Elementary Teachers' Cognitive Processes and Metacognitive Strategies During Self-Directed Online Learning

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This study involves an in-depth examination of Canadian elementary teachers' cognitive processes and metacognitive strategies they used during a self-directed online learning experience. The virtual revisit think aloud, a methodology that combines a retrospective procedure with screen recording technology, was used to capture verbalizations from 13 elementary teachers as they used an online database. Resulting think aloud protocols and post-task interviews were analyzed using qualitative methods. An inductive approach to analysis led to six themes related to the types of cognitive processes and metacognitive strategies teachers use during self-directed online learning: connecting to practice, tweaking and adapting, narrowing the focus, skimming through, reading for depth, and source credibility. The teachers in this study demonstrated a non-linear iterative process in which they continuously planned, monitored, and evaluated their learning during the self-directed online learning experience. Implications for teacher learning and research are discussed.

Keywords: self-directed learning; teacher professional learning; cognitive processes; metacognitive strategies; elementary teachers

Introduction

During online learning it is critical to apply higher reasoning cognitive skills and effective learning strategies in order to select and make sense of an enormous amount of information. Strategies an individual might use with offline texts, such as *back up and reread*, are necessary but not sufficient to successfully navigate and make sense of online material (Coiro, 2011).

While teachers report using the Internet multiple times per week to obtain up-to-date information related to their professional practice (Author 2015; Visser et al., 2014), the various skills and strategies that teachers employ as they self-direct their learning online are less understood. As teachers encounter new and diverse information online, they must successfully decipher, critically evaluate, and synthesize a range of text and media from a variety of sources, including public and private agencies as well as educators themselves (Coiro, 2011; Learning Forward, 2017). These skills are essential for teachers to deliver accurate content to their students and be productive professionals in a demanding field. However, we do not yet know whether teachers use specific strategies when navigating online for their professional learning, nor do we have a comprehensive understanding of what teachers' successful self-directed online learning (SDOL) experiences look like. It is unclear, for example, whether teachers effectively differentiate important from unimportant information, how they manage comprehension difficulties, such as distractors (e.g., advertisement pop-ups), and how they discern that the author of a resource is credible and trustworthy. Generating data about the types of cognitive processes and strategies teachers, particularly experienced teachers, employ as they self-direct their learning online can provide important feedback to website developers, professional development administrators, and teacher educators.

To study teacher professional learning in online environments, diverse methods of data collection, including interviews and surveys are needed. It is particularly important to obtain data about teachers' cognitive processes and metacognitive strategies they use *while* they engage in online learning tasks. Resulting data can contribute to the development and refinement of effective online learning environments, including the support tools that can foster successful learning. The purpose of this study, therefore, was to use a cued retrospective think aloud (called

'the virtual revisit think aloud') as the main data source to understand and identify teachers' cognitive processes and metacognitive strategies during a SDOL task. 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 (Author, 2017). The virtual revisit method has been found to generate comprehensive information about individuals' cognitive processes as they make online choices (Author, 2017). Our primary aim of this article is to extend current research on teacher professional learning by employing the virtual revisit think aloud to investigate the types of cognitive processes and strategies used by experienced teachers as they engage in SDOL. Moreover, this work builds on research that has used the virtual revisit think aloud method as an approach for capturing cognitive processes during an online navigational task (Author, 2017). A secondary aim of this article, therefore, is to provide feedback about the virtual revisit think aloud method as an approach for studying teacher learning.

We begin this article with a discussion of the theory that frames this research, teacher cognition. We then discuss the teacher professional learning literature in the context of Canada and provide a brief examination of formal and informal professional development. We end the literature review with an overview of self-directed online learning. The article continues with a discussion of the methodology. This is followed by a discussion of the findings, including educational and research implications.

Literature review

Theoretical framework: teacher cognition

This study is framed by the literature on teacher cognition. Teacher cognition is often guided by a set of organized beliefs, professional goals, and expectations and involves the process of

integrating theoretical and practical information (Bakkenes et al., 2010; Borg 2006). The study of teacher cognition involves the interactions between teachers' cognitive constructs and their classroom practice and has mainly focused on teachers' beliefs and pedagogical content knowledge (e.g., Tondeur et al., 2017), teachers' self-efficacy (e.g., Tschannen-Moran & Johnson, 2011), and teachers' attitudes and motivations (e.g., Baker, 2014). These areas have deepened our knowledge about the factors that affect teacher learning during initial teacher preparation programs and continued professional learning. Additionally, the study of teacher cognition has provided insights into the nuances of teaching and how the act of teaching is influenced by external and internal factors.

As a component of teacher cognition, metacognition is an internal and active process of self-monitoring and self-awareness, and involves knowledge of one's own cognitions before, during, and after instruction (Flavell, 1979). Metacognitive strategies are considered a critical aspect of successful learning and can contribute to a teacher's efforts to understand a particular pedagogical technique or educational issue (Baker, 1989). For the purposes of this study and within the context of online teacher professional learning, cognitive processes and metacognitive strategies are summarized under three main categories: planning, monitoring, and evaluating.

Planning

Reflective of higher reasoning skills, planning involves selecting approaches that coincide with a learning goal and deciding on the allocation of resources (Pintrich, 1999; Yilmaz & Baydas 2017). Learning approaches are intentionally selected and coincide with goals and meaningful decisions (Borko et al.,1981). In the context of teacher cognition, planning for successful learning requires a deep understanding of student needs and classroom practice. Several activities occur almost simultaneously as teachers plan for their learning, including the influence

of prior knowledge on decision-making processes (Lai & Lam, 2011), judgements based on professional experience and pedagogical knowledge (Enow & Goodwyn, 2018), and the ability to think critically about incoming information and whether it is worthwhile to continue along a specific learning path (Griffith, 2017).

Teachers select professional learning opportunities and material that are usually subject-specific and align with their professional goals. This selection process also tends to shift according to the dynamic nature of the classroom and student needs. Planning activities might include setting goals for their students and instructional practice as well as activating prior knowledge about a particular sub-topic or pedagogical technique. These types of cognitive strategies can contribute to the organization of information and comprehension of newly learned material (Pintrich, 1999).

Monitoring

Monitoring is an awareness of task comprehension where the learner prioritizes ideas for attention and filters out informational ambiguities (Pintrich, 1999; Yilmaz & Baydas, 2017). Garrison (1997) describes this awareness as an internal process, a cognitive responsibility, and an essential component of self-directed learning. Encompassing both cognitive and metacognitive processes, monitoring one's learning involves the process of taking responsibility for the construction of knowledge in which newly encountered information is integrated with previously learned material (Garrison, 1997). Existing knowledge is modified and enriched by monitoring one's own learning tasks and activities.

Through critical reflection, teachers monitor their learning by assessing the quality of the learned material in relation to their classroom practice. For instance, in their examination of how elementary teachers engaged in a professional learning activity, Peters-Burton and Botov (2017)

found that participants monitored their learning in regular periods to see if their goals were being met. Participants also iteratively checked that their planning aligned with their learning goals. Through the techniques of self-regulated learning microanalysis (a structured interview protocol that prompts participants to articulate their thinking), the authors captured participants' verbalizations about their monitoring processes. The authors found that participants used an outcome goal to self-monitor their learning and referenced support tools, including checklists and rubrics, as aids to their learning. Other monitoring activities that have been examined in the literature include tracking attention while reading, skimming and scanning for relevance, self-assessment through the use of questions, and being able to repair comprehension when it breaks down (Pintrich, 1999).

Evaluating

Evaluating involves the examination of one's own cognitive processes and the critical examination of presented material (Pintrich, 1999; Yilmaz & Baydas, 2017). As teachers seek out information related to their practice, they must organize and make sense of material at a deeper level. Identifying the main idea from an online resource, deciding which information is most relevant, and inspecting the source authorship are strategies with which a teacher might engage as they evaluate information they encounter during an online professional learning experience. Unfortunately, studies have shown that novice teachers do not spend a sufficient amount of time evaluating the source of online material (Laverty et al., 2008; Lee et al., 2012). Instead, they select online material on the basis of the resource offering a limited amount of text and being written by a teacher. Like any self-directed online learner, teachers who use the Internet to seek out information related to their practice must continuously assess and evaluate source features (e.g., website author) and the mode of information delivery (e.g., text or video).

This type of critical evaluation is essential to obtaining high-quality research-based information.

Setting the context: teacher learning in Canada

In Canada, the vast majority of teachers (> 90%) engage in various forms of professional learning (Canadian Teachers' Federation, 2014; Campbell et al., 2017). 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 opportunities to learn new content, gain insights, and apply new understandings' (Campbell et al., 2017, p. 8). The report, *The State of Educators' Professional Learning in Canada* emphasizes teacher learning as multifaceted; there is not a 'one-size-fits-all approach' to professional learning in Canada and nor should there be (Campbell et al., 2017). Teachers report engaging in multiple professional learning activities, including formal and informal professional development (PD).

Formal PD (e.g., a face-to-face workshop) 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, including SDOL, is unique to each teacher; learning opportunities are chosen by an individual with a particular goal in mind (Callanan et al., 2011). 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; learning is supported, sustained, and self-directed (Campbell et al., 2017; Darling-Hammond & Richardson, 2009). Formal PD can provide teachers with expert knowledge about current topics; however, 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). Additionally, barriers to formal PD were 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. Similar reports from across several countries suggest teachers often feel detached from mandatory PD activities and that these activities do not usually coincide with their learning goals (Appova & Arbaugh, 2018). Thus, 'opportunities for teachers to lead their own learning can benefit individual and collective professional learning and support changes in practices to benefit students' learning' (Campbell et al., 2017, p. 7).

The Internet has become a predominant source of informal PD (Marcià & García 2016). Teachers can access the Internet to informally engage with professional material and collaborate with teachers globally to gain insight into educational issues (e.g., differentiated instruction) or to answer specific questions about content or pedagogical techniques (Donohoo & Velasco 2016; Sharratt & Planche, 2016). Access to 'just-in-time' learning resources and participation in local and global online networks during or outside their workday expands opportunities for teachers' PD (Learning Forward, 2017). However, a major concern is that online resources come from many varied sources, including ministries of education, public and private agencies, and educators themselves (Learning Forward, 2017). Tracking and monitoring the use of PD websites and particular types of resources (e.g., demonstration videos) is 'challenging, yet essential' (Learning Forward, 2017). *The State of Educators' Professional Learning in Canada* (Campbell et al., 2017) summarizes the evidence, experiences, and examples of teachers' professional learning across Canada; however, there is little information in the report about teachers' online learning and no information about teachers' SDOL.

Self-directed online learning

As a component of adult learning theory (Knowles, 1975), self-directed learning (SDL) is a

complex process of independently seeking out and acquiring knowledge (Garrison, 1997). 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 (Caffarella, 1993; Knowles, 1975; Ponti, 2014; Rogers, 1969; Tough, 1971). Numerous studies in the field of SDL have examined learners' perceptions, motivational factors, and readiness to learn (Ayyildiz & Tarhna, 2015; Lee et al., 2014; McCartney et al., 2016; Mello 2016). Self-directed online learning (SDOL) has begun to receive more attention in the field of education and teacher PD (e.g., Author, 2017; Hursen, 2016).

The context of online environments makes SDOL an appealing mode of PD since it removes time and situational barriers. Additionally, teachers are able to access resources that are personally meaningful and have direct connections to their professional goals and classroom contexts (Trust, 2016). Their learning is 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). For practicing teachers, 'the process of learning in online networks requires a negotiation between what knowledge is available and what knowledge can be used in the contexts of [their unique] classroom' (Trust, 2016, p. 291). 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 that directly relates to their classroom context and to their belief systems (de Vries et al., 2014). Appova and Arbaugh (2018) found that teachers are motivated to learn when the topics they seek out correspond with their own interests and student learning needs. 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 types of cognitive processes and metacognitive strategies teachers employ as they self-direct their learning in online environments.

Generating data about the types of cognitive processes and metacognitive strategies teachers use during SDOL can offer both context-specific and broader contributions to the literature. PD administrators, such as school principals and school board consultants, can use study results to inform the allocation of resources for SDOL. Furthermore, understanding the strategies that experienced teachers employ during SDOL has implications for teacher educators who can scaffold pre-service teachers' learning based on what successful online learning might look like.

The innovative methodologies employed in this study also have implications for researchers examining cognitive processes during online learning. Documenting teachers' cognitive processes and strategies during moment-to-moment learning extends adult learning theories (e.g., Garrison, 1997) and enriches our understanding of teacher cognition in online environments. Ultimately, accurately tracking the use of online learning environments by capturing moment-to-moment processes facilitates better decisions about and increased quality of professional learning opportunities for teachers.

Study purpose and research questions

The purpose of this study was to examine elementary teachers' cognitive processes and metacognitive strategies during a self-directed online learning experience using the virtual revisit think aloud method as the main data source. The following research questions guided this study:

(1) What are elementary teachers' cognitive processes and metacognitive strategies during a self-directed online learning task?

(2) How do elementary teachers plan, monitor, and evaluate their learning during self-directed online learning?

Methods

This study employed qualitative methods to gain an in-depth understanding of the cognitive processes and strategies elementary teachers used as they self-directed their learning in an online environment. Qualitative methods provide insight into how individuals experience a particular phenomenon and the processes involved in a particular situation (Rowan & Huston 1997). Within the context of this study, the individuals are 13 experienced elementary teachers and the phenomenon is SDOL. The processes include the types of cognitive and metacognitive strategies involved during a SDOL task.

Context of the study

Participants used the Canadian Financial Literacy Database (CFLD) during their navigational experience. The CFLD was created on the recommendation of the federal Task Force on Financial Literacy, in part as a resource for elementary teachers who are increasingly being asked to incorporate financial literacy into the curriculum (Task Force, 2010). Attention to financial literacy has increased over the past decade and a general consensus in the literature is that if financial literacy is to lead to changes in financial behaviours, then financial literacy education must start early (Bramley, 2012; McCormick, 2009). Governments and school districts have responded to the call for greater access to financial literacy resources at the elementary level by recommending elementary teachers incorporate financial literacy into their existing program (Ontario Ministry of Education, 2010). As such, teachers are keen to find information and professional learning material that can support their teaching and learning about financial literacy (Author, 2019). Additionally, initial teacher education programs in Ontario have only

recently included training in financial literacy, adding to the heavy reliance on continued PD to develop financial literacy curriculum for the majority of teachers who have not received training on this subject (Author, 2019). In an initial review of the CFLD, we found the database to be content rich and interactive; thus, it was deemed appropriate to use as the main online source to examine teachers' cognitive processes and strategies during self-directed online learning.

Participants

Elementary teachers (kindergarten to sixth grade; N = 13) from two major cities in Ontario, Canada volunteered to participate in this study and all participants provided informed consent. The majority of participants taught in a public school (n = 12, 92%); the majority were between the ages of 30-49 (n = 9, 69%); and teaching experience ranged from four years to more than 20 years.

Data collection procedure

Participants met one-on-one with a member of the research team. They first completed a short demographic questionnaire that included questions about teaching experience, current grades taught, and use of the Internet for professional learning. The questionnaire was followed by a 20-minute open-ended SDOL task. Specifically, participants were asked to use the CFLD as they would normally do when seeking information related to their teaching practice. As participants used the database, their actions and online behaviours were captured using Camtasia Studio, a screen-recording computer software program developed by TechSmith. Immediately following their navigation, participants verbalized their thoughts while viewing the screen recording of their learning experience. Following the think aloud, a semi-structured interview was conducted.

Data sources

Multiple sources of data were obtained for triangulation, contributing credibility to the findings (Golafshani, 2003).

Demographic questionnaire

A demographic questionnaire was administered to participants to obtain data on a range of relevant factors (e.g., age, teaching experience, Internet use).

Virtual revisit think aloud

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

Semi-structured interviews

A semi-structured interview followed the participants' explorations and included the following questions: What were your general feelings while you explored the database? What did you find challenging while you explored the database? Were there any resources that stood out to you? What was it about these resources that made them stand out? Overall, did you find this database helpful? Is there anything further that you would like to share about the database or the think aloud?

Data Analysis

This study employed a general inductive approach to analysis in which the data from the think alouds and interviews were reduced to themes as a result of repeated coding, comparisons, and categorizations (Creswell, 2007). Audio recordings were first transcribed verbatim resulting in 13 think aloud and interview transcripts. The think aloud transcripts were first read reflectively to gain a general sense of the participants' thought processes. Phrases from the think aloud transcripts 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 units consisted of simple sentences and longer phrases as opposed to a specified number of words or lines within the transcripts. The research team then reviewed the thought units during two research team meetings. This review helped to establish connections between the thought units and three major categories: planning, monitoring, and evaluating. The review led to six themes related to the types of cognitive processes and metacognitive strategies the participants used during the SDOL task. The transcripts that resulted from the semi-structured interviews were then analyzed using an open-coding technique to corroborate the results from the think aloud analysis.

Findings and discussion

The goal of this section is to provide the reader with an integrative story of the results by discussing rich descriptions of participant data in the context of the authors' interpretations and relevant literature. Thus, the authors decided to combine the findings and discussion sections. We have organized this section according to three major categories (planning, monitoring, and evaluating) and six themes (connecting to practice, tweaking and adapting, narrowing the focus, skimming through, reading for depth, and source credibility). Figure 1 presents a visual model of the categories and themes. The model demonstrates a non-linear iterative process in which the teachers in this study continuously planned, monitored, and evaluated their learning during the SDOL task. Each theme is also presented in Table 1 along with a brief definition.

[insert Figure 1 and Table 1 here]

Planning

Throughout their online learning experience, the participants determined what was important to them in relation to their unique classroom contexts. Their prior knowledge of financial literacy as

well as the knowledge of their students appeared to guide their initial and continued navigational actions.

Theme 1: connecting to practice

All of the participants connected the online information they encountered to their teaching context. They decided to seek out information specific to their practice; they were mindful of the current and future needs of their students and their own instructional goals. For instance, one participant noted a direct connection between the online material and the level of her students: 'I started to look through things that would pertain to my age group, grade 5/6, 10-11 years olds.' Another participant stated that she 'would 100% give this [specific resource] to my students. It's a little hard' the participant admitted, 'but it could spark good conversation if the teacher has good entry points for that grade level, which I do.'

As participants navigated the online database, they demonstrated a clear link between their in-the-moment decisions and their teaching practice. One participant, for example, decided to investigate a lesson plan in greater detail after an initial scan. After focusing in on the details of the lesson plan she stated:

> I could really see using this in the classroom and I think it's something that I would really like to start in September so we're spiraling back to it, so we're doing something every month. Even as I'm looking at it now, I'm thinking of Financial Fridays or something that would be based on that.

Another participant approached the database from the perspective of her students' learning experiences: 'What I was really looking for was a website that I could use myself or take kids to where it was something that we could interact with more than just reading for

information.' To a degree, this participant was putting herself in her students' shoes and reflecting on how her students might interact with a learning resource.

These examples highlight the interconnectedness of teachers' navigational planning, professional learning goals, and classroom contexts (Trust, 2016). As participants planned their navigational route, they situated their thinking and learning within their unique classroom context. Participants made judgements about the newly found material based on their prior knowledge, professional experience, and pedagogical knowledge, aspects of planning that Enow and Goodwyn (2018) acknowledge as critical to being an efficient self-directed learner. Furthermore, participants approached the SDOL task with a 'problem-solving mindset' which allowed them to make a flexible plan (Coiro, 2011).

Theme 2: tweaking and adapting

Throughout their navigations, all participants described how they would extend and modify information they found. This 'tweaking and adapting' strategy appeared to inform the participants' navigational decisions and determine the next direction of their SDOL. As one teacher looked at information related to media and the use of technology in the classroom, for example, she shared: 'I would still like to adapt it or see what I could take from it, because I think that at this point, a lot of kids are getting cell phones before they're in high school.' Another participant discussed how her own decision to delve deeper into a topic was based on whether the material could be combined with her 'supportives and manipulatives.'

These examples show that the participants demonstrated their ability to think critically about incoming information and whether it is worthwhile to continue along a specific learning path. By tweaking and adapting newly learned material participants were able to tease apart the incoming information and deem which material was most relevant to them. Participants appeared

to be in control of not only the path along which they were directing their learning, but also the elements of found material that most resonated with their prior knowledge. Garrison (1997) discussed this approach to self-management as having task control; the learners (the teacher participants) assume responsibility in determining the path of learning. With this responsibility comes an increased awareness of the need to make learning meaningful and to adjust accordingly (Garrison, 1997).

Monitoring

During participants' 20-minute navigation, they considered the relevance of the information by making a conscious decision to narrow the focus of their search. Participants also acknowledged two types of reading strategies, skimming through and reading for depth. These types of metacognitive strategies can lead to knowledge construction in which newly acquired information is connected to existing understandings (Garrison, 1997).

Theme 3: narrowing the focus

Participants verbalized deliberate search strategies that were aimed at narrowing the focus of their search and, ultimately, contributed to their understanding of the incoming information. For instance, one participant explained: 'I clicked for target audience and I thought that will narrow it cause that will help me better understand what I'm looking at it.' Similarly, a participant reflected: 'So now that I've got an idea, I was like, okay now I'm going to click through and see what some of these [lesson plans] are.' One participant used headings as tools within the database to aid in narrowing the focus: 'This page actually has grade level labels which is fantastic, so I'm not going to bother with the ones that are not for grade four.'

These types of search strategies aided participants' ability to track their attention and hone in on the most relevant information. Like the techniques they employed while planning for

their learning, participants concentrated on their students and unique classroom contexts. Consistent with Peters-Burton and Botov's (2017) findings, participants referenced support tools and text features as aids to their learning.

Participants also narrowed the focus by considering their own achievable learning goals: 'I think I'm trying to figure out what would be most useful for me, and because I'm an educator I'm going there, trying to figure out how to find resources specifically for the students that I teach.' Participants reflected on their goals and whether their goals were being met, an iterative process that occurred throughout participants' navigation (Peters-Burton & Botov 2017).

Theme 4: skimming through

All participants described quick reading strategies, such as skimming through or scanning for relevant information. They were deliberate in their actions and acknowledged that scanning information meant 'I'm not reading everything.' This type of surface reading allowed them to get a sense of the relevance of the information and to quickly determine the applicability of the material before delving into particular topics. For instance, one participant stated: 'I'm just reading, and at this point also trying to figure out what I wanted to do, like if I wanted to look at the information further.' Another participant described her search process as a series of scans:

> And don't see anything in there, so I'm going to go through to the next several pages, and I'm going to continue to do this same thing. I'm going to look at the titles, read the descriptions, checking for specific grade assignments, or at least a general grade assignment by grade instead of just general students to see if there's anything worth opening up.

This participant was lightly scrutinizing the material as she quickly skimmed over the titles and descriptions to determine the most important information.

Participants also demonstrated a self-awareness of their monitoring techniques. ‘I don’t think I read the text completely,’ one participant acknowledged, ‘so I’m scanning quickly to see what I can get through.’ This self-awareness was echoed by another participant who described her information gathering process as determining the ‘gist’ of the material:

> I wasn’t quite sure what kind of resources they would be. I wasn’t sure if it would be lesson plans or websites or anything like that, so I just kind of scrolled down to get a gist of what kind of things they’re offering, reading the headings and descriptions as I was going along.

Theme 5: reading for depth

Participants also verbalized their engagement in deep reading, pausing and processing information as opposed to moving quickly through the resources. ‘I was looking through, reading, pausing a little longer to read it since I was thinking that I was on the right track,’ one participant noted. Participants spent ‘quite a bit of time reading [lesson pages] cause [they were] curious to see how they would present this to the class.’

Participants most often demonstrated their self-awareness of deep reading after performing a skimming through strategy (as demonstrated by both the think aloud transcripts and screen capture recordings). Employing a skimming through strategy may have alerted participants to attend to potentially meaningful information. When engaging with the material at a deeper level, participants were monitoring their depth of information processing. One participant shared how her attention to the presented information was directly related to her ability to successfully interpret what she was reading: ‘I was reading it, the words at the top of the page and putting my cursor over it to make sure that I was really understanding.’

Monitoring activities employed by the participants in this study were essential to participants' comprehension and knowledge construction. To achieve deep levels of comprehension, participants narrowed the focus of their learning path and skimmed through the presented material for the most relevant information. Participants related information to prior knowledge, interpreted the incoming information, and continuously connected new material with their professional experiences. It is likely that participants' interest in the material they thoroughly read impacted their depth of processing (Catrysse et al., 2018; Garrison, 1997,). Garrison (1997) suggested that monitoring one's own learning directly coincides with their responsibility to construct meaning. In the current study, knowledge construction appeared to occur during the process of narrowing the focus, skimming through, and reading for depth. Throughout their SDOL experience, participants revisited their purpose and goals, while at the same time they monitored their understanding (Coiro, 2011). They adjusted their speed and direction while clarifying their purpose and goals. It is possible that these self-monitoring strategies modified and enriched existing content and pedagogical knowledge.

Evaluating

The quality of the resources on the database appeared to affect the participants' navigation. Participants specifically reflected on the credibility and trustworthiness of the source. Inspecting author credentials involves critically thinking about the incoming information, interrogating the source, and discriminating reliable from unreliable material.

Theme 6: source credibility

Half of the participants spoke directly about the validity of sources related to who was providing the information in the database. For instance, two participants found banks and other known sources to be trustworthy while one participant specifically spoke about the authorship of a

source in relation to the community in which she teaches. Another participant was skeptical of the banks as sources for financial literacy education material: ‘A lot of the links went back to banks, and so that to me meant, well, what is the ulterior motive of this? Who is supplying this information, and what do they want out of this?’ This participant continued: ‘I was starting to pay attention to who was sponsoring [and] who developed the resource at that point.’

The suggestion that financial institutions may have underlying motivations (e.g., to sell their product) for distributing resources aimed at teachers and their students was echoed by another participant during the middle of her navigation: ‘This is where I started noticing that most of the people funding these are credit unions or something that has to do with banking, which then always makes me wonder about ulterior motives.’ A different participant described her technique for identifying the source: ‘So now I’m starting to notice the names on the right hand, I guess not sponsor but third party, and that’s making me click on it, just seeing who it’s from.’

General discussion

From putting themselves in their students’ shoes to critically evaluating the credibility of online resources, the teachers in this study demonstrated a range of strategies to help them plan, monitor, and evaluate their learning. The complexity of the cognitive and metacognitive processes at play during the instance of SDOL explored here indicates a depth that goes beyond common assumptions that searching for information on the Internet is a relatively simple, straightforward process. For the teachers in this study, these instances of SDOL reveal an interconnected, iterative process of overlapping and complementary strategies (as emphasized in Figure 1).

The strategies related to planning, monitoring, and evaluating emerged not in a linear pattern, but in an iterative process with participants shifting their focus between the three navigational orientations as they worked toward learning about materials that they deemed useful, credible, and appropriate for their unique classroom contexts. Taken together, these findings indicate that the teachers who participated in this study were engaging in a variety of cognitive practices and diverse navigational strategies in order to effectively structure their SDOL experience. Throughout this study, teachers indicated that their planning, while deeply rooted in their own professional judgements and experiences (Enow & Goodwyn, 2019), also integrated aspects of active, deliberate monitoring, similar to those Peters-Burton and Botov (2017) found in their study. The six themes discussed here overlapped and fed into each other. These findings indicate that the processes of planning, monitoring, and evaluating, rather than being distinct constructs, are interconnected in an iterative cycle of SDOL.

Implications for research and practice

The online context in which this study occurred contributes to the literature on adult and self-directed learning. While teacher cognition and SDL have been extensively investigated, no research has examined the iterative process of planning, monitoring, and evaluating during teachers' SDOL. As such, our findings contribute to the study of teacher cognition and PD. Future research can corroborate these findings by examining the cognitive processes that occur in different online contexts and during both formal and informal professional learning. Additionally, because opportunities for teachers' SDOL abound with other online resources (Author, 2019) further research is necessary to better understand the ways in which teachers interact with the range of learning resources available on the Internet.

The findings of this study also suggest that preparing to teach a lesson is not a single step process. Teacher educators can model this process with their pre-service teachers and build in space in assignments that promote metacognition. Additionally, due to the role evaluation plays in teachers' SDOL, it is imperative that teacher educators guide the process of source evaluation by developing instruction that supports teachers in their considerations of what makes a resource appropriate and credible. Further, implications for practice include opening conversations among teachers and school personnel that support teachers in developing individual strategies that allow space for planning, monitoring, and evaluating when they are engaging in SDOL. This can help teachers seek out SDOL opportunities for sustained learning that are not single experiences, but that are structured to foster depth and reflection.

A secondary goal of this study was to provide feedback on the virtual revisit think aloud. Based on the findings of this study, the virtual revisit think aloud seems to be an effective approach to understanding cognitive thought processes that occur during learning. In general, research that has used the think aloud methodology is extensive (Ericsson, 2003). Over the past several decades, cognitive researchers have employed the think aloud to gather data about participants' cognitive structures and processes (Ericsson, 2003). The think aloud method makes monitoring cognitive processes possible and can generate direct data about the cognitive processes that occur during task performance. Across research domains a variety of think alouds have been employed, including the concurrent and retrospective think aloud. Each type of think aloud, however, has its limitations. For instance, the concurrent think aloud in which participants verbalize their thought processes while simultaneously completing a task, puts a greater demand on a participants' cognitive load. A higher cognitive load could result in limited task

performance and surface-level verbalizations. The virtual revisit think aloud appears to avoid these limitations by allowing participants to complete a task and verbalize their thoughts separately. The screen-recording is used as a cue to aid in the recall of original thoughts allowing for deeper levels of verbalizations. Findings from this study, therefore, suggest that the virtual revisit can result in thorough and descriptive verbalizations and that these verbalizations can contribute to comprehensive insights into teachers' SDOL.

Study limitations

There are three main study limitations that should be considered when interpreting the findings. The first limitation relates to the online database used in this study. While the CFLD was appropriate for our study, the findings are limited to the resources on this database. Future research will need to consider additional online resources across subject areas. A second limitation to note is the relatively small sample size. While the study does follow a qualitative approach and the small sample size provides rich descriptions about participants' experiences, a larger group of participants will contribute to the credibility of the study's findings. A third limitation involves reactivity, 'influences of the verbalizations on the decision process' (Ranyard & Svenson, 2010, p. 119). Reactivity may have occurred as a result of participants' awareness that they were completing a task in the presence of researcher.

Conclusion

This research describes an in-depth representation of elementary teachers' SDOL experiences, specifically their cognitive processes and metacognitive strategies as they navigated an online database. Planning, monitoring, and evaluating are overlapping constructs that occur during SDOL and were observed during the 20-minute navigation. While this study is specific to one educational database and included a relatively small sample size, the results provide preliminary

insights into teachers' SDOL. The cognitive and metacognitive processes at play in teachers' SDOL are complex and iterative. As teachers increasingly turn to online resources for their professional learning, it is essential to understand the cognitive strategies they employ during SDOL.

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Table 1.

Themes

Category	Theme	Definition
Planning		
	Connecting to practice	Making judgements about newly found material based on prior knowledge, professional experience, and pedagogical knowledge.
	Tweaking and adapting	Extending and modifying information based on professional goals and student needs.
Monitoring		
	Narrowing the focus	Using search strategies that aid in the ability to track attention and hone in on the most relevant information.
	Skimming through	A type of surface reading that provides a sense of the relevance of the information and quickly determines the applicability of the material.
	Reading for depth	Engaging with material at deeper level of information processing.
Evaluating		
	Source credibility	Reflecting on the validity and trustworthiness of the sources.