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Teachers' cognitive processing of complex school-based scenarios: Differences across experience levels

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HIGHLIGHTS

- Expert teachers process school scenarios differently to beginning and pre-service teachers.
- Teacher groups differed in strategy, scope, content, and reasoning used to process the scenarios.
- Group differences are starkest when processing scenarios without pre-existing answer options.
- Teachers are more confident in their answers to school scenarios than non-school scenarios.

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ABSTRACT

Teachers are confronted with and must process challenging situations every day. Yet the development trajectory of their processing ability is unknown. Our two-part mixed method studies use a think-aloud methodology to understand how teachers cognitive process difficult school-based and non-school-based scenarios. Studies 1 and 2 examine the differences between expert, beginning, and pre-service teachers without and with pre-existing response options, respectively. Results from qualitative (but not quantitative) analyses indicate group differences in strategy, scope, content, and reasoning. Furthermore, we find that teaching is a domain-specific expertise. We discuss how this information can inform teacher education and professional development programs.

Teachers encounter challenging school situations every day. Although a teacher's level of effectiveness increases with years of experience (Atteberry, Loeb, & Wyckoff, 2015), the specifics of this developmental trajectory is unclear. Cognitive psychologists have been studying development of expertise since the 1960s, exploring domain-specific skills such as chess (Chase & Simon, 1973; de Groot, 1966), physics (Larkin, McDermott, Simon, & Simon, 1980), and music (Colley, Banton, Down, & Pither, 1992). In contrast, studies on the development of teacher expertise are lacking. An explicit understanding of the cognitive processes of expert teachers can be particularly useful for training of pre-service teachers and for professional development of beginning teachers (Berliner, 2001). This explicit understanding can function as a scaffold which teachers can refer to, modify, and apply to their own professional lives (Shulman, 1986) given that cognitive processes are malleable (Hennissen, Beckers, & Moerkerke, 2017). The need for such scaffolds is high as teachers with limited teaching experience are expected to perform at equal professional competence levels to their experienced colleagues (Tait, 2008).

A seminal study in the area of cognitive processes and teacher expertise is by Swanson, O'Connor, and Cooney (1990). The researchers examined the cognitive processing differences between expert and novice teachers in solving classroom discipline problems using a think-aloud methodology. A think-aloud methodology involves a participant verbalizing his or her thoughts while solving problems. In effect, the methodology allows investigations into teachers' cognitive processing; that is, the information attended to, strategies employed, and inferences drawn from the information without interrupting the flow of working memory (Ericsson & Simon, 1984). Using a similar methodology, Swanson and colleagues (1990) found that expert teachers focused on defining and representing the problems, unlike novice teachers who focused on generating possible solutions to the problems.

The current set of two mixed-method studies will extend

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Swanson and colleagues' (1990) study in five important ways. First, we recognize that teachers frequently encounter a variety of challenging scenarios other than classroom discipline problems, such as meeting departmental deadlines and dealing with anxious parents. Thus, a variety of school-based scenarios, including classroom discipline scenarios, are used in the studies. Second, we recognize the usefulness of studying teachers with more than two experience levels (e.g., pre-service vs in-service or early-career vs late-career teachers as is often used in previous studies) when examining cognitive processes, in order to obtain a more nuanced understanding of the trajectory of expertise development. Accordingly, we compare the cognitive processes of teachers in three key stages of their career—at the pre-service, beginning, and experienced ('expert') stages. Third, we compare teachers' responses to school-based scenarios with non-school-based scenarios (i.e., medical-based scenarios) in order to explore the domain-specificity and career-stage specificity of teacher expertise. Fourth, most studies on cognitive processing have examined the expert answer *generation* process. However, how experts *recognize* appropriate responses when presented with a range of predefined responses is also of interest (e.g., Gauthier, Williams, Tarr, & Tanaka, 1998; Rhodes, Hayward, & Winkler, 2006; Tanaka & Curran, 2001). Hence, we not only compare the cognitive processing differences between the three teacher groups when presenting scenarios without response options (*generation;* Study 1) but also with response options (*recognition;* Study 2). Fifth, cognitive processing studies have traditionally examined how one chooses to respond yet their confidence in whether their response is accurate has not been captured. Thus, we examine the confidence ratings of the participants' responses to the scenarios.

In summary, this two-part mixed methods paper aims to identify the cognitive processes undertaken by pre-service, beginning, and expert teachers when responding to challenging school-based and non-school based scenarios. Specifically, the similarities and differences in the levels and content of the mental representations and confidence ratings between the three teacher groups are examined.

1. Study 1

In Study 1 we examined how expert teachers differ in the way that they solve school-based problems as well as non-school-based problems compared to beginning and pre-service teachers. Based on previous research in both education and cognitive psychology, we expected differences between the three teacher groups in five key areas: strategy, scope, content, reasoning, and confidence ratings.

1.1. Cognitive processing of school-based scenarios

Strategy. The mental structure of organizing and accessing knowledge to solve problems differs between experts and novices (Ericsson & Simon, 1984), manifested in the different strategies that experts use. Specifically, experts tend to seek to understand the problem before proposing solutions (Chi, Glaser, & Farr, 1988). Indeed, Swanson and colleagues (1990) found that novice teachers addressed classroom discipline problems at a surface level, whereby they focused immediately on generating a solution to a perceived problem. The problem is compounded as novice teachers' visual focus is limited; novice teachers tend to focus on one event for a long time at the sacrifice of noticing other relevant events (Van den Bogert, van Bruggen, Kostons, & Jochems, 2014). Such a strategy of immediately generating solutions and failing to notice other events mean novices may miss the principles and abstractions underlying the problem. On the other hand, expert teachers used more analytical and evaluative strategies than other strategies. Other studies using various media (e.g., classroom videos and static slides) also support the finding that expert teachers are able to better interpret and evaluate classroom events and behaviors than advanced beginner and novice teachers (; Carter, Cushing, Sabers, Stein, & Berliner, 1988; Nelson, 1988; Peterson & Comeaux, 1987). Expert teachers' greater ability to analyze and evaluate scenarios is a result of their extensive experience (Berliner, 1988). In this vein, we expected differences in the frequencies of analytical and evaluative strategies made about the challenging school-based scenarios between the three groups, with the highest frequency from the expert teachers (H1).

Scope. Experts, through years of experience, have formed highly developed schemas, which are templates of organized and interrelated thoughts, patterns, and behaviors (Anderson, 1984). Associated with a more developed schema is an expert's ability to generate more solutions to problems than novices (Kagan & Tippins, 1991), as the schemas are more accessible, detailed, nuanced, and have formed multiple links with other schemas and ideas than a novice's schema (Shulman, 1986). Thus, we expected differences in the frequency of possible responses generated for the school-based scenarios between the three groups, with the highest frequency from the expert teachers (H2).

Content. Based on educational literature on behavioral modification and psychoeducational procedures, Swanson and colleagues (1990) divided expert and novice teachers' responses to classroom disciplinary scenarios into two categories: internal-based responses and external-based responses. Internal-based responses were activities that focused on modifying the level of internal controls within the student. Examples included providing empathy, setting up a time to discuss with the student, and communicating with parents. External-based responses focused on modifying the structural elements of the classroom. Examples included providing contingent praise, giving warnings, confronting the student, and sending them to administration. We used Swanson and colleagues' internal-based and external-based response categories as a basis to classify our responses as well as including other response types that emerged from the corpus. Swanson and colleagues found that expert teachers were more likely to use external-based responses and novice teachers were more likely to use internal-based responses. We expected differences in the frequency of response types between the three teacher groups for the school-based scenarios (H3).

Reasoning. Novice teachers often are overwhelmed by classroom events (Olson & Osborne, 1991) as they manage multiple simultaneously occurring events while teaching. Novice teachers, given the multiplicity and complexity of the events and their relative lack of experience, often cannot respond effectively to these events (Doyle, 1986). According to the dual process model of cognition, this is the result of cognitive overload, whereby the resources needed to process external stimuli exceeds the internal resources available (Sweller, 1989). In contrast, an expert's large mental database of actual experiences is more readily accessible than novices' mental database (Shulman, 1986) and they tend to not experience cognitive overload. As a result, expert teachers have the capacity articulate more clearly the justification for their choices of responses to challenging school-based scenarios. Thus, we expected differences in the number and sophistication of the reasoning provided for their choice of responses in the school-based scenarios between the three groups (H4).

A particular form of reasoning that experts tend to use is analogical reasoning (references to their previous experiences). This type of reasoning is helpful as experts are able to access their experiences from the past and use this knowledge to guide them in responding to future challenging scenarios. Indeed, business