.1196236

Tough, A. (1971). *The adult's learning projects: A fresh approach to theory and practice in adult learning*. Ontario Institute for Studies in Education.

Trust, T. (2016). New model of teacher learning in an online network. *Journal of Research on Technology in Education*, *48*(4), 290–305. https://doi.org/10.1080/15391523.2016.1215169

Tschannen-Moran, M., & Johnson, D. (2011). Exploring literacy teachers' self-efficacy beliefs: Potential sources at play. *Teaching and Teacher Education*, *27*(4), 751–761. https://doi.org/10.1016/j.tate.2010.12.005

Upitis, R., & Brook, J. (2017). How much professional development is enough? Meeting the needs of independent music teachers learning to use a digital tool. *International Journal of Music Education*, *35*(1), 93–106. https://doi.org/10.1177/0255761415619426

Van Bommel, J., Randahl, A. C., Liljekvist, Y., & Ruthven, K. (2020). Tracing teachers' transformation of knowledge in social media. *Teaching and Teacher Education*, *87*, Article 102958. https://doi.org/10.1016/j.tate.2019.102958

Visser, R., Evering, L., & Barrett, D. (2014). #TwitterforTeachers: The implications of Twitter as a self-directed professional development tool for K–12 teachers. *Journal of Research on Technology in Education, 46*(4), 396–413. https://doi.org/10.1080/15391523.2014.925694

Yin, R. (2012). Case study methods. In H. C. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf & K. J. Sher (Eds.), *APA handbooks in psychology®. APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological,* 141–155. American Psychological Association. https://doi.org/10.1037/13620-000

Yurkofsky, M. M., Blum-Smith, S., & Brennan, K. (2019). Expanding outcomes: Exploring varied conceptions of teacher learning in an online professional development experience. *Teaching and Teacher Education*, *82*, 1–13. https://doi.org/10.1016/J.TATE.2019.03.002

Authors

Pamela Beach is an Assistant Professor in Language and Literacy in the Faculty of Education at Queen's University. Pamela's work explores how online and multimedia resources can be used in teacher education and professional development. She is particularly interested in self-directed online learning in the context of literacy education.

Elena Favret is completing her M.Ed. in the Faculty of Education at Queen's University. Her teaching experience in the UK has shaped her interest in topics of language and

literacy, teacher professional development, inclusive education, and engagement in collaborative learning.

Alexandra Minuk is a Master of Education candidate at Queen's University in the Faculty of Education. Her background as a special educator has shaped her interests in inclusive education, teacher professional development, technology as a teaching and learning tool, and literacy development at any stage.

Appendix A

Coding Scheme

Theme	Code	Sub-code
Self-managing	Connecting to practice Saving information Skimming through Reading for depth	Cross-curricular connections Immediate relevance Relevance to literacy practice Relevance to students
Monitoring Learning	Describing web behaviours Distraction or confusion Noticing teacher resources Noticing tools or web features Reflection of think aloud process	
Evaluating	Source quality Source credibility	
Increases in Self-Efficacy	Vicarious learning Self-efficacy for teaching literacy Enhancing literacy knowledge	