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INFLUENCE OF SCHOOL MEMORIES ON PRACTICING MATHEMATICS TEACHERS' TEACHING OF ALGEBRA

by
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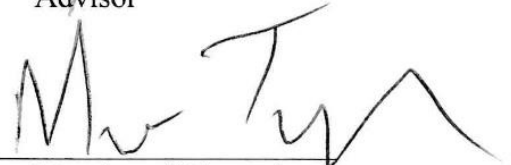
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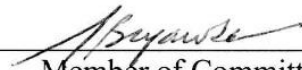Department of Education

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All praise and *thanks* to the Almighty *Allah*

who gave me the strength and ability to complete this thesis

AN ABSTRACT OF THE THESIS OF

Yusra Khattab   for   Master of Arts

Major: Mathematics Education

Title: Influence of School Memories on Practicing Mathematics Teachers' Teaching of Algebra

Many teachers enter the teaching profession with a huge repertoire of memories about their schooling experience. As students, they spent around 15 years in school observing teachers and interacting with them. This leave them with some ideas about what teaching is and make some believe that they know how to teach, what works and what doesn't work in teaching, since they were once students. Research on memories suggest that autobiographical memories have a directive function in which memories of past experiences direct or guide individuals' current and future attitudes and behaviors. The purpose of this study is to (1) describe the structure and content of practicing mathematics teachers' autobiographical school memories of their experiences of learning algebra at school, (2) examine how these memories influence their current teaching of algebra, and (3) investigate if there is a difference in the directive function of autobiographical memories between novice and expert teachers and between teachers who have a teaching diploma and those who do not. The study follows a qualitative research design. The participants were practicing mathematics teachers who teach at the intermediate level in private schools in Greater Beirut Area. Data were collected using a questionnaire and individual semi-structured interviews, 42 teachers filled the questionnaire, and 8 of those teachers were later selected for the interview based on the analysis of the questionnaire. Results show that the participants remembered a variety of practices they experienced while learning algebra. They recalled how their teachers explained lessons, what activities they were engaged in, how their teachers assessed them, how the discussion was carried out inside the classroom, and how their teachers interacted with them. They also remembered their own achievements, difficulties, and ways of studying algebra. The influence of these memories was manifested in several ways. Positive memories guided the participants into reproducing the good practices that they have experienced when they were students. In contrast, negative memories guided the participants into avoiding the repetition of bad practices that they have experienced. Moreover, the participants' memories of their difficulties in learning algebra directed them to understand the difficulties that their students currently face., On the other hand, some memories of the participants' achievements and positive interactions with their teachers inspired them to become mathematics teachers. Our results also show that there were some differences in the extent to which novice and expert teachers are influenced by their memories. Some of the novice teachers depended a lot on their school memories to guide their teaching, while others did not refer to the practices they experienced as students. On the other hand, expert teachers were more influenced by their school memories when they started teaching, but later on with experience, they learned several other practices that they now follow. Our results also show that there were differences in the influence of memories between and within the categories of teachers who have a TD and those who do not.

CONTENTS

ix

x

TABLES

CHAPTER I

Introduction

Background

A lot of the research done in the field of education investigated different methods to improve students' learning. Education researchers try to understand the context of the school, the classroom, the environment, the teachers, the students, and the relationships between them, etc. Researchers have proposed and recommended different new methods to improve teaching and learning. In the past few years, there has been an emphasis on student-centered teaching, the use of technology in the classrooms, constructivism, inclusive education, differentiated instruction, STEM education, etc. However, despite the calls for educational reform, the teaching of mathematics remained to be conventional and traditional (Agudelo-Valderrama, Clarke, & Bishop, 2007).

"The literature shows that many mathematics teachers who make attempts to modify their teaching practices are unable to overcome what they see as insuperable barriers to change" (Agudelo-Valderrama et al., 2007, p.71). One of these barriers is that several teachers find it hard to imagine and understand how these new approaches will be incorporated into their classrooms and in their teaching. The question here is how we can expect teachers to teach in reformed ways when they were schooled through traditional approaches, while not being well trained to use the new approaches. When teachers face a difficulty in implementing the new approaches, and in the absence of sufficient support, they prefer to rely on their past experiences and teach in the ways that worked for them (Miller & Shifflet., 2016).

Several studies examined why teachers teach the way they do and what are the sources of their content and pedagogical knowledge. Different sources were identified, that include their teaching experience in the classroom, their interaction with other teachers, teacher-training

1

courses, and their K-12 experiences as students (Oleson & Hora, 2014; Rayati & Roshdi, 2013). Teachers' K-12 experiences as students represent the teachers' first encounter with teaching. Students spend around 15 years in school observing teachers and interacting with them; they leave school with a huge repertoire of memories about their schooling experience. For teachers, these memories may become the basis of their conceptions of teaching that inform their decisions and teaching practices (Johnson, 1999 as cited in Rayati Damavandi & Roshdi, 2013). They believe that they know how to teach and what works and what not because they were once students (Miller & Shifflet, 2016; Miller, 2017). Teachers' school memories influence their view of what teaching is and how a teacher should behave with students concerning pedagogical and content issues (Lortie, 2002). However, teachers' observation while they were students is incomplete since they were not exposed to how teachers prepare lessons and on what basis they make decisions regarding what and how to teach (Lortie, 2002).

Usually before going into their classroom to teach, teachers go through a university degree in the subject matter they want to teach and attend a teacher education program to receive a diploma that prepares them to teach. Teachers carry their school memories into their university classes; they compare and contrast what and how their teachers used to teach them with what they are learning (Miller & Shifflet, 2016). Teachers then, enter their own classrooms to teach; during their teaching, they may revisit their school memories, reflect on them and act in light of them (Oleson & Hora, 2014). Teachers' memories of the way they were taught and learned may influence the way they teach in different ways (Oleson & Hora, 2014); some may decide to reproduce the way they were taught while others try to teach in a different way because they did not like the way they were taught.

One of the most remembered subjects in the memories of school is mathematics (Haught et al., 2016). Individuals often remember positive or negative experiences with their mathematics classes, lessons, and teachers, depending on the kind of experiences they had during their school years; the type of teachers they had, their performance in mathematics, the way they were taught, etc. (Bekdemir, 2010; Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010; Haught et al., 2016). Within mathematics, the word "algebra", in specific, was found to evoke negative memories of an abstract topic in mathematics (Greenes et al. 2001; Lee and Freiman 2004 as cited in Wilkie, 2016), because of the difficulties students face while learning algebra. However, other individuals recalled positive experiences with algebra, they remember it as a challenging topic they enjoyed (Millsaps, 2000; Van Amerom, 2002). The students, who choose to become mathematics teachers, enter the profession carrying with them their memories of school. Most teachers remember being taught algebra through traditional approaches (Boaler & Greeno, 2000; Lortie, 2002; McLaughlin & Talbert, 2001 as cited in Frost, 2007 as cited in White-Clark, et al., 2008), through lectures, practice exercises, and textbook-based lessons (White-Clark, et al., 2008). While some others recalled the use of word problems as opposed to drill exercises and real concrete examples in their learning of algebra (Millsaps, 2000).

Memories of individuals' past experiences are called autobiographical memories (Fivush, 2012; Sternberg & Sternberg, 2012a). Studies on autobiographical memories evolved over time and focused on different aspects of autobiographical memories that include how and why people remember their past (Berntsen & Rubin, 2012; Bluck et al., 2005). Researchers studied the representation, accuracy, structure, content and functions of autobiographical memories (Berntsen & Rubin, 2012). Researchers were interested in whether memories are represented in verbal or visual forms in the brain (representation), whether the remembered events are

reproduced or reconstructed, vivid or false (accuracy), whether the memory recalled is specific or general (structure), positive or negative (emotional content), and what themes do the memories include (content) (Berntsen & Rubin, 2012). The studies mainly targeted the representation, accuracy, structure and content of autobiographical memories, however, few studies focused on the function of autobiographical memories, i.e. why or for what uses do individuals remember their past experiences (Pillemer, 2003).

Research on memories suggests that memories have a directive function in which memories of past experiences direct or guide individuals' current and future attitudes and behaviors (Pillemer, 2003; Pillemer & Kuwabara, 2012). Memories of past experiences "come to mind repeatedly and provide guidance when encountering new life challenges. Their directive force is felt when confronting novel situations that are structurally similar to the original episode recorded in memory" (Pillemer 2003, p. 196).

Analysis of memory function is enriched by the analysis of the content and structure of autobiographical memories (Pillemer, 2001). Researchers did not only study how autobiographical memories influence individual's attitudes and behaviors, they also looked at whether distinct memory structure and content have the same or different directive function, and they also explored individual differences in the use of autobiographical memories (Biondolillo & Pillemer, 2015; Kuwabara & Pillemer, 2010; Pillemer et al., 2003; Vranic et al., 2018).

Consequently, the questions that arise here are: what memories do teachers actually have about the way they learned algebra at school? What aspects of learning algebra are more memorable? Do they have more positive or negative memories about their learning of algebra? How specific are their memories? Do these memories direct how they teach algebra? How do these memories influence their teaching of algebra? Do teachers teach in the same way they were

taught? Are novice and expert teachers influenced by their memories in the same way? Are teachers who have a teaching diploma and those who do not have, influenced by their memories in the same way? These questions led the present study to be conducted.

Purpose of the study

The purpose of this study is to describe the structure and content of practicing mathematics teachers' autobiographical school memories, and to examine how these memories influence their current teaching of algebra. The study also investigates if there is a difference in the directive function of autobiographical memories between novice and expert teachers and between teachers who have a teaching diploma and those who do not.

Research Questions

(1) What are the structure and content of teachers' autobiographical memories of their experiences of learning algebra at school?

(2) How do the emotional content and structure of autobiographical memories of learning algebra influence the practicing mathematics teachers' teaching of algebra?

(3) How does the influence of autobiographical memories differ between novice and expert teachers and between teachers who have a teaching diploma and those who do not?

Rationale

This study targeted the school memories of novice and expert practicing mathematics teachers who teach at the intermediate level in private schools in Beirut – Lebanon. In addition, I investigated the influence that these memories have on their teaching of algebra. In this section,

we provide justifications for the focus of this study on (1) the content and influence of memories, (2) the memories of learning algebra, (3) the Lebanese context, and (4) novice and expert practicing teachers.

Focusing on the content and influence of memories. In the past, research on memory focused mainly on memory structure, organization, and accuracy (Pillemer, 2003). The studies relied on experiments done in laboratory settings using different stimuli such as numbers and words (Pillemer, 2003). In the early 1980, research on memory shifted to a more naturalistic approach, where researchers started focusing more on the analysis of memory functions (Pillemer, 2003). Memory functions were defined as the "real world usefulness or adaptive significance of memory mechanisms" (Bruce, 1989, p. 45 as cited in Pillemer, 2003). Three memory functions were identified: *Social functions* in which memories are used to facilitate interpersonal interactions through memory sharing, *Self functions* where memories promote personal identity and support a sense of coherence or continuity over time, and *Directive functions*, which involve using memories to make decisions in the present and to guide future behaviors. (Bluck, 2003; Bluck et al., 2005; Pillemer & Kuwabara, 2012, p. 184). Research on memory functions focused more on the social and self-function of memories, while the directive functions have received comparatively little attention (Pillemer, 2003). Bluck and her colleagues (2005) stated that there are two areas in research on memories that are understudied and these are memory content and memory functions. Therefore, there is a gap in the research literature related to memory content, memory functions in general, and the directive function of memory in specific.

In addition to that, when reviewing literature related to the functions of autobiographical memories, none of the studies targeted the school memories of teachers. Hence, this study will

6

extend the research on memory content and the directive function of memory and will fill a gap by studying the school memories of teachers. We are interested in examining how teachers' autobiographical school memories direct their current practices in teaching algebra.

Focusing on memories of learning algebra. Research about teachers' memories targeted teachers who teach different subjects such as geography, science, mathematics, and English, but limited research was done in each area. Even within the subject of mathematics, most research focused on the memories of mathematics in general (Frost, 2010; Guillaume & Kirtman., 2010; Millsaps, 2000; Scott, 2005), while only one study focused on primary level geometry teaching and learning (Barrantes & Blanco., 2006). In this study the conceptions of primary prospective teachers about school-level geometry and its teaching and learning were described and analyzed considering the memories and expectations the prospective teachers provided about teaching and learning of geometry (Barrantes & Blanco., 2006). No studies targeted teachers' school memories of learning and teaching algebra in specific.

Learning algebra is associated with a transitional phase (transition from arithmetic to algebra) with which strong emotions (positive and negative) are attached (Christou & Vosniadou, 2012; Van Amerom, 2002; Wilkie, 2016). The strong emotion experienced at the time of the events and novelty of the events are two possible reasons for why events persist in memory and are remembered in later years (Pillemer et al., 1996). In this study, our focus is on the memories of teachers' experiences of learning algebra at school, and how do these memories influence teachers' teaching of algebra. A quick review of studies in algebra education shows that students' memories of learning algebra at school have a strong emotional component attached to them. The word "algebra" may evoke positive or negative memories, depending on

the individual experiences with learning it. Some individuals recalled positive experiences with learning algebra, they remember it as a challenging topic they enjoyed (Millsaps, 2000; Van Amerom, 2002). However, many students have negative memories of algebra (Greenes et al. 2001; Lee and Freiman 2004 as cited in Wilkie, 2016), because of the difficulties they faced while learning it. Most students find algebra a difficult abstract topic that makes no sense and has no connection to real life (Van Amerom, 2002; Wilkie, 2016). These issues are amplified with teaching approaches that do not make the learning any easier or interesting (Van Amerom, 2002).

Studies on algebra also show that students' introduction to algebra is a transitional novel event in their lives. Algebra is defined as "a branch of mathematics that deals with symbolizing general numerical relationships and mathematical structures and with operating on those structures" (Kieran, 1992). Students are usually introduced to algebra after studying arithmetic for some time (Lins & Kaput, 2004). This transition from arithmetic to algebra had been a topic of discussion for researchers over time (e.g. Christou & Vosniadou, 2012; Gallardo, 2002; Linchevski & Herscovics, 1996; Van Amerom, 2002; Warren, 2003). Some students succeed in having a smooth transition from learning arithmetic to learning algebra. These students grow up having positive memories of their positive experiences with learning algebra (Millsaps, 2000; Van Amerom, 2002). However, other students fail to have a smooth transition from learning arithmetic to learning algebra, a situation that creates major difficulties for them and leaves them with unpleasant memories (Christou & Vosniadou, 2012; Van Amerom, 2002; Wilkie, 2016).

Therefore, this study will fill a gap in literature by focusing on teachers' memories of their learning of algebra at school.

Focusing on the Lebanese context. Research on teachers' memories and the directive influence of memories were conducted in several countries such as the United States (Ellsworth & Buss, 2000; Frost, 2010; Guillaume & Kirtman, 2010; Kuwabara & Pillemer, 2010, Millsaps, 2000; Miller & Shifflet, 2016), Spain (Barrantes & Blanco, 2006), Turkey and Slovakia (Hudson et al., 2010), Ireland (Dolan et al., 2014), Iran (Rayati Damavandi & Roshdi, 2013), Finland (Heikkilä et al., 2012), and Canada (Chang-Kredl & Kingsley, 2014). However, no studies about teachers' memories and the directive influence of memories were conducted in Lebanon. There was one study that was conducted by Ghamrawi (2019) about the indelible memories of science classroom practices of students in Lebanon, however the participants in the study were students who graduated and went to pursue different careers, so they were not necessarily teachers.

This study was implemented in private schools in Beirut, in which the Lebanese mathematics curriculum is taught. The reason this is an interesting context for this study is that the Lebanese national mathematics curriculum, which is used in most private and public schools in Lebanon (Mullis et al., 2016) was implemented in 1998 and was reviewed and modified in 2003, but no further revisions and modifications were done later (Mullis et al. 2016). Therefore, many teachers who are currently teaching have encountered the same curriculum and textbooks as students; this issue makes studying teachers' memories and their influence on their teaching in the Lebanese context reasonable.

Teachers were selected from private schools, since private schools constitute around 60% of the schools in Lebanon (Jurdak & El Mouhayar, 2014); and due to ease of access, the Greater Beirut Area was chosen for this study. The intermediate grade level (Grades 7, 8, and 9) is chosen for this study, since according to the Lebanese curriculum, the study of Algebra starts to be taught in these grades (CERD, 1997).

Focusing on novice and expert practicing teachers. In studies about teachers' memories, researchers targeted prospective and practicing teachers, but the focus on prospective teachers' school memories and their expectations of teaching was more evident (e.g. Dolan et al., 2014; Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010; Hudson el at., 2010; Miller & Shifflet, 2016; Scott, 2005; Sexton, 2004; Sexton, 2007). The studies that targeted prospective teachers reported the teachers' intentions of how to teach in light of their prior experiences, however targeting practicing teachers reveal the real actions that teachers actually took inside the classrooms in response to their memories. Little attention was given to practicing teachers' school memories and their influence on their teaching. The studies that dealt with practicing teachers examined how their different experiences, including their school memories, teaching education courses, their own teaching experience, and how their interaction with colleagues and family members shape their teaching (Frost, 2010, Rayati & Roshdi, 2013, Millsaps, 2000). This study targeted practicing mathematics teachers to extend the research in this area.

The practicing teachers targeted in the published studies have been teaching for a range of 5 to 28 years, but no study targeted novice teachers in their first years of teaching. It was said, prospective teachers "prefer to fall back on preconceived ideas of teaching and learning rather than critically reflect on practice – it is simply easier to rely on past experience" (Moore & Ash, 2002 as cited in Miller & Shifflet., 2016, p.22). This study included novice-practicing teachers, in their first 3 years of teaching along with expert teachers, to examine how they use their memories in their teaching after completing their degrees and going to the actual field of teaching.

The study also targeted expert practicing mathematics teachers who have been teaching for more than 3 years. In a study done by Pillemer and his colleagues (1988), they found that "the

proportion of specific memories decreased as the number of years since graduation increased"
(Pillemer et al., 1988 as cited in Pillemer et al., 1996). For this reason, this study will include
expert teachers as well to compare between the directive influence of memories between novice
and expert teachers.

Therefore, this study examined the school memories of learning of algebra practicing
mathematics teachers and their influence on their teaching of algebra. This study targeted novice
and expert practicing teachers who are teaching the Lebanese curriculum in private schools in
Greater Beirut Area - Lebanon, and examined the differences in the influence of their school
memories on their teaching. This study also attempted to analyze the influence of
autobiographical memories on teachers' practices of teaching algebra from the perspective of the
directive function of autobiographical memories.

Significance

This study will be of significance for research about teachers, for teacher educators, and
for teachers. For research, this study will provide insights into the degree to which mathematics
teachers' teaching is influenced by their memories of learning algebra. This study will also
highlight the practices that practicing mathematics teachers tend to replicate and the practices
that they avoid repeating. For teacher educators, this study might show teacher educators the
importance of paying attention to teachers' prior education experiences in order to consider this
factor when training new teachers. For teachers, this study might make teachers aware of their
own memories and practices in order to assess and evaluate what they are doing inside the
classroom.

CHAPTER II

Literature review

Through their lifetime, individuals pass through different experiences, some of which are deemed as important and remembered for a long time, and others are just lived in the moment and forgotten later on. Going to school is a major event in most people's lives; individuals spend a considerable time of their lives in schools, at least 5 hours per day for around 15 years. Thus, memories of the school constitute a major portion of their memories.

Memories are essential for our learning, and cognitive models of human learning emphasized this by declaring that the humans do not learn new knowledge from scratch but that we understand new knowledge in light of our prior knowledge and experiences that are kept in our minds as memories (Rayati Damavandi & Roshdi, 2013). Through memories, we are able to remember what we did in the past to manage our present and future lives.

Students leave school with a huge repertoire of memories of their learning experience. Those who decide to pursue a teaching profession, go into teaching with a set of memories that might direct their teaching behavior. Some decide to imitate and reproduce the same teaching practices they experiences while others oppose them and teach in a different way (Chang-Kredl & Kingsley, 2014). Memories of experiences of learning have a great effect in informing the way teachers teach; researchers were interested in teachers' school memories and the impact it has on their practices and views of what teaching is (Barrantes & Blanco, 2006; Dolan et al., 2014; Ellsworth & Buss, 2000; Frost, 2010; Guillaume & Kirtman, 2010; Miller & Shifflet, 2016; Millsaps, 2000; Scott, 2005). Findings from different studies showed that teachers carry their school memories with them into teacher education courses and their classroom teaching

(Feiman-Nemser & Buchmann, 1985; Frost, 2010; Levin & He, 2008; Lortie, 2002; Millsaps, 2000; Oleson & Hora, 2014; Scott, 2005).

Individuals consider their schooling experience as a significant event of their lives, and for teachers, in specific, school memories are very significant. Teachers return to work in schools which a familiar context they spend 15 years in (Miller & Shifflet, 2016); this triggers the 15-years' worth of memories in their minds. Teachers bring these memories with them to their own classrooms and to teacher education programs that they attend. Therefore, examining school memories gives insights into the teachers' attitudes, experiences, beliefs, values, philosophies and helps explain their current and future behaviors (Miller, 2017).

In the first part of this chapter, we will define what is meant by autobiographical memories and we will describe - from the different studies- the memories teachers recalled about their schooling experiences in the different subject areas. In the second part of this chapter, we will discuss how these memories influenced teachers' teaching before and after receiving formal training, and as novice and expert practicing teachers. In the third part of this chapter, we will describe the theoretical framework adopted in this study, which is the theory of the directive function of autobiographical memories.

Autobiographical school memories

Definition of autobiographical school memories. Memory is defined as "the means by which we retain and draw on our past experiences to use that information in the present" (Tulving, 2000 as cited in Sternberg & Sternberg, 2012a, p.187). The type of memory that is concerned with personal experiences is called the episodic memory; "episodic memory consists

of personal experiences stored as information about episodes or events; these memories are context bound and refer to specific times and spaces, and to relations among events." (Tulving, 1972 as cited in Ben-Peretz, 1995, p.8).

Nelson (1993) considered autobiographical memory as a subcategory of episodic memory; "autobiographical memory is specific, personal, long-lasting, and (usually) of significance to the self-system . . . it forms one's personal life history" (Nelson, 1993, p.8 as cited in Pillemer, 2000, p.49). "Autobiographical memory is best defined as the construction of a coherent narrative woven from the fleeting memories of our past experiences" (Fivush, 2012, p.226).

School memory is defined as "an individual way of reflection about one's own school experience, as in the reconstruction of the self" (Meda & Viñao, 2017, p.2). It refers to the individual's "memory of their school, school time and teaching" (Meda & Viñao, 2017, p.2).

The memories we are interested in, in this study, are the teachers' mathematical autobiographical school memories, which refer to teachers' personal past experiences as students with the learning and teaching of mathematics at school (Kaasila, 2007).

Accuracy of autobiographical memories. Autobiographical memories are a representation of the past (Sternberg & Sternberg, 2012a), that "become visible when told and described to someone" (Heikkilä et al., 2012). Memories are not passively reproduced; they are actively reconstructed and reinterpreted based on our experiences and in light of our present (Chang-Kredl & Kingsley, 2014; Fivush, 2012; Heikkilä et al., 2012; Pillemer, 2000; Sternberg & Sternberg, 2012b). Therefore, these memories may not be an accurate representation of the

original event (Chang-Kredl & Kingsley, 2014; Ellsworth & Buss, 2000; Sternberg & Sternberg, 2012b). Pillemer (2000) stated,

> There is widespread agreement that memory is an active, reconstructive process rather than a passive, reproductive process. In the process of constructing a memory narrative, errors can occur. At the same time, memory, for the most part, does its job; that is, memory descriptions usually are consistent with the general form and content of past experiences, even if particular details are lost, added, or distorted in the act of remembering (Pillemer, 2000, p. 55).

In everyday life situation, the accuracy of remembered events is not critical as long as the remembered episode is similar enough to the original event, even though some details are omitted or misremembered (Pillemer, 2000).

Structure of autobiographical memories. Conway & Rubin (1993) described three types of autobiographical knowledge structures: lifetime periods, general events, and event-specific memories (Conway, 1996). "Lifetime periods are the most general, most abstract, or most inclusive type of knowledge and denote time periods typically measured in units of years" (Conway, 1996, p.67). Lifetime periods represent distinct times in an individual's life, such as when being at school or university, when working, when the children were little, etc., lifetime periods contain knowledge about significant others, common locations, actions, activities, plans, and goals (Conway, 1996). General memories consist of repeated events and single events (Conway, 1996; Pillemer et al., 1996); they are typically measured in months, weeks, and days (Conway, 1996). General event memories represent a set of memories linked together by a

theme, for example first time events, periods of illness, holidays, etc.; organization of general event memories has yet to be investigated (Conway, 1996). "Event specific knowledge refers to memory for highly specific knowledge unique to a single event and typically measured in seconds, minutes or possibly hours" (Conway, 1996, p. 67). Pillemer (2000) defined specific memories as memories of events that took place at a specific time and place, contains the rememberer's unique circumstances at the time the event happened, and include sensory images and feelings that help the rememberer to relive the moment when recalling it (Pillemer 2000).

Content of autobiographical memories. "Autobiographical memories are episodes recollected from an individuals' past life" (Cohen, 1989 as cited in Ben-Peretz, 1995, p.9). The content of these memories describe different types of life experiences ranging from extremely negative and troubling events to extremely positive and uplifting events (Pillemer, 2000; 2001). Individuals may remember traumatic events they passed through or heard in the news, and they may also remember critical incidents and insights that occur as part of their daily lives (Pillemer, 2000). Individuals' autobiographical memories may also be categorized around different content categories such as stressful events, special occasions, school, births, traveling, romantic involvement, holidays, etc. (Rasmussen & Berntsen, 2009).

Prior studies on teachers' autobiographical memories did not look into the structure of these memories but only looked into the content of these memories. Different studies were done, targeting teachers from different subject areas (Barrantes & Blanco, 2006; Ellsworth & Buss, 2000; Frost, 2010; Guillaume & Kirtman, 2010; Hudson, et al., 2010; Miller & Shifflet, 2016;

Millsaps, 2000). The next section will discuss the content of the memories teachers recalled from their school experiences.

Content of teachers' autobiographical school memories

Researchers were interested in studying prospective and practicing teachers' school memories: what memorable practices could they recall, what characteristics of teachers they could not forget, and what could they remember from what and how they were taught. Different studies investigated memories in general (e.g. McGarr & Gavaldon, 2019; Miller & Shifflet, 2016; Sexton, 2004, 2007) or in specific content areas including mathematics (e.g. Barrantes & Blanco, 2006; Ellsworth & Buss, 2000; Frost, 2010; Guillaume & Kirtman, 2010; Millsaps, 2000; Oleson & Hora, 2014; Scott, 2005), science (e.g. Dolan et al., 2014; Ellsworth & Buss, 2000; Hudson, et al., 2010; Oleson & Hora, 2014), and English language (e.g. Cancino, et al., 2020, Rayati Damavandi & Roshdi, 2013).

Some studies targeted prospective teachers, while others targeted practicing teachers. In these studies, participants were asked to recall and reflect on their prior schooling and learning experience by responding to a prompt to describe their memories (Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010; Kaya, 2018; McGarr & Gavaldon, 2019; Miller & Shifflet, 2016). Or by responding to a questionnaire and sit for an interview or a focus group discussion (Barrantes & Blanco, 2006; Cancino, et al., 2020; Dolan et al., 2014; Frost, 2010; Millsaps, 2000; Oleson & Hora, 2014; Scott, 2005; Sexton, 2004, 2007). The recalled memories revolved mainly around two themes: (1) the characteristic of their prior teachers and (2) the practices and behaviors their prior teachers carried out while teaching of the subject. The findings in general report that the characteristics that the teachers possessed had an influence on students' attitudes towards the subject matter that they were teaching. Positive examples of teachers left students

17

with positive attitude toward the subject and were remembered as good teachers, while negative examples of teachers left students with a negative attitude towards the subject and were remembered as bad teachers.

Memories of prior teacher characteristics. When investigating school memories, a repeated emergent theme was about the memories of prior teacher characteristics. Participants recalled positive and negative teacher examples; these teachers showed characteristics that participants evaluated as good or bad. Participants described personal and professional characteristics they remember their teachers possessed; they appreciated teachers that developed personal connections with their students (Miller & Shifflet, 2016; Sexton, 2007), and those who possessed characteristics such as being kind, caring, fair, passionate, dedicated, self-confident, influential, motivated and entertaining (Dolan et al., 2014; Ellsworth & Buss, 2000; Heikkilä et al., 2012; Miller & Shifflet, 2016; Sexton, 2004). As for the professional characteristics, participants remembered teachers who had the ability to motivate their students, encourage, inspire, support, challenge, and engage them in the lessons to make the class more interesting and enjoyable (Chang-Kredl & Kingsley, 2014; Dolan et al., 2014; Guillaume & Kirtman, 2010; Kaasila, 2007; McGarr & Gavaldon, 2019; Sexton, 2004, 2007; Uitto et al., 2018). Other positive characteristics of teachers also included being firm in their classroom discipline, treating all students fairly, and developing their students' critical thinking skills (Sexton, 2004, 2007). These teachers were seen as facilitators, where they guide students to be active participants in the learning process (Ellsworth & Buss, 2000).

Negative teacher examples, shared characteristics such as being boring, unenthusiastic, aggressive, impatient, unpassionate, not sincere, and uninteresting (Dolan et al., 2014; Sexton, 2004, 2007). Some of these teachers also carried out undesirable behavior such as yelling, giving

18

negative and discouraging comments or feedback, and in some cases carried out physical punishments (Guillaume & Kirtman, 2010; Miller & Shifflet, 2016; Miller, 2017). Other negative memories about teachers were related to their level of control in the classroom, over strict teachers had uninteresting and boring lessons (Dolan et al., 2014; Ellsworth & Buss, 2000; Heikkilä et al., 2012), and over lenient teachers had unproductive and chaotic lessons and classes.

Memories of teaching practices. Another emergent theme when investigating teachers' school memories is the memories of their prior teachers' practices; how they learned and how they were taught. Teachers recalled practices related to the instructional format their teachers followed, the teaching methods their teachers implemented, the materials and tools that their teachers used, and their assessment methods.

Teachers recalled how their prior teachers carried out the lesson in their classrooms and what mode of instruction was followed in the classroom. In mathematics and English classes, participants recalled that their teachers followed a direct instructional approach that depended on teachers' explanation and demonstration (Barrantes & Blanco, 2006; Guillaume & Kirtman, 2010; Rayati Damavandi & Roshdi, 2013). Some participants noted that their teachers would move too fast in explaining without giving students enough time to understand the concepts (Ellsworth & Buss, 2000). However, in science lessons such as geography, participants recalled being taught through a participative, collaborative, inquiry-based approach that depended on fieldwork, projects, discussions, and problem solving (Dolan et al., 2014).

Teachers also remembered some of the strategies that were used in the classroom. The most recalled teaching method was solving exercises and simple problems for practice (Barrantes & Blanco, 2006; Guillaume & Kirtman, 2010; Millsaps, 2000; Rayati Damavandi & Roshdi,

2013). Participants recalled a great emphasis being put on rote learning memorization of concepts and procedures in all subjects (Barrantes & Blanco, 2006; Dolan et al., 2014; Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010). Participants mentioned that their school learning experience was filled with moments of doing exercises and practice, and this was more evident in learning mathematics than in other subjects. In geography classes, students recalled memorizing essays and textbook content for examination (Dolan et al., 2014). In mathematics classes, students remembered being asked to memorize multiplication facts (Guillaume & Kirtman, 2010), formulas, concepts, processes (Barrantes & Blanco, 2006), and other mathematics material.

As for activities, the teachers remembered solving worksheets individually or in groups, in addition to playing games and having competitions that were challenging (Dolan et al., 2014; Guillaume & Kirtman, 2010; Hudson, et al., 2010; Millsaps, 2000; Oleson & Hora, 2014; Rayati Damavandi & Roshdi, 2013). In mathematics and science classes, participants valued the connections that were made between the lesson and real life. (Borko et al., 1992; Dolan et al., 2014; Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010). They noted that they felt frustrated when the content had no clear connection to real life but they were satisfied when they were able to see the practical application and relevance and usefulness of what they are studying and everyday life (Dolan et al., 2014; Ellsworth & Buss, 2000). Other methods that teachers recalled and benefited from when they were students were repetition of explanation (Oleson & Hora, 2014), correcting students' errors, and targeting their misconceptions (Hudson et al., 2010; Rayati Damavandi & Roshdi, 2013).

Memories about what materials and resources were used, were also evident in teachers memories. In several studies participants mentioned that the primary resource for learning and

for exercises was the textbook (Barrantes & Blanco, 2006; Dolan et al., 2014; Guillaume & Kirtman, 2010; Sexton, 2004). Teachers in different studies recalled lessons being explained using different resources, some recalled the use of the chalkboard only (Barrantes & Blanco, 2006) , while some remembered using videos to explain science lessons (Hudson et al., 2010) or using technology in mathematics but infrequently (Guillaume & Kirtman, 2010). As for the material used in the classroom to explain the lesson or to do activities with, teachers recalled that in mathematics classes, some manipulatives were used such as counting and place value material, calculators, geometric bodies made of wood or cardboards (Barrantes & Blanco, 2006; Guillaume & Kirtman, 2010; Scott, 2005). Teachers noted that these tools were not often used, and when they were used, they did not carry out any meaningful activity with it (Barrantes & Blanco, 2006).

When asked about their school memories, some teachers could just remember exams and quizzes (Barrantes & Blanco, 2006; Dolan et al., 2014; Hudson et al., 2010). Great emphasis was put on examination in their school years that left them with only negative memories about the subject matter they were taught, but teachers did not mention more about memories about how they were assessed. In one study, participants were prompted to remember how they were evaluated in geometry; their responses showed that examination was the most dominant tool for evaluation (Barrantes & Blanco, 2006). They recalled their prior teachers taking notes about students' performance in classroom activities, but these were not reflected in their evaluation grades (Barrantes & Blanco, 2006).

Teachers carry their memories as students with them through their teacher training program classes and into their own classrooms; these memories may have a great influence on these teachers. Pillemer and his colleagues (1996) referred to school memories as educational

21

episodes; they considered as one important influence on students' lives. In classrooms, teachers do not only transmit knowledge, "they also present information in idiosyncratic and potentially memorable ways, they have pivotal conversations with individual students, they write detailed and personalized comments on student assignments, and they interact closely with students on an informal as well as a formal basis" (Pillemer et al., 1996 p. 319). The memoires of these interactions with teachers may have a lasting consequence on students, and influence their teaching in different ways. In the next section, we will discuss the influence of autobiographical school memories on prospective teachers in their teacher training program classes, and on novice and expert teachers in their own classrooms.

Influence of school memories on teachers

Unlike students of other occupations, prospective teachers enter their profession with general insights about what teaching is and how it works (Balli, 2014; Rayati Damavandi & Roshdi, 2013). These insights come from their memories of their long schooling years and their interaction with their practicing teachers. The powerful effect that memories have on teaching was stressed by Johnson (1999), he stated that "unknowingly –memories of school - become the basis of our initial conceptions of ourselves as teachers, influence our view of students, etc. and act as justification for our teaching practice" (as cited in Rayati Damavandi & Roshdi, 2013).

Lortie's (1975) referred to the phenomenon of students' observations inside the classroom as the 'apprenticeship of observation'. As students, teachers have observed their own teachers' practices and behaviors for several hours per day for around 15 years (Lortie, 2002). This observation happens in a small place –the classroom- where students are few meters away from the teacher and it is not a passive observation (Lortie, 2002). Sometimes students imagine taking the place of their teacher in the classroom to predict the teacher's possible reaction to their

22

behavior. If the student aspires to become a teacher, then this role-playing becomes frequent, students try to imagine how they could act if they were in place of their teachers (Lortie, 2002). Consequently, these observations -that serve as an apprenticeship- leave students with a huge repertoire of memories that inform their knowledge of what teaching is and how a teacher should behave (Chang-Kredl & Kingsley, 2014; Miller & Shifflet, 2016; Miller, 2017).

However, Lortie cautions that students observations' of their teachers are limited or partial, because students observe what is acted on the 'front stage' but are not aware or exposed to what happens in the 'backstage' of teaching (Lortie, 2002 as cited in Rayati Damavandi & Roshdi). Students' observations do not reveal the full process of teaching so they could not know the reasons behind teachers' actions or their intentions (Lortie, 2002). They are never exposed to how teachers make preparations and reflections, set plans, select goals, choose activities and exercises, or decide on pedagogical methods (Lortie, 2002). Students' view of what teaching is comes from 'student-oriented perspective' and not a 'pedagogically-oriented perspective' (Lortie, 2002). Therefore, the apprenticeship of observation does not equip teachers with the needed knowledge and skills for the 'inner world of teaching' (Cook, 2009); instead, it might leave them with 'inappropriate images and inadequate expectations of teaching' (Karavas & Drossou, 2010 as cited in Rayati Damavandi & Roshdi, 2013).

Teachers enter into the teaching professions believing that they know how to teach, what works and what does not work for students because they were once students (Miller & Shifflet, 2016; Miller, 2017). Feiman-Nemser and Buchmann (1985) referred to this phenomenon as the 'familiarity pitfall'. They fall into the familiarity pitfall because they are not strangers to the classroom; they have been in the classroom to learn for years while watching how teachers teach (Feiman-Nemser & Buchmann, 1985). Their close examinations of classroom teaching make

them believe that they have mastered and understood the work of a teacher (Feiman-Nemser & Buchmann, 1985). They fall into the 'illusion of expertise' as they trust their school memories and experiences (Miller & Shifflet, 2016), which "mislead prospective teachers into thinking that they know more about teaching than they actually do and make it harder for them to form new ideas and new habits of thought and action". (Feiman-Nemser, 2001 as cited in Hawley el al., 2012)

Prospective teachers bring their school memories along with their formed conceptions into their teacher education programs. As teachers go into practicing teaching, they also bring their school memories into their classrooms. The next section discusses the influence of prospective teachers' school memories on their conceptions of teaching. The later section will discusses the influence of novice and expert practicing teachers' school memories on their actual teaching.

Influence of school memories on prospective teachers. Prospective teachers do not enter the teacher education program without an idea on what teaching is; on the contrary, they enter with a huge repertoire of their school memories along with their assumptions and conceptions of how to teach (Ball, 1996 as cited in Oleson & Hora, 2014; Lortie, 2002). Therefore, prospective teachers' school memories become a valuable source that informs their learning while enrolling in the teacher education program. Lortie argues that prospective teachers form their conceptions about teaching before receiving formal training (Zeichner & Tabachnick, 1981). They already feel that they are part of the teaching community that they are familiar with and they consider their university instructors as additional members of that community (Lortie, 2002).

Multiple studies investigated prospective teachers' school memories and their intentions and expectations of how they want to teach. These studies were done with prospective teachers upon their entrance to teacher education programs and before receiving any instruction in these courses (Miller & Shifflet, 2016; Sexton, 2004, 2007; Scott, 2005; Barrantes & Blanco, 2006). These studies required prospective teachers to recall how they were taught and then asked them to describe how they intend or expect to teach. Teachers' responses were divided into three categories; some wanted to imitate what they experienced in school, others rejected the way they were taught, while some had difficulty in freeing themselves from what they are used to (Barrantes & Blanco, 2006, Cancino et al., 2020).

Some prospective teacher intended to follow the same practices that they encountered in school and thus they wanted to teach in the same way they were taught. These teachers were convinced that the way they were taught is the right way to teach and learn and thus they replicated certain characteristics and practices. They wanted to be kind, helpful, fun, passionate, motivating, encouraging, etc. because they saw that these are the characteristics of a good teacher (Miller & Shifflet, 2016; Sexton, 2004, 2007). In Cancino and his colleagues study (2020), one participant stated that he likes to replicate the positive features that his teachers had, he described how his teachers had a positive attitude and had an appropriate way to promote learning and interact with students. He described that he agreed with these positive features and he believes that it is adequate to imitate these practices (Cancino et al., 2020). Other teachers described instructional practices that they benefited or enjoyed and thus they wanted to use in their classroom. For example, they wanted to use activities that engage students (Barrantes & Blanco, 2006), use manipulatives and physical objects for academic and motivational reasons

(Barrantes & Blanco, 2006; Scott, 2005), and refer to the textbook as a source for teaching and learning (Barrantes & Blanco, 2006).

On the other hand, some teachers showed a different reaction to their school memories by opposing the characteristics and practices their prior teachers exhibited (Barrantes & Blanco, 2006; Cancino et al., 2020). These teachers did not wish to copy their teachers; they did not want to be boring, cruel, or unpassionate teachers (Miller & Shifflet, 2016; Sexton, 2004, 2007). They used their memories of what they disliked and constructed a different view towards what kind of teacher they want to be (Miller & Shifflet, 2016); they described that they try to be better teachers than their prior teachers and try not to make the same mistakes they did (Cancino et al., 2020).

In between imitating and rejecting, there exists a decision where teachers do not wish to be imitators of their prior teachers because they know there is a different way to teach, but they are struggling to liberate themselves from their memories and try different methods (Barrantes & Blanco, 2006; Scott, 2005). One of the main reason that makes teachers replicate the practices their teachers used to follow even though they are convinced that there are other ways to do so is the lack of knowledge of other methods and the lack of experience in how the other methods should be implemented (Barrantes & Blanco, 2006; Lloyd, 2006).

The conceptions formed through school memories become core to the individual and make it hard for them to change and accept new ideas (Barrantes & Blanco, 2006; Hawley el al., 2012; Rayati Damavandi & Roshdi, 2013). This makes the role of teacher education programs in equipping teachers with the necessary knowledge and skills for teaching a challenging one. Studies found that teachers filter what they are learning in teacher education courses through their school memories, so they would approve on some methods and reject other methods

depending on what conception they have previously formed. (Calderhead & Robson, 1991; Clark & Peterson, 1986; Goodman, 1988; Lortie, 2002; Mead, 2002 as cited in Balli, 2014; Holt-Reynolds,1992 as cited in Miller & Shifflet, 2016; Friedrichsen et al., 2009). For example, prospective teachers may accept methods because it worked for them as students and reject other methods because it did not work for them (Balli, 2014). In some cases, "teachers often use whatever justifications necessary to appear congruent with their beliefs, and turn conflicting evidence into support for their beliefs, even when beliefs contradict one another" (Pajares as cited in Rayati Damavandi & Roshdi, 2013).

Teacher education programs should consider teachers prior experiences, and offer them time to reflect and analyze these experiences to be more open to accept new ideas and be willing to use and implement them (Miller & Shifflet, 2016; Rayati Damavandi & Roshdi, 2013). Prospective teachers may be prompted to use their school memories as a critical lens to analyze the theories and methods they are learning in their courses (Miller & Shifflet, 2016). Unless teacher education programs targets teachers predispositions and train them to accept and implement new ideas; teachers will prefer to 'fall back on preconceived ideas of teaching and learning' because it is 'simply easier to rely on past experiences' (Lortie, 2002; Moore & Ash, 2002 as cited in Miller & Shifflet, 2016). Therefore, the field of teaching will be filled with teachers who are not concerned with improving teaching and learning, but are only reproducing the same traditional ideas.

These issues arise again in the literature related to practicing teachers. The next section discusses the relationship between school memories and practicing teachers' teaching.

Influence of school memories on practicing teachers. Teachers' memories of their school experience are long lasting and have an influence on their teaching. Teachers carry these memories with them through their journey to become teachers and they act in light of them consciously or unconsciously. Teachers form strong conceptions about teaching from their school memories, although these conceptions may be hard to change but later experiences such as taking teacher education courses, field training, and teaching experience could play a significant role in altering these conceptions and shaping teachers practices.

In the following two sections, we will discuss and distinguish between the influence of school memories on novice practicing teachers and on expert practicing teachers.

Influence of school memories on novice practicing teachers. After completing the teacher education courses and receiving a teaching diploma, teachers move into the classroom as certified teachers carrying different conceptions about teaching that they formed from their school experiences and teacher education courses. However, some teachers may start teaching even before taking any formal training (Frost, 2010). As novice practicing teachers, they go into their classroom with idealistic expectations and intentions about what to do in the class and how to teach students (Feiman-Nemser, 1983). They expect that the transition to being a teacher is easy, since they were watching teachers all these years and because they hold a teaching certification. However, "the once familiar scene looks strangely unfamiliar" (Feiman-Nemser, 1983). As students enter the school, they realize that the culture of the school has changed since when they were students (Miller & Shifflet, 2016); and as they get subjected to the educational policies, school rules, and as they experience actual teaching, their image of what teaching looks like may no longer seem appropriate (Fragnoli, 2005 as cited in Miller & Shifflet, 2016). This is

28

the issue that Lortie (1975) argued about when he talked about the apprenticeship of observation. Observing teachers at school does not equip teachers with the skills they need in the "inner world of teaching" (Lortie, 2002), so when they go into actual classrooms they experience a reality shock (Feiman-Nemser, 1983).

Studies done with novice practicing teachers had different results regarding how novice teachers reacted with their school memories. The majority of studies found that novice teachers tend to discard what they learned in teacher education programs (Allen, 2009; Strom, 2015; Zeichner & Tabachnick, 1981), and return back to their school memories and thus reproduce the instructional practices they experienced as students (Cochran-Smith et al., 2010 as cited in Strom, 2015; Zeichner & Tabachnick, 1981). This shift occurs because of the insufficient preparation teachers get at the prospective level (Feiman-Nemser, 1983); and because of the conflict between the expectation of the teacher education programs and the schools (Zeichner & Tabachnick, 1981). Teachers discover that what they learnt in teacher education courses does not work in real classrooms (Shin, 2012 as cited in Farrell, 2012) and that they lack the knowledge for other methods (Barrantes & Blanco, 2006). Hence, the only source of knowledge for teaching -that could work in actual classrooms- they have is their prior experience in the school (Frost, 2010).

In his study, Starkey (2010) investigated the extent to which high school teachers used technology in their instruction. One of the participants reported that he does not feel comfortable to use technology in mathematics class because he thinks that mathematics is better learned by solving problems by hand, which is the learning method he experienced as a student (Starkey, 2010). Therefore, he has no experience in how technology could be integrated in the teaching and learning of mathematics (Starkey, 2010). Another study done by Strom (2015), examined

29

how a first year secondary school science teacher constructed his teaching practices in teaching environmental and earth sciences. Results found that the teacher's beliefs and intentions about teaching were persistent through his pre-formal training and his first year of teaching (Strom, 2015), and that his enactment of practices that he held prior to formal training is a complex activity that is influenced by different factors (Strom, 2015).

However, other studies showed that novice-practicing teachers showed dissatisfaction with the methods they were taught through and wanted to adopt different teaching practices (Albaba, 2017; Moodie, 2016). In Moodie (2016) study, he talked about the anti-apprenticeship of observation, his findings showed that novice teachers were influenced by their negative school memories and motivated to teach in an opposite or different way than what they experienced as students.

Nevertheless, what and how teachers intend to teach may be different from what and how they actually teach. In the school, teachers are subjected to the institutions rules and regulations that they should abide by even though it may differ from their conceptions. Teachers may not be encouraged to use new teaching practices (Shin, 2012 as cited in Farrell, 2012), and thus resort to replicate the traditional methods they experienced as students. In one study done by Albaba (2017) on EFL teachers, found that teachers were not satisfied with the traditional methods for teachers and wanted to apply what they were taught in teacher education courses. However, they were working with teachers who adopted traditional teaching practices and an administration that does not provide support for new teaching practices. Therefore, they were forced to revert to traditional teaching practices and were not encouraged to use any of the new methods that they learned (Albaba, 2017).

A look into the literature shows evidence that teachers' practices are shaped by policies imposed by the educational institution; teachers try to adapt their practices and satisfy the institutional demands (Cobb, et al., 2003; Floresa & Day, 2006; Pillen et al., 2013; Zeichner & Tabachnick, 1985). Teachers bring to the school their own school memories and their assumptions of how and what to teach, however the demands of the school they are working in may be different from their assumptions. If such a conflict occurs, teachers get confused about whether they have to comply with the demands or stick to their own personal ideas (Floresa & Day, 2006; Pillen et al., 2013). In a study done by Floresa & Day (2006), they investigated how novice teachers' practices were shaped through the interaction between personal, professional and contextual factors. One participant mentioned that she first had to comply with the schools demands and work against what she believed in because she was supervised and assessed, but later, she started teaching as she wanted and not according to what she was told (Floresa & Day, 2006).

Influence of school memories on expert practicing teachers. Findings in several studies (Davin et al., 2018; Frost, 2010; Millsaps, 2000; Oleson & Hora, 2014; Rayati Damavandi & Roshdi) suggest that the influence of school memories was still evident in teachers' instructional decisions after spending years of teaching. The studies that targeted expert practicing teachers, found that teachers are constantly reflecting on their school memories and acting in light of them; how teachers learned influenced how they want to teach others (Oleson & Hora, 2014).

Responses of expert practicing teachers regarding how they are influenced by their school memories were similar to those of prospective teaches. Some teachers reported that they do replicate in their teaching some of the practices that they benefited from and enjoyed, such as using competitive strategies in teaching mathematics (Millsaps, 2000) and having the teacher

repeat the explanation of the lesson (Oleson & Hora, 2014). Other teachers wanted to teach in the way they wished their teachers had followed (Oleson & Hora, 2014); they wanted to teach their students the skills that they were not taught (Frost, 2010). For example, one teacher preferred to be given time to practice on her own, so now in her classroom she makes sure she gives her students enough time to work individually (Millsaps, 2000). Another participant, determined to teach her students mathematical reasoning and communication skills, because she did not have the chance to learn these skills in school (Frost, 2010). Nevertheless, this makes teachers fall into the impression that what worked or did not work for them, will work or not work for their students without taking into consideration their students' needs (Oleson & Hora, 2014). Some practicing teachers also reported having the issue of freeing themselves from reproducing the same instructional strategies that they experienced as students in school (Millsaps, 2000). The influence of their school memories on their conception is so strong that they are repeating the same behaviors knowing that there is a better way to do things (Millsaps, 2000). For example, one teacher mentioned that he wishes to allow his students to think and reason on their own, but he feels that he must teach the required information directly to them. He is having trouble in giving students the freedom to explore and think because of his memories of being in a controlled classroom (Millsaps, 2000).

In Rayati Damavandi and Roshdi (2013) study, they found that most of the practices that teachers carry out in the classroom regarding teaching English language grammar are the practices that teachers know from their memories of their learning experiences; these practices were reinforced rather than modified when they tried them in their classes (Rayati Damavandi & Roshdi, 2013). In another study done by Frost (2010), one participant noted that she started teaching before getting a teaching degree, so as a new teacher she carried out the practices that

32

she remember from her experience as a student. However, as she started teaching she found that some of these methods are not efficient so she started looking for different methods and trying them to improve her students' learning (Frost, 2010).

One study was done by Oleson and Hora (2014), to investigate the sources of teaching practices of STEM faculty and to examine if they teach in the way they were taught. Findings of the study showed that the faculty members are influenced by their prior experiences as students; however, they do not imitate the practices of their previous instructors thoughtlessly (Oleson & Hora, 2014). They try to use different methods in their classrooms and discover from their teaching experiences and their interaction with students in the classroom what teaching practices work for their students and what does not work, what misconceptions their students have, and they develop ways to improve their teaching (Oleson & Hora, 2014).

Another study by Davin, Chavoshan, and Donato (2018), showed that an experienced English Language teacher's positive and negative school memories of studying language influenced her classroom teaching, by reproducing the positive experiences, and opposing the negative ones. The teacher fosters a warm and structured learning environment similar to the one she experienced as a student, while she minimizes the focus on explicit grammar instruction that she hated as a student (Davin et al., 2018).

Studies that examined the influence of teachers' autobiographical memories based their analyses on different theoretical frameworks; some analyzed it from the perspective of the influence of prior experience and preexisting knowledge (Guillaume & Kirtman, 2010; Oleson & Hora, 2014), constructivism (Millsaps, 2000), apprenticeship of observation (Cancino et al., 2020), and from a situated and sociocultural perspective (Frost, 2010), etc. Although some studies referred to teachers memories as autobiographical memories, none of the studies

33

considered the theories of autobiographical memories as a lens to study these memories. In this study, we will attempt to discuss the influence of autobiographical memories on teachers' current practices from the perspective of the directive function of autobiographical memories.

Theoretical Framework

Research on memory took several different perspectives; some studied memories from a neural and biological perspective where they focused on the processing of autobiographical information and how memories are constructed based on "the interplay of functionally distinct subsystems of the mind and brain" (Berntsen & Rubin, 2012). Another perspective to the study of memories was from social and cultural aspects of autobiographical memories; this perspective focused on "the role of the self, its goals, and its social and cultural context in the processing of autobiographical information and construction of memories" (Berntsen & Rubin, 2012). Within the social and cultural perspective, a functional approach to the study of memories was created; rather than focusing on "*how*, *how much*, and *how* accurately people remember their past", the functional approach focuses on *why* humans remember their past (Bluck et al., 2005).

In an attempt to answer the question of "what functions does it serve for people to remember, reflect on, and share the experiences of their lives?" (Bluck et al., 2005), researchers identified different functions for autobiographical memories. Memory functions were defined as the "real world usefulness or adaptive significance of memory mechanisms" (Bruce, 1989, p.45 as cited in Pillemer 2003). Researchers have identified several functions, but most of them fit within one of three categories (Bluck, 2003). The three functions of autobiographical memories are: (1) *Social functions* in which memories are used to facilitate interpersonal interactions through memory sharing, (2) S*elf functions* where memories promote personal identity and support a sense of coherence or continuity over time, and (3) *Directive functions,* which involve

34

using memories to make decisions in the present and to guide future behaviors. (Bluck, 2003; Bluck et al., 2005; Pillemer & Kuwabara, 2012, p. 184). These memory functions are not considered to be discrete categories; in fact, they overlap in many situations (Bluck, 2003; Bluck & Alea, 2002; Wong & Watt, 1991 as cited in Pillemer, 2003). This means that the same memory could serve several functions at the same time, which present a challenge to how these functions are studied (Bluck, 2003).

Most prior research focused on the memory structure, memory accuracy and on the social and self functions of autobiographical memories; however, the directive functions are underrepresented in research (Pillemer, 2003). The focus of this study will be on the directive functions of autobiographical memory. We are interested in examining how teachers' autobiographical school memories direct their current practices in teaching algebra.

Directive function of autobiographical memories. Directive functions of autobiographical memories examine how memories of specific experiences and life episodes serve as guides for people's attitudes and behaviors in the present and the future; for problem solving, decision making, and future planning (Pillemer, 2003; Pillemer & Kuwabara, 2012). "To function effectively in new and changing life situations, people must make predictions about future events; they must construct successful plans of action; and they must access relevant past information at the moment it is most useful. This is where memory is essential" (Pillemer, 2000).

Functional categories. Pillemer (2000) suggested six functional categories to understand the directive function of autobiographical memories "memorable messages, symbolic messages, originating events, anchoring events, turning points, and analogous events" (Pillemer, 2000, p. 65). Pillemer (2001) stated, "The categories are not mutually exclusive, and formal coding rules have yet to be established, but they illustrate one preliminary organizational framework for

35

analyses of purpose and meaning" (Pillemer, 2001). In this section, we will explain how the directive function is explained from the perspective of these six categories.

Memorable messages. Some events may persist in memory for years and continue to be influential because of the valuable message they contain (Pillemer et al., 1996). Memorable messages may be spoken words that people make to give an order or offer an advice; they are influential especially when the speaker is powerful, respected, or loved (Pillemer, 2000). Individuals might remember statements said by their parents, teachers, friends, or significant others; these statements were reported to have an effect on individuals' behaviors, decisions, and lives. "Many memorable messages contain an explicit directive or prescription for behavior"; the spoken statement need not to be related to a major life decision in order to be memorable and have an influence, sometimes a simple recommendation can have a big influence (Pillemer, 2000).

Symbolic messages. Not all valuable messages are explicitly told or directed to individuals; sometimes messages are delivered without the intention of providing a directive. Speakers may be unaware that their words became memorable and influential to someone else. Symbolic messages are created through an "active, constructive process on the part of the recipient" (Pillemer, 2000). Individuals might interpret events they experience or words they hear from professors, parents, teachers, and others as having a symbolic meaning and thus have an influence on their lives.

Originating events. Memories of originating events are memories of experiences that motivate and inspire individuals' decisions to pursue a certain life path (Pillemer, 2000; 2001). Pillemer (2000) stated that "memories of originating events need not carry an explicit, rule-structured directive; they inspire rather than prescribe". Individuals frequently trace the

beginning of an academic or career path, the birth of a set of enduring beliefs and attitudes, and other beginnings to a single memorable event (Pillemer, 2000). "People often recount, when, where, and how 'it all began'" (Pillemer, 2000, p. 71); it could be a visit or a trip to a certain place, an interaction with some individual, an experience with a tool, etc. "An originating event is perceived as creating, or at least contributing to, a new life course" (Pillemer, 2000, p.73). The connection between the originating event and the present activity is real to the rememberer; however, it might not be considered as the actual direct cause of the chosen life path. Erikson (1975) referred to this as the "originological fallacy", in which life outcomes are causally linked to early events only retrospectively, where individuals link past events to known present outcomes (Pillemer et al., 1996; Pillemer, 2000). Nevertheless, the connection between the memory and the outcome or present activity is important regardless of its absolute truth-value.

Anchoring events. Memories of anchoring events are memories of episodes that "validate current beliefs and feelings, it can offer reassurance at times of trouble or difficulty, and it can refocus thoughts and behaviors in accordance with the underlying lesson represented by the memory" (Pillemer, 2000, p. 74). A memory may "provide persistent affirmation of what is valuable or continued warning of what to avoid" (Pillemer, 2001). Anchoring events are assumed to support existing thoughts and emotions; "the memories can provide reassurance, direction, or validation, especially in contexts where one's skills or values are questioned" (Pillemer et al., 1996). A praise by another person may become the source of reassurance at particular moments such as when in self-doubt, a statement made by an individual may anchor a troubling belief about a certain issue. However, not all anchoring events are represented as verbal statements from others; it could be represented as an exciting or terrifying experience the individual pass through.

Turning points. Turning points are a variation of originating events, they are episodes that "alter or redirect the ongoing flow of the life course" (Pillemer, 2000, p. 76). Memories of turning points are memories of experiences that reorient and shift academic interests, career paths, and other life activities.

Analogous events. "One way that memories of past episodes inform current beliefs and actions is by analogy: the lessons from an earlier, structurally similar experience are applied to present circumstances" (Pillemer, 2000, p. 79). The directive influence of autobiographical memories is clearest when individuals face a novel situation. "Figuring out how to behave in a new situation is most certainly helped by being reminded of an old situation that is like the new situation. The old situation then becomes a guide to follow or even a guide to what not to do" (Schank, 1990, p. 24 as cited in Pillemer, 2000, p.80). Memories that guide present behavior might be triggered when confronting the current situation without a purposeful search for a memory (Pillemer, 2003). This happens when an individual face a situation that is structurally similar to an event that is recorded in memory that they experienced in the past (Pillemer, 2000). The past and present situations might be similar in terms of general details and not necessarily the exact match (Pillemer, 2000). Memories of analogous events will be activated by the similarity of the current situation the individual is facing, and will direct or guide the individual to what or what not to do.

Awareness of the influence of memory. The influence of memories on people's attitudes and behaviors might occur with individuals being aware or unaware of it; that is because the memory process may operate inside or outside the individual's conscious awareness (Pillemer, 1992; Pillemer & Kuwabara, 2012, p.194). An implicit or an explicit connection can be drawn

between autobiographical memories and individuals' attitudes and behaviors (Pillemer, 2000, p.83). Sometimes individuals are aware that their current behavior is influenced by a prior experience they could recall. Kuwabara and Pillemer (2010) stated, "When confronted with a decision, an individual could consciously or explicitly consult the contents of autobiographical memory searching for relevant past instances". In this case, the connection between the individual's action and his/her memory is explicitly defined. However sometimes individuals are unaware that their current actions are influenced by their memories, and in this case it is hard to draw a connection between current actions and memories. In a study conducted by Kuwabara and Pillemer (2010), the participants did not draw an explicit connection between their memories and their current decisions when asked about the reasons behind their current behavior. Pillemer and Kuwabara (2012) suggested that "to better understand how the level of conscious awareness influences the directive impact of autobiographical memories, research participants should be interviewed about reasons underlying their behavioral choices and perhaps even encouraged to "think aloud" as they make their decisions" (p. 195).

Memory characteristics and the directive function. Different studies were conducted to examine how the directive function of autobiographical memories differs across the different characteristics of the remembered event. The characteristics under study were memory specificity (specific or general) and emotional content of memories (positive or negative).

Memory Specificity. Memory specificity refers to whether a memory is specific or general. Pillemer (2003) found that specific memories have a strong guiding power that influences beliefs and behaviors. He defined specific memories as memories of events that took place at a specific time and place, contains the rememberer's unique circumstances at the time

the event happened, and include sensory images and feelings that help the rememberer to relive the moment when recalling it (Pillemer 2000, p. 50). In their study, Kuwabara and Pillemer (2010) coded the memories as specific and general memories, they defined to specific memories as "explicit descriptions of unique, one-time events", while "general memories were defined as non-specific descriptions of events or references to a series of repeated events" (Kuwabara & Pillemer, 2010). The results of their study showed no clear advantage for either memory type in influencing people's behavior. Memory specificity and its influence on memory functions have not been much researched yet, and the question remains about whether specific and general memories have similar effects in influencing intentions and behaviors (Pillemer, 2012, p. 193).

Emotional content of memories. Researchers were interested in whether positive and negative memories hold the same or different directive function. Results of some studies showed positive memories are more associated with social and self functions of autobiographical memories, while negative memories serve a directive function (Pasupathi, Lucas, & Coombs, 2002; Rasmussen & Berntsen, 2009). Memories of positive events are used to "build personal and social resources, thereby facilitating social bonding" while "negative events would cause the individual to focus on and encode the aspects of the events that are necessary in order to solve the problem and prevent future mistakes" (Rasmussen & Berntsen, 2009). Yet other studies showed that recalling a positive memory had more influence on individuals' intentions than recalling a negative memory. Positive memories have the power to provide continuous inspiration and motivation for individuals (Pillemer & Kuwabara, 2012). Kuwabara and Pillemer (2010) found that undergraduate students who were asked to recall a positive memory about their university reported greater intentions to give a donation to their university than students who

40

were asked to recall a negative memory. Similarly, Biondolillo and Pillemer (2015) found that students who recalled a positive memory that would increase their motivation to exercise reported higher intentions to exercise than students who recalled a negative memory. These results show that positive and negative memories have a directive influence on individuals' intentions and behaviors but each in its own way.

Individual characteristics and the directive function. Studies also investigated how the directive function of autobiographical memories differs across the characteristics of the rememberer; the studies looked into gender differences and age variations in the use of autobiographical memories.

Gender differences in the use of memories. Very few studies looked into the gender differences in the use of memories. Pillemer and his colleagues (2003) found that women recounted a greater number of specific memories than men did (Pillemer et al., 2003), but they did not look into the difference in the use of these memories. Vranic, Jelic, and Tonkovic (2018) examined in their study the gender differences in the use of autobiographical memories. They found that there were gender differences in the directive use of autobiographical memories but no difference in the social and self use (Vranic et al., 2018). The study showed that women tend to use autobiographical memories to direct their behavior more than men do (Vranic et al., 2018). This assumption requires more research to validate the finding.

Age variations in the use of memories. As with the case of gender, very few studies also looked into the age variation in the use of memories. Vranic and his colleagues (2018) also investigated in their study the age differences in the use of autobiographical memories. They

found age varied in the directive and social functions of autobiographical memories, but no variation with respect to the self function (Vranic et al., 2018). The study showed that young individuals (18–45 years) tend to use autobiographical memories for directing behavior and social bonding more than older adults do (46-90 years).

Strategies for measuring the directive influence of memories. Pillemer and Kuwabara (2012) discussed the questions of how to measure the directive effect of memory; two major strategies were suggested and reviewed. The first strategy is to observe individuals' behaviors after prompting them to recall a relevant past experience. This could be done with experimental approaches where an intervention could be used to trigger a certain selective memory related to the behavior measured then followed by a measurement of the targeted behavior (Pillemer & Kuwabara, 2012). The second method to measure the directive function of autobiographical memories is to get self-reports from the participants; this could be done through case studies, surveys, and correlational approaches. Measuring the directive function through these approaches relies on the participants' awareness of memory process, their ability to report their memories, and their ability to draw an explicit connection between their memories and behaviors (Pillemer & Kuwabara, 2012). Correlational approaches can establish the causal connection between memories and behaviors through examining individual's behavior, as they solve a current problem for example, and then ask them about the reasons underlying their behavioral choices, and they might be encouraged to think aloud as they make their decisions (Pillemer & Kuwabara, 2012). In case studies the person providing the memory is the one who will identify and report the causal connection between the recalled memory and the current behavior, but case studies do not have the power to draw this connection and establish this causality (Pillemer &

Kuwabara, 2012). This method will allow researchers to measure the directive influence of memory as reported directly by the individuals. It will reveal the explicit directive influence that the individuals are aware of, but it does not reveal the implicit influence that they are not aware of.

Conclusion

The aim of this study is to describe the memories of practicing math teachers about their experiences of learning mathematics and to examine how these memories influence their teaching of algebra. To do this, we will rely on self-reports from mathematics teachers about their school memories of learning mathematics, and about the directive influence of their school memories on their teaching of algebra. It is not possible for researchers to establish a causal connection between a recalled memory and an observed behavior from cases, however participants can identify this connection and report it (Pillemer & Kuwabara, 2012). For this, we will only be interested in this study to examine the influence of memories that teachers are aware of and can explicitly report. The next chapter will explain in details the methodology that will be followed in this study.

CHAPTER III

Methodology

In this study, I was interested in investigating practicing mathematics teachers' autobiographical school memories that influence their teaching of algebra. The study was guided by three research questions:

1) What are the content and structure of practicing mathematics teachers' autobiographical memories of learning of algebra at school?

2) How do the emotional content and structure of autobiographical memories of learning algebra influence the practicing mathematics teachers' teaching of algebra?

3) How does the influence of autobiographical memories differ between novice and expert teachers, and between teachers who have a teaching diploma and those who do not?

Research Design

To examine teachers' school memories and the influence they have on their teaching, most previous studies in this area adopted a qualitative research design (e.g. Barrantes & Blanco, 2006; Ellsworth & Buss, 2000; Frost, 2010; Guillaume & Kirtman, 2010; Millsaps, 2000; Miller & Shifflet, 2016; Oleson & Hora, 2014; Scott, 2005). A qualitative design is used for discovering the nature of the meaning related to a certain phenomenon from the perspective of certain individuals (Gall et al., 2014; Flick, 2018, p. 2), and in most of these studies, the focus was on uncovering teachers' learning experiences and their influence on their conceptions of teaching. In this study, the purpose was to describe the content and structure of the autobiographical school memories that practicing mathematics teachers have about their learning of mathematics and to examine the influence of these memories on their teaching of algebra from the viewpoint of the

practicing mathematics teachers. To do this, we relied on self-reports from mathematics teachers about their school memories of learning mathematics, and about the directive influence their school memories had on their teaching of algebra. Pillemer and Kuwabara (2012) stated that participants providing the memories can identify the causal connection between the recalled memory and the acted behavior, however it is not possible for researchers to establish this connection from case examples. For this reason, in this study, I was only interested in examining the influence of memories that teachers are aware of and can explicitly report.

   Previous studies used tools such as written prompts (Guillaume & Kirtman, 2010; Ellsworth & Buss, 2000; Miller & Shifflet, 2016), questionnaires (Scott, 2005; Barrantes & Blanco, 2006; Rayati Damavandi & Roshdi, 2013; Dolan et al., 2014; Hudson, et al., 2010), individual interviews (Rayati Damavandi & Roshdi, 2013; Frost, 2010; Oleson & Hora, 2014; Millsaps, 2000). Approaches such as focus groups (Barrantes & Blanco, 2006; Scott, 2005), and classroom observations (Frost, 2010; Oleson & Hora, 2014) were also used in some cases to collect data about teachers' memories of their school experiences and their current or expected teaching practices. This study used a questionnaire and individual semi-structured interviews to collect data. The questionnaire allowed us to gather data from multiple teachers in a short amount of time, while the interviews allowed an in-depth examination of teachers' memories and the influence they had on teachers' current practices.

   The study looked deeply into the school memories that influence practicing mathematics teachers who were teaching mathematics at the intermediate grade level (grades 7-8-9) in private schools in the Greater Beirut Area, Lebanon, in which the language of instruction is English and where the official Lebanese curriculum is followed. Forty-two teachers were selected to fill a questionnaire and eight teachers were chosen and interviewed according to criteria that will be

45

discussed in a later section. The intermediate grade level is chosen since according to the Lebanese curriculum, the study of algebra starts in these grades. Students in these grades, study about prime numbers, negative integers, fractions, decimals, square roots, rational and irrational numbers and powers with positive and negative exponents. They also learn to apply different operations on these numbers (CERD, 1997). In addition to that, students learn to simplify, factorize, and expand different algebraic expressions, solve first degree equations, system of equations, and system of in-equations (CERD, 1997).

Participants

The population of this study consisted of practicing intermediate mathematics teachers who were teaching in private schools in Greater Beirut Area - Lebanon, in which the language of instruction is English and where the official Lebanese curriculum is followed. The participants in this study were forty-two practicing mathematics teachers who were teaching intermediate grade levels during the academic year 2018-2019. The forty-two teachers were from 17 different private schools in the Greater Beirut Area – Lebanon. The participating teachers were mixed in gender, expertise, and age. There were 32 female and 10 male mathematics teachers, 36 expert and 6 novice teachers, 31 teachers who had a teaching diploma and 11 who did not, and the age of the participants ranged from 23 to 60 years. The 42 participating teachers were asked to fill a questionnaire, and then eight were selected from the pool of participants who showed interest to participate in an interview.

The eight teachers were supposed to be as follows: two novice teachers who have a teaching diploma, two novice teachers who do not have a teaching diploma, two expert teachers who have a teaching diploma and two expert teachers who do not have a teaching diploma. In the

46

literature, there is no agreement as to how many years teachers teach and are still considered novice, and when they are considered experts. This number ranges from 1 year to 5 years in different studies (Farrell, 2012). Farrell (2012) suggested that teachers in their first 3 years of teaching could realistically be considered teachers novice. Therefore, in this study, novice-practicing teachers were considered teachers in their first three years of teaching (Farrell, 2012; Huberman 1989, 1993 as stated in Farrell, 2012), and therefore expert teachers were considered teachers who have been teaching for more than three years. The selection of teachers in this way helped us answer our third research question that is related to the effect of the teaching degree and the years of experience on how teachers are influenced by their memories.

The main selection criteria for the eight teachers were their responses on the questionnaire. We selected the teachers who reported that they often recall their experiences of learning algebra at school and were able to express how their teaching is influenced by their memories. Other criteria for selecting the eight teachers involved the following: should be teachers who completed the Lebanese Baccalaureate, and are currently teaching intermediate grades in private schools that follow the Lebanese curriculum. There were no specific criteria related to the gender, age, and nationality of the teachers.

Two teachers accepted to participate in the interview for the categories of novice with TD, novice without TD, and expert without TD. Therefore, they were automatically selected to participate in the interviews. All the six selected teachers were females, so for the category "expert with TD", we decided to choose female teachers as well to remove any gender differences when comparing the influence across teachers. In the category "expert with TD", there were 12 teachers that fit this category. Accordingly, in order to choose only two, we made a

list of the teachers in the category and randomly started contacting them, the first two teachers who were available for the interview were chosen.

Data Collection Tools

For this study, a questionnaire and individual semi-structured interviews were used to collect data. The questionnaire was used to collect data from multiple teachers within a short amount of time. However, using the questionnaire alone was not a good choice since in some studies researchers reported that the participants did not respond to the written part of the questionnaire given (Rayati Damavandi & Roshdi, 2013). Unlike questionnaires that pose the same question for all participants, semi-structured interviews provided a unique conversation with each participant since the researcher was free to adjust the questions for each interviewee according to what they know and what they are willing to share (Rubin & Rubin, 2005). Therefore, we decided to use these two tools together to be able to gather data from forty-two teachers in a short time and to choose eight teachers to interview. The individual interviews allowed an in depth conversation with each participant on his/her own.

Questionnaire. The first tool that was used in this study was a questionnaire (Appendix I); the questionnaire consisted of two parts. The first part collected general background information about the teachers such as their gender, age, years of experience, and educational degrees. The second part of the questionnaire consisted of five multiple-choice questions and two short answer questions. The multiple choice questions (questions 1-5) were developed by the researcher with the aim of gathering gather data about how often teachers recall their memories of learning algebra at school and whether these memories are positive or negative. The questions also required teachers to rate to what extent their teaching of algebra was influenced by the way

they were taught or influenced by a prior algebra teacher, and to what extent they reproduce the practices they experienced as students.

The sixth question was adapted from a study conducted by Pillemer and his colleagues (1996) which aimed to examine the influential memories college students and alumni have about their college experiences. The sixth question was a question that required a written response; the participants were asked to recall a memory of their experiences of learning algebra in the middle school that had an influence on the way they currently teach algebra, and to describe how and why this memory influenced their teaching. The teachers were asked to describe the memory in detail (what happened, when, who was involved, and what did they feel during that time) and to describe how this memory influenced their teaching. In the seventh question, the teachers were asked if they have any other influential memories that they would like to share. Aside from these general directions, the teachers were not given any other prompt or directions.

Semi-structured interviews. The second tool that was used to collect data for this study was individual semi-structured interviews, these interviews were used to collect teachers school memories about leaning mathematics and the influence these memories had on their teaching of algebra. According to Rubin and Rubin (2005), qualitative interviews are the appropriate tool to be used to ask people to describe their experiences. "Qualitative interviews are conversations in which a researcher gently guides a conversational partner in an extended discussion" (Rubin & Rubin, 2005, p. 4). Semi structured-interviews were used because they start with a specific set of questions that could be followed by other questions that emerge from the participants' responses to the initial questions (Rubin & Rubin, 2005, p. 4).

49

The interview questions (Appendix II) were formulated by the researcher with the aim of understanding better what the teachers wrote in the questionnaire and to collect additional information about the influence of their school memories. The interview starts with four question (questions 1-4) that were asked to all teachers, the questions required teachers to describe when and why they decided to become teachers, what were their experiences with learning algebra, and how was their relationship with their teachers. The aim of these questions was to get background information about the teachers, to understand their memories and how they were influenced in light of their background.

Moreover, the interviews contained a question that followed up on the teacher's response to the written question in the questionnaire. The question was "In the questionnaire, you also talked about a memory related to (remind the participant of their questionnaire response). How does this memory influence how you teach your students, how does it influence the way you react to your students". The purpose of this question was to allow teachers to elaborate on how the memory they mentioned in the interview influenced their teaching. The response from the interview was added to the response from the questionnaire, and was considered as one memory.

In an attempt to gather more memories that had an influence on teachers' teaching, the second set of questions (question 5: i-v) were developed. The main question was the same as that in the questionnaire; it required teachers to recall more memories that had an influence on their teaching. Research on autobiographical memory usually uses prompts and cues (Walls et al., 2001) to trigger memories; therefore, in this study a combination of cues and probes was used to increase the chance of retrieving a memory (Baddeley, 1999; Engelkamp, 1998 as cited in Wahl-Alexander et al., 2017). Prompts/cues were related to algebraic topic prompts (prime numbers, negative numbers, algebraic expressions, fractions, decimals, powers, or other topic in algebra).,

teaching practices prompts (activities, assignments, misconceptions, feedback, use of materials, methods of assessment), and affect prompts (positive, negative).

The third set of questions (6: i – iv) asked teachers, according to their qualifications (novice, expert, with TD, without TD), about why and how do they think their qualifications affect how they are influenced by their memories.

It is important to note that since this was a semi-structured interview, the interview questions changed for each participant, depending on their responses in the questionnaire and the flow of the conversation.

Data Collection Procedure

After getting the approval to conduct this research from the Institutional Review Board (IRB), the researcher contacted 25 schools to get their approval to allow the intermediate mathematics teachers employed in them to participate in this study. Out of the 25 schools, 17 schools accepted to let their teachers participate. The researcher met with the principal of each school and took their approval by signing a consent form. After that, the researcher got the approval of the intermediate mathematics teachers in each school to participate in the study by filling the questionnaire. Participation in the study was voluntarily; participants who agreed to participate signed a consent form and were given a hard copy of the questionnaire. The questionnaire was left with the teachers for one week, and then it was collected by the researcher from the schools. The researcher was able to collect 42-filled questionnaire from 42 teachers in 17 different schools (Table 1).

Table 1

Distribution of participating teachers across participating schools

School	Number of participating teachers
School 1	6 teachers
School 2	5 teachers
School 3	3 teachers
School 4	2 teachers
School 5	2 teachers
School 6	2 teachers
School 7	1 teacher
School 8	3 teachers
School 9	2 teachers
School 10	1 teacher
School 11	2 teachers
School 12	1 teacher
School 13	1 teacher
School 14	2 teachers
School 15	3 teachers
School 16	3 teachers
School 17	3 teachers
Total	42 teachers

After the questionnaires were collected, the researcher selected eight teachers according to the criteria mentioned earlier from the pool of teachers who agreed to participate in the interview. The teachers who agreed to participate in an interview provided their phone number at the end of the questionnaire. Following the data collection procedure approved by the IRB, the researcher directly contacted the selected teachers through the phone and agreed on a time and place at their convenience to conduct the interview. Each participant was given another consent form for agreeing to participant in the interview. Each teacher was interviewed individually by the researcher for around 30-60 minutes, all the interviews were audio recorded and later transcribed for analysis.

Data Analysis Procedure

After the questionnaires were collected and the interviews were conducted and transcribed, the researcher started analyzing the data in order to answer the three research questions.

Data organization. The unit of analysis for this study was chosen to be "an autobiographical memory", which was defined as a personal past experience. Data from the written questions in the questionnaire (questions 6 and 7) and from the interviews (question 5: i-iii) were collected and responses were divided as memories. A response was considered an autobiographical memory if it contained a description of an experience that the participant passed through when s/he was at school. If the response contained a description of more than one experience, then it was divided as several memories. For example, the response of participant 14 (P14) on the questionnaire was divided into 3 memories describing three different experiences:

Some memories: (1) in grade 6 and 7, I had 2 teachers who were providing a very safe environment in classroom though I was very shy; but in their classes I was very good participant and I had very good grades. (2) In grade 9, I was also very good in math (not excellent); I like the subject; but I have a negative memory since the math teacher once hit a student in the class. (3) In grade 11, the teacher always was looking to each student in the class and asking, "Is it clear? Did you understand?"

In many responses, the teachers mentioned a memory in the questionnaire without describing the influence, so in the interview I asked about the influence of that memory and added the response from the interview to the response from the questionnaire. Therefore, each participant's response to the interview question that followed up on her response to the written question in the questionnaire was added to the response from the questionnaire, and was

53

considered as one memory. For example, the responses of participant 14 to the questionnaire and interview were combined together as one memory,

> Questionnaire response "I always recall, the memories I've learned when I was a student, especially while explaining a new concept in my classes. Examples: Rules of multiplication of signed numbers, friend of my friend is my friend, enemy of my enemy is my friend… and so on". Interview response: "I use it, and the students like it. For that rule I tell my students that when I was a student, they taught me this and they ask me: oh, you still remember it, thank you for telling us about it. I like to tell them that I was also once a student, and some things were hard for me".

The next step was to eliminate from the responses those that are not considered as memories, in 19 responses from the questionnaires and interviews the teachers reported that they do not recall a memory related to the posed question. For example, one teacher mentioned, "Sorry my memory is very vague regarding my learning experience in algebra at school" (P2). Consequently, such responses were not considered as memories. Other responses that were not considered as memories were responses that were very brief and did not provide a sufficient description of an experience the participant had while learning algebra, for example, one participant said: "In equations, I don't forget the balance" (P29), or responses described something that is not related to the question, for example,

> I am going to talk about a behavior, a behavior of the teacher, not something in math. Never underestimate a kid, never underestimate a student, because the student can surprise you at any time, and don't judge a student based on grade. Never try to tell a student you cannot do this, try to open a conversation, and try to see what they like."(P5)

The focus of this study is on the influence of autobiographical memories of learning algebra at school, for this, the memories that were not about algebra were also eliminated in the analysis process. In 12 responses from the questionnaires and interviews, the participants described an experience they had with learning a mathematics topic other than algebra, such as geometry and calculus.

As a result of this process, I got 112 responses that were autobiographical memories of learning algebra at school that were considered in the data analysis for this study. These memories were coded for memory specificity (specific or general), emotional content (positive, negative, neutral), practice content and the influence of the memory.

Coding for memory specificity. Teachers' autobiographical memories were coded for memory specificity; the memories were assigned into one of the two categories specific or general. Specific memories were defined as memories that contain an explicit description of a one-moment-in-time event; it is typically measured in seconds, minutes or possibly hours. (Conway, 1996; Pillemer et al., 1996). The following memory is an example of a specific memory,

> I still remember when my teacher explained "identities" in grade 8. It was a completely
> new concept and I came back home super confused. When I explain this topics to my
> students (grade 8), the reaction of some of them made me think of myself. (P5)

This memory was considered as a specific memory because it describes a particular incident that happened with the participant where she felt confused about a certain lesson in a specific day.

General memories were defined as memories that consist of a nonspecific discussion of events, or they summarize repeated events; it is typically measured in months, weeks, or days

(Conway, 1996; Pillemer et al., 1996). The following memory is an example of a general memory,

> In general, I remember that at school we used to skip all word problems and do only
> drilling exercises. This raised so many questions in my head, like why do we learn that
> lesson, and where are we going to see it in real life? So now, as a teacher I insist on
> showing my students a real life application of each lesson, sometimes beyond the word
> problems of the book. (P11)

This memory was considered as a general memory because it described a practice that the
participant often experienced in the classroom and that is her teacher asking her to skip word
problems and solve the drilling exercises.

Coding for emotional content. The autobiographical memories were also coded for their
emotional content; the emotional content of memories can be described as positive, negative, or
neutral to describe pleasant, unpleasant, and unemotional experiences. Therefore, each memory
was assigned to one of the three codes: positive, negative, or neutral. Positive memories were
memories that described a pleasant experience that the participant passed through. Words such as
'loved', 'liked', 'enjoyed', 'understood', 'did well', 'were fun', 'motivating', 'inspiring',
'comfortable', 'supported', 'proud', 'easy', 'friendly', etc. were used as cues to identify a
positive memory. An example of a positive memory,

> In grade 9, my favorite subject was mathematics as usual. However, in this specific year,
> my passion increased dramatically because of the math teacher. I can recall that her
> remarkable way of explanation made me love the material more and more, especially
> algebra. In fact at the time in the final exam, I was the only student in the 4 sections that

was able to score full mark. As a result, the teacher announced my name and shared my results in all classrooms and showed how proud she was. This occasion never leaves my mind and it always pushes me further to teach from my heart and motivate any successful student that aims to reach high results. (P27)

This memory was considered as positive, since the participant described her increase in passion for the subject mathematics, described her teacher's way of explanation as remarkable, and described that this memory motivated her to teach from her heart and to support her students to become successful.

Negative memories were memories that described an unpleasant experience that the participant passed through, words such as 'did not like', 'were difficult', 'hard', 'confusing', 'suffering', 'offensive', 'not understand', 'not fair', 'embarrassed', 'afraid', etc. were used as cues to identify negative memories. An example of a negative memory,

I suffered memorizing multiplication table. I had trouble with 7th, 8th, and 9th table. My first memories of learning math in a classroom are from third grade and this suffering kept till grade 6. This memory influenced on my teaching and tried to go out of comfort zone through different methods to awake curiosity in kids. (P16)

This memory was considered as negative because the participant described her suffering with the memorization of the multiplication table.

Neutral memories were memories that did not contain how the participant felt during the event or how s/he felt about the experience. The memory contained only a description of what happened. For example,

My high-grade math teacher used to teach us a lot of the concepts as a song or rhyming sentences. Ex. In lesson of powers (multiplication) he used to say "same base different

57

power, keep the base add the power" and in fact I teach this sentence to my students every year in the lesson of powers. Same as some sentences that can replace theorem and are more likely to be used by students "adding equals to equal keep them equal". (P24)

Coding for practice content. Teachers' memories were analyzed to extract categories for teaching practices. The analysis followed a top-down qualitative coding, where the researcher started with some codes that were used as probes in the interview (activities, assignments, tricks, tips for studying, misconceptions, feedback, use of materials, methods of assessment). While analyzing additional codes also emerged. In order to come up with categories for the teaching practices, the researcher referred to the "Danielson Framework for Teaching" (Danielson, 2007).

The Danielson Framework for Teaching identifies the aspects of a teacher's responsibilities that are reflected in daily work, that define what teachers should know and be able to do in the exercise of their profession (Danielson, 2007). The framework divides the complex activity of teaching into 4 domains, 22 components, and 86 elements (Appendix III). The four domains are (1) planning and preparation, (2) the classroom environment, (3) instruction, and (4) professional responsibilities. Each domain includes a list of components; each component defines a distinct aspect of a domain and two to five elements describe a specific feature of a component. Domains 1 and 4, describe the behind-the-scenes work associated with teaching. Planning and preparation domain (Domain 1) described the teachers' work of organizing for classroom instruction, while the professional responsibilities domain (Domain 4) describes the teachers skills needed for their commitment to high ethical and professional standards and seek to improve their practice (Danielson, 2007). On the other hand, domains 2 and 3, describe practices that are carried out inside the classroom setting during

instruction. The classroom environment domain describes teaching skills needed to create a positive atmosphere that promotes learning such as creating an environment of respect and rapport, and managing student behavior, etc. The instruction domain corresponds to the "interactive work that teachers undertake when they bring complex content to life for their students" (Danielson, 2007), such as engaging students in learning, using questioning and discussion techniques, etc.

Lortie's description of the apprenticeship of observation (1975) notes that students who spend a huge number of hours observing teachers in the classroom, are only able to see what the teachers do inside the classroom, however students do not have access to the behind the scenes work of teachers. Consequently, in this study, we were interested in examining the participants' memories of their experiences with their teachers' teaching practices inside the classroom. Therefore, the recalled practices through memories were considered under the second domain "Classroom Environment" and the third domain "Instruction".

After coding the practices in the first level analysis of the participants' responses, the codes were categorized under corresponding elements in the domain that best fit the assigned codes. For example, the coding of practices such as: instructional games, instructional activities, worksheets, homework, were categorized as "Activities and assignments", which is an element in the framework under the instruction domain. After doing this for all codes, the list of categories that emerged referred to one element from the second domain "Classroom Environment" and five elements from the third domain "Instruction".

Each element in the framework is defined through a 4-point rubric that describes the level of performance for each practice (unsatisfactory, basic, proficient, and distinguished). In order to define these practices for this study, we referred to the description provided under 'distinguished'

and 'unsatisfactory' performance level to characterize the good and bad teaching practices (Table 2). The 'distinguished' level of performance was expected to be associated with the positive experiences the participants had with their teachers' teaching, where they described good teaching practices, while the unsatisfactory level of performance was associated with the negative experiences, where they described bad teaching practices.

In this study, we considered 6 elements from the Danielson (2007) framework which represent different teaching practices. "Teacher interaction with students" refers to the practice of how teachers communicate and treat students inside the classroom, whether the interaction is respectful and caring or demeaning and sarcastic. "Explanation of content" refers to the practice of how teachers explain and demonstrate lessons, whether the explanation is clear and connected to students' knowledge and experience or if it is unclear and confusing. "Discussion techniques" refer to the practice of how teachers carry out the conversations in the classroom, whether students are given the chance to initiate and contribute to the discussions or if the teacher is dominating the talk. "Activities and assignments" refer to the practice of using activities, assignments, and other classwork in the classroom, whether the activities and assignments are cognitively engaging and do enhance students understanding or whether they are inappropriate for the students. "Instructional materials and resources" refer to the practice of using tools to explain lessons or carry our activities, whether they are suitable to the instructional purposes and engage students mentally or if they are unsuitable and do not engage students mentally. "Assessment and feedback" refer to the practice of evaluating students learning, whether teachers assess students fairly and give them constructive feedback in an appropriate way or if they assess them unjustly and provide them with a poor quality feedback.

Table 2

Description of domains, components, and elements of the Danielson framework for teaching (Danielson, 2007 p. 77-91)

Category of teaching practice	Description	
	Distinguished	Unsatisfactory
Domain 2: The Classroom Environment		
Element 2a.1: Teacher interaction with students	Teacher interactions with students reflect genuine respect and caring for individuals as well as groups of students. Students appear to trust the teacher with sensitive information.	Teacher interaction with at least some students is negative, demeaning, sarcastic, or inappropriate to the age or culture of the students. Students exhibit disrespect for the teacher.
Domain 3: Instruction		
Element 3a.3: Explanation of content	Teacher's explanation of content is imaginative and connects with students' knowledge and experience. Students contribute to explaining concepts to their peers.	Teacher's explanation of the content is unclear or confusing or uses inappropriate language.
Element 3b.2: Discussion techniques	Students assume considerable responsibility for the success of the discussion, initiating topics and making unsolicited contributions.	Interaction between teacher and students is predominantly recitation style, with the teacher mediating all questions and answers.
Element 3c.1: Activities and assignments	All students are cognitively engaged in the activities and assignments in their exploration of content. Students initiate or adapt activities and projects to enhance their understanding.	Activities and assignments are inappropriate for students' age or background. Students are not mentally engaged in them.
Element 3c.2: Instructional materials and resources	Instructional materials and resources are suitable to the instructional purposes and engage students mentally. Students initiate the choice, adaptation, or creation of materials to enhance their learning.	Instructional materials and resources are unsuitable to the instructional purposes or do not engage students mentally.
Element 3d.3: Assessment and feedback	Teacher's feedback to students is timely and of consistently high quality, and students make use of the feedback in their learning.	Teacher's feedback to students is of poor quality and not provided in a timely manner.

Coding for influence of memory. Teachers' responses were analyzed to understand how the memories influenced their teaching, i.e. what actions did teachers take in their current teaching as an influence of their school memories. The analysis followed a top-down qualitative coding approach. The researcher started with two themes that emerged from the literature (e.g. Barrantes & Blanco, 2006; Miller & Shifflet, 2016; Millsaps, 2000), which are to reproduce the same practices experienced as a student, and opposing the practices experienced as a student and doing something different instead. While analyzing additional themes for the influence of autobiographical memories also emerged.

To answer the third research question, the participants were categorized into four categories: novice teacher with TD, novice teacher without TD, expert teachers with TD, expert teachers without TD. In addition, responses to the questions from the interview (questions 1-4, 5: iv-v, 6: i-iv) were also be used to analyze and compare how the influence of memories differ with respect to teachers' expertise.

Trustworthiness Criteria

In order to assess the quality of qualitative research several issues and strategies should be taken into consideration. Assessing the quality of qualitative research is made to ensure the trustworthiness of the study and its findings. Trustworthiness is defined as "that quality of an investigation (and its findings) that made it noteworthy to audiences" (Schwandt, 2015, p. 308). Lincoln and Guba (1985) developed 4 criteria to assess the trustworthiness which include truth value, applicability, consistency, and neutrality. These four criteria were later renamed into credibility, transferability, dependability, and conformability of the research being conducted (Schwandt, 2015, p. 309).

Credibility. Credibility, which is similar to internal validity, "addresses the issue of the inquirer providing assurance of the fit between respondents' views of their life ways and the inquirers reconstruction of the same" (Schwandt, 2015, p. 309). In other words, ensuring credibility is to ensure that the study reflects the reality of the phenomenon as told by the participants (Merriam, 2002). Several ways were suggested to enhance credibility that include prolonged engagement, persistent observation, triangulation, negative case analysis, referential adequacy, member checks, or peer examination (Lincoln & Guba, 1985; Merriam, 2002). For this study, peer examination was carried out to ensure the credibility of this study. Peer examination or peer debriefing "is a process of exposing oneself to a disinterested peer in a manner paralleling an analytical sessions and for the purpose of exploring aspects of the inquiry that might otherwise remain only implicit within the inquirer's mind" (Lincoln & Guba, 1985, p. 308). The researcher presented the study to other researchers to get their insights and questions about the method used and the interpretation done.

Transferability. Transferability, which is similar to external validity, "deals with the issue of generalization of finding, and whether the findings from the study could be applied to other contexts (Lincoln & Guba, 1985; Merriam, 2002; Schwandt, 2015). Transferability can be achieved by providing a rich, thick description of the study, by providing "sufficient information on the case studied such that readers could establish the degree of similarity between the case studied and the case to which findings might be transferred" (Schwandt, 2015, p.309). In this study, the researcher thoroughly described the methodology of the study, the context in which it took place, the participants, the selection criteria, the data collection tools and procedure.

Dependability. Dependability, which is similar to reliability, "focuses on the process of the inquiry and the inquirer's responsibility for ensuring that the process was logical, traceable, and documented" (Schwandt, 2015, p.309). In other words, it refers to whether the "results are consistent with the data collected" (Merriam, 2002, p. 27). Lincoln and Guba (1985) argue that "since there is no validity without reliability and thus no credibility without dependability" (Lincoln & Guba, 1985, p. 316), then if one can ensure the credibility of the study it might not be necessary to ensure the dependability of the study separately. However, while this argument has strengths it also carries some weaknesses so other strategies must be adopted to ensure dependability directly (Lincoln & Guba, 1985). Strategies such as triangulation, peer examination, investigator's position, and audit trail could be used to ensure dependability (Lincoln & Guba, 1985; Merriam, 2002). In this study, dependability was enhanced by using peer examination that was also used to ensure credibility, in addition to keeping an audit trail. "An audit trail is a transparent description of the research steps taken from the start of a research project to the development and reporting of findings. These are records that are kept regarding what was done in an investigation" (Cohen & Crabtree, 2006). "An audit trail in qualitative study describes in detail how data were collected, how categories were derived, and how decisions were made throughout the inquiry" (Merriam, 2002, p. 27). In this study, the researcher kept a research journal throughout the study about how the data were collected and analyzed (Merriam, 2002).

Conformability. Confirmability, which is similar to objectivity, is "concerned with establishing the fact that the data and interpretations of an inquiry were not merely figments of the inquirer's imagination" (Schwandt, 2015, p. 309). Confirmability can be achieved by confirmability audit and triangulation (Lincoln & Guba, 1985). In this study, confirmability was

ensured by having a confirmability audit or external audit, which "involves having a researcher not involved in the research process examine both the process and product of the research study. The purpose is to evaluate the accuracy and evaluate whether or not the findings, interpretations and conclusions are supported by the data" (Cohen & Crabtree, 2006). In this study, an independent researcher reviewed the results of the study following the trail of the researcher (Merriam, 2002; Schwandt, 2015). The researchers met twice during this process, once to explain the coding process, and later to discuss and compare their coding. The independent researcher coded 25% of the data used in this study, and results of the comparison showed that there was around 92% agreement between the coding of the researcher carrying out this study and the other independent researcher. In specific, the agreement percentage was as follows for the 4 categories coded, 86% for practices content, 93% for emotional content, 96% for the structure, and 93% for the influence of memories.

CHAPTER IV

Results

This research aimed to study how teachers' autobiographical memories of their learning of algebra at school influence their current teaching of algebra. The study looks into what teachers remember about their experiences of learning algebra at school, how these memories influence their teaching of algebra, and how the influence of memories differs with expertise acquired as a teacher. This chapter reports the results of this study following the order of the research questions. The first part of this chapter describes the results of the content and structure of teachers' autobiographical memories of their experiences of learning algebra at school. The second part reports about the relationship between the content and structure of the memories and the influence of these memories on teachers' teaching of algebra. The last part illustrates how the influence of the memories differs between novice and expert teachers and between teachers who have a teaching diploma (TD) and those who do not.

Forty-two mathematics-practicing teachers participated in this study; 6 of these participants mentioned that they do not remember anything about their experiences of learning algebra at school, while the remaining 36 participants provided a total of 112 memories (through the questionnaire and interviews) related to learning and teaching algebra at school. In their memories, the participants described various practices from different grade levels related to different algebraic topics.

Although they were not asked to mention explicitly the grade level in which the memory took place, in 35.71% of the memories, the participants identified the grade level from which they remember an experience. The majority of the memories (24.11%) were from the intermediate grade level, while only 6.25% of the memories were from the secondary grade

level, and 5.36% were from the elementary grade level. In the remaining 64.29% of the memories, the participants did not explicitly mention the grade level in which the memory took place.

In their memories, the participants referred to several algebraic topics to which the memories were related. These included topics such as factorization and remarkable identities, equations and inequalities, algebraic expressions, fractions and decimals, operations, powers, prime numbers, and signed numbers. Table 3 below shows the distribution of the memories across the various algebraic topics.

Table 3
Distribution of algebraic topics described in participants memories

Algebraic Topic	Frequency	Percentage
General algebra	63	56.25
Factorization and remarkable identities	13	11.61
Equations and inequalities	8	7.14
Algebraic expressions	8	7.14
Fractions, decimals, percentages	7	6.25
Operations	5	4.46
Powers	3	2.68
Prime numbers	3	2.68
Signed numbers	2	1.79
Total	112	100%

The participants' memories about their experiences with learning algebra at school, described various experiences with their teacher's teaching and their own learning of algebra, and while recalling these memories the participants described how they felt during or about what they experienced. In the section below, we will report on what teachers remember about their experiences of learning algebra at school. More specifically this section will describe the content of the autobiographical memories that the participants recalled in this study.

Content of autobiographical memories

In this study, I distinguish between two types of content in participant' autobiographical memories. In particular, the content is classified based on a practice content and an emotional content. The practice content section will describe the experiences that the participants remembered, while the emotional content section will describe how the participants felt about or during the recalled experiences. This section will report on the results of the content of the participants' autobiographical memories based on these two categories.

Practice content in autobiographical memories. Results show that participants recalled a wide variety of practices that they experienced while learning algebra when they were students. Results show that in 84.82% of the memories the participants described their experiences with practices performed by their teachers, while in 15.18% of the memories the participants described practices carried out by themselves when they were students. We will be presenting the practices performed by the participants' teachers under the categories adopted from some of the elements of the Danielson Framework for Teaching, while the practices carried out by the participants will be presented under the categories that emerged in our analysis. Table 4 shows the distribution of the practices described in participants' memories.

Table 4

Distribution of the practices described in participants' memories

Practice	Frequency	Percentage
Participants' experiences with their teachers' practices		
Explanation of content	36	32.14%
Activities and assignments	28	25.00%
Teacher interaction with students	18	16.07%
Assessment and Feedback	7	6.25%
Discussion techniques	3	2.68%
Instructional Materials and resources	3	2.68%
Total memories regarding teaching practices	**95**	**84.82%**
Participants' personal learning experiences		
Difficulties in leaning algebra	8	7.14%
Ways of studying algebra	5	4.46%
Good performance in algebra	4	3.57%
Total memories regarding personal learning experiences	**17**	**15.18%**
Total	112	100%

Participants' experiences with their teachers' practices. Results of this study show that in 84.82% of the memories, the participants described experiences they had with their teachers teaching practices. The participants recalled a wide variety of teaching practices that they experienced or observed their teachers doing while they were students. The major category, in terms of highest frequency, was explanation of content (32.14%), then activities and assignments (25.00%), followed by interaction with students (16.07%). The rest of the memories were distributed over practices such as assessment and feedback (6.25%), discussion techniques (2.68%), and instructional materials and resources (2.68%). In the sections below, we will describe what the participants remembered about each category.

Memories about explanation of content. The majority of the memories were related to the participants'' teachers' explanation of content; in 31.25% of the memories, the participants

remembered a range of methods that their teachers followed in order to explain certain topics and procedures. Participants' memories about their teachers' explanation of content ranged from explanation that was appropriate and connected to students' real lives to explanation that was unclear or confusing. The participants recalled how their teachers' taught them to understand the remarkable identities, deal with negative exponents in fractions, solve equations, evaluate an algebraic expression, and solve a word problem. One participant remembered in detail how her teacher explained the steps to solve a system of two equations; she also illustrated how her teacher taught them to choose the best way to solve according to the given system:

> I remember when I was taught how to solve system of 2 equalities. Our teacher used to teach us how to choose the best way of solving system according to given system.
>
> For example, if the system was given $\begin{cases} 3x - 2y = 4 \\ 2x + 3y = 3 \end{cases}$ the best way was done by elimination since y has different coefficients and different signs. If the system was given $\begin{cases} x + y = 5 \\ 2x + y = 18 \end{cases}$ best is substitution; in both y has coefficient 1 so better to use substitution or if both y or x have the coefficient $\begin{cases} 3x + 2y = 7 \\ 5x + 2y = 3 \end{cases}$ then $2y = 3 - 5x$, then $3x + 3 - 5x = 7$ and so on. (P12)

Participants also remembered how their teachers used various representations while explaining, used songs or rhyming sentences for rules and formulas, and related algebra to real life situations. For example, one participant remembered the sentence her teacher used to explain the rule of the multiplication of powers:

> My high-grade math teacher used to teach us a lot of the concepts as a song or rhyming sentences. Ex. In lesson of powers (multiplication) he used to say "same base different power, keep the base add the power" (P24)

Another participant described how her teacher referred to fruits when explaining how to add two numbers:

> When we were young, algebra was a bit overwhelming, because we had to deal with numbers. Sometimes the numbers didn't represent something specific, they were numbers. When a teacher of mine taught us how to express our numbers in drawings, it made a lot more sense. We learned to create real life situations out of them. Ex instead of "2+5" I used to think, "I bought 2 apples and then 5 more, how many apples do I have now?" (P3)

On the other hand, some participants recalled when their teachers did not explain the material clearly, did not relate algebra to real life, or when their teachers' explanation focused on procedures rather than conceptual understanding. One participant described how her teacher explained solving an equation by moving numbers from one side to the other without explaining the concept of balancing sides:

> Solving an equation for example, x+5=2. They didn't tell us that we need to find x, they didn't teach me that we need to maintain the balance of right hand side and left hand side, so we need to remove the 5 from here by minus-ing a 5 so the right hand side to keep the balance we should also remove a 5. We were taught that x+5 =2, 5 take it to the other side it becomes negative, as a child I won't be able to understand why, the positive, the addition becomes subtraction on the other side, but why. (P1)

Memories about activities and assignments. In 25% of the memories, the participants remembered various activities and assignments that their teachers used to engage them in learning. The participants described a range of activities related to different algebraic topics. For

example, one participant described the mock market activity her teacher created to help them learn operations:

> I remember the market our teacher used to open. Our teacher used to open a small market in the class with a lot of items carrying the prices and we were the customers. Using daily life problems about buying and selling, we learned different types of operations and we really experienced their importance. (P29)

Other participants recalled other activities such as drawing and coloring a pizza like shape to learn fractions, using an egg box with marshmallows to learn about multiplication, finding prime numbers by crossing the numbers that are divisible by 2 to 10 in a hundred-number grid, etc.

Furthermore, the participants highlighted that their teachers used to engage them in solving brainteasers, challenging questions, and drilling exercises through extra worksheets to practice. As for the homework assignments, some participants remembered their teachers assigning a huge load of homework that consisted of a long list of exercises. For instance, one participant described:

> Homework was a huge load of homework, I had teachers assigning the homework by pages, they would go page 56 to 58, all due tomorrow, that was a lot of drilling, I was fast in math so it made it easy for me, but I think it was not that easy for other students. (P37)

Memories about interaction with students. The third most frequent teaching practice that recurred in participants' memories was their teachers' interaction with students. Around 16.07% of the participants' memories described their teachers' interaction with them in the classroom. Teacher's interaction with the students ranged between interactions that reflected support and

care and interactions that were inappropriate or demeaning. The participants remembered whether teachers were friendly or not, supporting or not, and encouraging or not in algebra sessions. Through their memories participants acknowledged that these practices were central to teaching algebra. For example, one participant recalled that even though she was a shy student, she used to participate in a teacher's class that provided a safe environment; another participant recalled that her teachers' acknowledgment of her performance in algebra made her proud of herself and pushed her to excel more. For instance, one participant recalled a memory with a teacher who used to encourage his students to do better in algebra:

> I remember having an algebra teacher who was so relaxed, and encouraged his students all the time. He became my role model, and he use to express his belief in all his students. He used to tell us that everyone can succeed in Algebra - I can still remember his encouraging words. (P38)

On the other hand, other participants described memories like when a teacher hit a student, a teacher who encouraged negative competition between students to get better grades, and a teacher who was not supportive of the students' choices.

Memories about assessment and feedback. In 6.25% of the memories, the participants described how their teachers used to assess their work. Some mentioned having unfair assessment, having challenging exams, a lot of quizzes, others recalled depending on paper-pencil exams only for assessment, while others recalled being assessed during group work. Some participants also remembered how their teaches used to give them feedback, one participant recalled how her teacher used to pass by the students while they are working in groups one by one to check their work, and then ask those with the best solution to present it in front of their

73

peers. On the other hand, another participant remembered that her teacher used to give students feedback in an inappropriate way, she described that the teacher used to call the student to the board and then give then the feedback in front of the others, which made some students, feel humiliated.

Memories about discussion techniques. In 2.68% of the memories, the participants recalled memories that described how their teachers' used to carry out the discussion in the classroom. For example, one participant described that her teacher used to give them time to discuss problems in depth and to reason by building on each other's' responses. She recalled the following memory:

I feel that what was stuck in my mind up till now are the scenarios when there was a lot of reasoning based on repetition, reasoning based on other people's reasoning. […] The cases and examples that influence me the most back then when I was a student is when problems were discussed in depth and we were given the chance to give our opinion, expand, analyze. (P37)

On the other hand, some participants noted that their teachers did not give them enough time to share ideas, and answer questions. One participant stated in her response:

We were never given time to answer the teacher's questions during instruction class. The teachers would ask the question, then answer it herself right ahead. (P36)

Memories about instructional materials and resources. In 2.68% of the memories, the participants described their teachers' practices regarding their use of instructional materials and resources. Some participants mentioned that their teachers did not use any hands on materials in

the explanation of lessons, while other participants remembered in detail the perfectly prepared

materials that their teachers used to use, such as laminated cardboard pieces in the shape of a

pizza and ice cream to explain fractions. One participant described the following memory:

> The material that our teacher used to use, they were perfect, I still remember the material
>
> she used in fractions, I still remember those used in multiplication, and in division, they
>
> were close to us. […] Some of them were cardboards, but they were elegant, not any
>
> cardboard, it was laminated. When she used to explain fractions, I still remember in grade
>
> 3, she got us the pizza that was cut, I still remember the ice cream that was cut in half,
>
> you feel that it is so delicious, so true it is an ice cream. (P29)

Students' personal learning experiences. Around 15.18% of the recalled memories

correspond to the participants' personal experiences in learning algebra. Results also show that

participants' autobiographical memories about their experiences with learning algebra at school

did not only refer to their experiences with their teachers' practices, but they also described their

own personal experiences with learning algebra. Participants remembered the ways they used to

study algebra (7.14%), the difficulties they had in learning algebra (4.46%), and others described

their good performance in algebra (3.57%).

Participants recalled that their studying of algebra depended on a lot of drilling exercises

and memorization of rules and formulas. They remembered having to memorize the

multiplication tables, prime numbers, remarkable identities, cases for inequality signs, and other

rules and formulas. Some participants remembered that they used to repeat the practice done in

the classroom when they study for a quiz or an exam. For example, one participant highlighted

the following memory:

At that time when I was studying I used to recall all notes given by the teacher and I used to repeat all the practices done in class and at home, I mean I take the book and start from beginning to the end doing all the practice. (P28)

In addition to that, participants recalled the difficulties they had in learning algebra, such as understanding factorization and remarkable identities, dealing with negative numbers, finding prime numbers, solving word problems, and operating on fractions. One participant remembered that she had trouble in working with fractions with unlike denominators. She reported the following memory:

Adding and subtracting fractions with unlike denominators wasn't easy for me. […] When it came to unlike denominators, I used to cross-multiply the product. This led me to big terms and made simplifying the fractions at the end more difficult. I got a very low grade in the test and I got all my answers with very big terms. (P5)

On the other hand, other participants recalled that they used to perform very well on algebra; some recalled that they found algebra to be very easy and that they used to understand the teachers' explanation for the first time; others recalled getting good grades in algebra. For instance, one participant recounted the following memory:

It [Algebra] was so easy for me, […] specifically in grade 8 I started having 20s and 19s. In algebra I remember it was so easy for me, like the expanding, everything related to fractions and numbers, yes I remember it was so easy. (P10)

Emotional content in autobiographical memories. The memories about participants' school experiences of learning algebra were accompanied by a range of emotions to describe how they felt about or during the experiences that they remembered. The participants in this

study described how they felt about the event that they recalled; they described events that they liked and enjoyed (i.e., positive memories) and events that they disliked and criticized (i.e. negative memories).

Results show that in this study, more positive memories were recalled than negative memories. Specifically, 37.5% of the memories were positive, while 27.68% of the recalled memories were negative. The remaining 34.82% of the memories were identified as neutral since the participants described only the event that occurred without explaining how they felt during that event (Table 5).

Table 5
Distribution of emotional content described in participants memories

Emotional content of memory	Frequency	Percentage
Positive	42	37.5%
Neutral	39	34.82%
Negative	31	27.68%
Total	112	100%

Positive autobiographical memories. Most of the recalled memories in this study were positive (37.5%), participants used words such as "loved, liked, enjoyed, understood, did well, were fun, motivating, inspiring, comfortable, supported, proud, easy, friendly" to describe the positive emotions they had during or about the recalled experiences. The participants expressed their positive emotions when they remembered how much they enjoyed and benefited from their teachers' teaching, how good their teachers treated them, and how well they did in algebra.

Participants expressed positive emotions when they recalled memories about enjoyable, beneficial, and helpful instructional practices that their prior teachers used in the classroom. The participants described emotions of having fun, enjoying, being comfortable, being motivated, and loving what and how their teachers taught them. For example, one participant expressed

77

having fun while solving brainteasers; she said, "I had a teacher who used to give us brain teasers in Brevet. They were fun, challenging, and helped motivate us at the beginning of the class" (P2). Another participant expressed that she loved the way her teacher used to explain the lesson of algebraic expressions, she recalled, "I loved the way he used to explain the Reduce, Expand, and Factorize algebraic expressions using colored chalks" (P10). Another participant described that her teacher's remarkable explanation made her like the material more and motivated her to perform better. She remembered the following memory:

> In grade 9, my favorite subject was mathematics as usual. However, in this specific year, my passion increased dramatically because of the math teacher. I can recall that her remarkable way of explanation made me love the material more and more, especially algebra. (P27)

Participants also described positive emotions when they recalled how their teachers treated them and interacted with them. The participants described how their teachers provided a safe classroom environment and how their teachers were friendly, caring, and encouraging in the algebra sessions. They described emotions of love, friendliness, pride, and comfortableness with how their teachers treated them in the classroom. For example, one participant described how she felt comfortable to participate in class even though she was a shy student because her teacher provided a safe classroom environment:

> I had 2 teachers who were providing a very safe environment in classroom. […] Maybe it is about the grade 6 teacher, I remember that she was a positive memory, because it was the most year, I felt that I have to participate. By the way, I was a very shy student, but with this teacher, I felt more comfortable to focus and participate (P14)

Another participant expressed her positive emotions in a memory she had with her teacher, who rewarded her for being able to solve a challenging exercise. She described the following:

> I have a good memory since my school years. […] When I was in grade 7, the math teacher challenged us with one difficult exercise (level 8 and 9) in expansion and factorization. He told us the first learner who will give me the correct answer; I will get a meal from MacDonald's. I remember that I enjoyed eating the next day :). (P19)

In several other memories, the participants described that they used to like and enjoy studying algebra and that they used to understand algebra well from the first time and get good grades on algebra. For example, one participant said, "I have always liked math, I have always gotten good grades, especially in algebra" (P10). Another participant said, "I used to understand from the first time and I used to help my friends" (P29). Similarly, one participant remembered, "In their classes I was very good participant and I had very good grades" (P14).

In all of these memories, the participants described their positive emotions towards the various experiences they passed through while they were learning algebra as students. However, not all participants' memories of their experiences with learning algebra were positive. In the next section, we will report on the negative memories that the participants recalled.

Negative autobiographical memories. Around 27.68% of the recalled memories were negative. Participants used words such as "did not like, were difficult, hard, confusing, suffering, offensive, not understand, not fair, embarrassed, afraid," to describe their negative emotions that they felt during or about the recalled memories. The participants expressed negative emotions when they remembered the unbeneficial teaching practices that their teachers used to follow, the

unpleasant way their teachers' treated them, and the difficulties they faced when they were learning algebra.

Participants showed negative emotions when they described unpleasant experiences with their teachers' instructional practices. Participants remembered when their teachers did not explain the lessons clearly, did not give enough time to discuss and share ideas, gave long assignments with lots of drilling exercises, and promoted memorization of rules and formulas without explaining their origin, etc. When they described these memories, the participants described emotions of frustration, confusion, hatred, and disapproval. For example, one participant remembered being frustrated because her teacher never taught her the reasoning behind the tricks to solve equations:

I learnt how to solve equations by using tricks instead of balancing equations, which frustrated me as a student because I never understood the mathematical reasoning behind those tricks. (P37)

Participants also showed negative emotions when they remembered experiences where their teachers unpleasantly treated them. The participants described feeling discouraged, afraid, embarrassed, and anxious. For example, one participant remembered, "When I used to make a mistake, I used to be afraid of the reaction of the teacher" (P37). In another memory, a participant described feeling anxious because of the unhealthy competitive spirit her teacher used to promote in the classroom. She explained the following event:

Other memories I have are those related to the competitive spirit found in Lebanese schools. Being a product of Lebanese system, I cannot but remember how students used to compete to get better grades. […] This used to create a lot of anxiety in students including me. (P38)

80

The negative memories that the participants recalled were not only about their experiences with their teachers' practices; in some of these memories, the participants remembered the difficulties they faced with learning algebra. The participants described emotions of confusion, suffering, crying, and feeling bad about themselves. For example, one participant remembered having trouble with solving word problems, she explained. "I still remember that I suffered as a student from solving word problems. […] The teacher did not help students in analyzing the problem" (P6). Another participant remembered crying for not understanding the lesson of remarkable identities, she recalled. "Identities, I took this is grade 8 and it was really challenging for me as a student, I remember that day I went home and started crying because I did not understand" (P5). Another participant remembered feeling bad about the mistakes he used to do as a student:

> What I recall mostly from my algebra experience are my mistakes as a student. Mistakes
> like taking "$7^0 = 0$" on a midterm exam, […] forgetting about the "-" sign in front of x in
> an equation, "$2-x=7 => x=5$", and many more. I felt bad at the time. (P30)

In all of these memories, the participants described their negative emotions towards the various experiences they passed through while they were learning algebra as students. Nevertheless, not all memories contained a description of positive or negative emotions regarding the recalled experience; in some of the memories, the participants did not express any emotions along with the remembered event. In the next section, we will report on the neutral memories that the participants recalled.

Neutral autobiographical memories. In 34.82% of the memories, the participants did not express any emotional content. These memories were identified as neutral memories. In

particular, some participants described how they were taught or how they learned algebra without mentioning how they felt during the described event. Some participants described how their teachers explained certain concepts, or they described the activities their teachers used without telling if they enjoyed or benefited from these or not. For example, one participant said, "I still remember the trick that my teacher taught me how to evaluate an expression. Always replace the variables by parenthesis." (P5). Another participant recalled, "I remember the pizza activity, you have a pizza, you cut it then draw and color" (P3), and a third participant described, "Teaching algebra in school was more in classical ways, the teacher used to introduce formula and teach us how to apply it" (P42). These participants did not describe how they felt about or during these memories.

In all of the above sections, we described what the teachers remembered about their experiences of learning algebra at school. We described the practice content and the emotional content found in the participants' memories. We explained different practices that they recalled, and we reported on the emotions they expressed in these memories. In the next section, we will report on the results of the structure of the recalled memories in this study.

Structure of autobiographical memories

The autobiographical memories that the participants recalled about in their experiences of learning algebra at school were not all in the same specificity. Some of these memories described particular incidents that the participant experienced once while learning algebra, while other memories described general events that they experienced repeatedly. Results show that 57.14% of the memories collected from the participants for this study were general, while 42.86% of the memories were specific.

Results show that teachers recalled more "general memories" about their experiences of learning algebra at school through the two data collection tools used. In the questionnaire, participants were asked to recall a memory of their experience of learning algebra that influences their teaching without any further probe or cue; with this 54% of the memories recalled through the questionnaire were general, while 46% were specific. In the interviews, the participants were given several specific cues and probes to trigger their memories. Despite this result, 59.7% of the memories were general, while 40.3% of them were specific (Table 6).

Table 6
Distribution of the specific and general memories collected from the questionnaire and interviews

Memory specificity	From questionnaire		From interviews		From both	
	Frequency	%	Frequency	%	Frequency	%
Specific	23	46%	25	40.3%	48	42.86%
General	27	54%	37	59.7%	64	57.14%
Total	50	100%	62	100%	112	100%

General autobiographical memories. Results show that 57.14% of the memories collected from the participants for this study were general. The general memories that the participants recalled described their repeated experiences with some teaching practices that their teachers frequently used while teaching algebra, in addition to their own repeated experiences with learning algebra.

The teaching practices that the participants described in the general memories were practices that their teachers repeated in the classroom for over days, weeks, or months. For example, one participant recalled that when her teacher used to explain a lesson, he always asked students if they understood or if they have any questions "In grade 11, the teacher always was

looking to each student in the class and asking, "Is it clear? Did u understand?" (P14). Another participant recalled that her teacher frequently gave her brainteasers, which are a form of questions that require a lot of thinking to be solved "I had a teacher who used to give us brain teasers in Brevet. They were fun, challenging, and helped motivate us at the beginning of the class." (P2). Likewise, a third participant recalled that her teacher constantly asked them to skip word problems and to focus on solving the drilling exercises "In general, I remember that at school we used to skip all word problems and do only drilling exercises" (P11). One participant also remembered that her teacher never gave them a chance to think and answer the questions that she posed "We were never given time to answer the teacher's questions during instruction class. The teachers would ask the question, then answer it herself right ahead" (P36).

In these general memories, the participants described the practices that their teachers frequently followed in the classroom; this means that these are events that the participants repeatedly experienced as students while learning algebra, and thus the memories that they recalled about these experiences were general.

In other general memories, the participants described some of their own repeated experiences with learning algebra. For example, one participant recalled the way she used to study at home by recalling the following memory:

> The way I was studying was efficient, at that time when I was studying I used to recall all notes given by the teacher and I used to repeat all the practices done in class and at home, I mean I take the book and start from beginning to the end doing all the practice. (P28).

On the other hand, another participant recalled her continuous suffering with learning the multiplication table:

84

I suffered memorizing multiplication table. I had trouble with 7th, 8th, and 9th table. My

first memories of learning math in a classroom are from third grade and this suffering

kept till grade 6. (P16)

These participants along with some others remembered how they had to deal with the learning of

algebra over time, their memories that described their frequent studying practices, their repetitive

success, and their recurrent suffering were deemed to be general memories.

Specific autobiographical memories. Results show that 42.86% of the memories

collected from the participants for this study were specific. The specific memories that the

participants recalled described unique experiences with some teaching practices that their

teachers followed on one occasion while teaching algebra. Participants experienced these

practices in a particular time in a particular session, which made the recalled memory a specific

one. For example, one participant described a specific memory where she said, "I have a

negative memory since the math teacher once hit a student in the class" (P14). Another

participant recalled the following incident, where she asked the teacher about the reason behind

learning algebra:

As a student, learning and practicing algebra was very abstract and, on rare occasions,

was related to real-life. I remember an incident with one of my teachers, asking him why

is we learning fractions, and he said, "Because we have to and end of discussion". (P7)

Another example of a specific memory, one participant described the activity that her teacher

deployed in order to explain equations. She described the following:

I still remember the activity done when explaining equations in grade 7 by the teacher.

The teacher showed us a balance (2 arms) where she placed one object on the right hand

and 3 objects on the left hand and the balance showed equilibrium state. That activity

helped us to understand what is meant by equations since the mass of the object on the

right side was equal to the mass of the three objects on the left side and the purpose was

to find the mass of one ball (found on the left side). (P29)

These participants described particular incidents that happened with them when they were learning algebra. In these specific memories, participants remembered a particular conversation she had with her teacher and a particular activity that her teachers used. In other specific memories, participants recalled unique incidents they experienced with their teachers while learning algebra. For example, one participant recalled the one time her teacher took her to another class to solve an exercise for them. She remembered the following incident:

Once, this teacher came to our class during the Arabic session and asked the teacher to

take me to grade 10 to solve for them an exercise on factorization that they were not able

to do. […] I still remember it, it was $x^4 - 16$, this is from 25 years ago. (P28)

Other participants remembered particular incidents where they had trouble with learning algebra; for example one participant recalled that one day she went home crying because she did not understand the lesson. She described the following occurrence:

In remarkable identities, I took this is grade 8 and it was really challenging for me as a

student, I remember that day I went home and started crying because I did not understand

and my dad explained it for me (P5)

These participants remembered unique instances they experienced while learning algebra, their memories that described these particular encounters were considered to be specific memories.

86

Influence of autobiographical memories on teaching practices

      Results of the analysis of the influence of memories on teaching practices show that the autobiographical memories of learning algebra at school influenced the participants in different ways. Table 7 shows that the majority of the memories (41.07%) guided participants into reproducing the same practices that they experienced as students in algebra classes, while some memories (25.89%) guided participants into producing different practices that those they experienced as students. Table 7 also shows that other memories had a different influence on the participants. For example, 7.14% of the recalled memories guided the participants into understanding their students' difficulties and other reactions they show in class, while 2.68% of the recalled memories guided participants into becoming mathematics teachers. The remaining 23.21% of the memories did not include a description of how they influence the participants' teaching of algebra.

Table 7

Frequency and percentage of influence of autobiographical memories on practices

Influence category	Frequency	Percentage
Reproduce practices experienced as a student	46	41.07%
Produce practices different than those experienced as a student	29	25.89%
Other influence		
Understand students' reactions and difficulties	8	7.14%
Influence to pursue a major in mathematics or career in teaching	3	2.68%
No influence was described	26	23.21%
Total	112	100%

      Our analysis also shows that there is a relationship between the types of influence the autobiographical memories had on participants and the characteristics of the memories recalled (the structure; practice and emotional content). In the next section, we will present in details how

the structure, emotional content, and practice content of the recalled autobiographical memories influence participants' teaching practices.

Table 8

Frequency and percentage of the memories across the influence

Memory Structure and Emotional content	Influence									
	Reproduce same practices experienced as a student		Produce practices different than those experienced as a student		Other influence		No influence		Total	
	F	%	F	%	F	%	F	%	F	%
Specific negative	0	0.00	7	46.67	6	40.00	2	13.33	15	13.39
Specific positive	10	58.82	0	0.00	1	5.88	6	35.29	17	15.18
Specific neutral	12	75.00	1	6.25	0	0.00	3	18.75	16	14.29
General negative	0	0.00	15	93.75	1	6.25	0	0.00	16	14.29
General positive	15	60.00	0	0.00	3	12.00	7	28.00	25	22.32
General neutral	9	39.13	6	26.09	0	0.00	8	34.78	23	20.54
Total	46	41.07	29	25.89	11	9.82	26	23.21	112	100.00

F: Frequency

Reproducing practices remembered through autobiographical memories. Results show that 41.07% of the recalled memories in this study, (which correspond to 45.83% of the specific memories, 37.5% of the general memories and 59.52% of the positive and 53.85% of the neutral memories) directed participants into reproducing the same practices experienced as a

student. Participants reported that they imitate their prior teachers when it comes to the practices that they liked and benefitted from. When they explained why they reproduce the practices they recalled from their school memories of learning algebra, they provided some reasoning for doing so. Participants described how much they liked, enjoyed, and benefitted from the practices they experienced as students, and they mentioned that they reproduce these practices to engage and help their students in learning algebra just as they experienced it. For example, one participant said, "I loved the class being this way, so I teach it somehow the same way" (P1). Another participant stated, "I really enjoy that lesson, because I have great memories of this, and I repeat it now" (P37). In another instance, one participant described, "Those memories influenced my teaching, because I'm strong believer of being relaxed and help your students be relaxed in class. Students need to learn without putting a lot of pressure on them. They have to feel safe and enjoy learning." (P38). A different participant said, "My teachers made sure to tackle different ways of solving and this is what I do. I try applying several methods in representing the problem to cater to all my students' understanding" (P3).

Reproducing teaching practices recalled through general positive and neutral memories. Results show that 60% of the general positive memories and 39.13% of the general neutral memories recalled by participants in this study contained descriptions of practices that participants reproduce in their classrooms. Participants described through these memories, teaching practices that their teachers used to do repeatedly in the classroom and that they enjoyed and benefited from when they were students and thus, they use the same practices in their teaching. Participants described that they reproduce how their teachers used to explain the lessons for them, engage them in activities, and interact with them during the algebra classes.

89

Participants reproduced some of the methods that their teachers used while explaining algebra lessons. For example, one participant recalled how her teacher used various representation (such as visual representation) for the problem presented to cater to students' ways of understanding and learning; she described that she loved these visual representations that helped her understand better, and for this she use several methods in representing a problem to cater to all her students' understanding. Another participant remembered how her teacher used to stress on having them underline the key words in a word problem, she described that this was a very important practice that help students translate what is written in English words into mathematical symbols and for this, she makes sure to follow the same practice with her students.

Participants also described that they use similar activities and assignments to what their teachers used to engage their students in learning algebra. Participates recalled that their teachers used to give challenging brainteasers, bonus questions, extra worksheets to support their learning, and to engage them constantly in a race activity where they have to solve a number of questions in a short amount of time. The participants explained that they found these activities to be fun, motivating, and helpful and for this, they now use these same activities with their students. For example, one participant described the following activity:

> I had a teacher who used to give us brainteasers in Brevet. They were fun, challenging and helped motivate us at the beginning of the class. I try to do this with my students in algebra, as there are nice critical questions that can serve as brainteasers. (P2)

Another participant also recalled how her teacher used to pass by the students while they are solving to correct their work, and then choose the best solution to be presented in front of the class. This participant described that she follows the same method with her students and

commented that she does that because this method is very effective and helps in building the students' self-confidence. She gave the following response:

I like the way when students work in groups, the teacher passes group by group, then she decides which solution is the best, so she asks this student who wrote this best solution to explain it in front of the class and write it on the board. Yes [I use it with my students], it is very effective, plus it is good for me, for them, and for building self-confidence, when a student feels he wrote a complete correct answer, and he plays the role of the teacher, it is very good for their personality. (P29)

In addition to reproducing instructional practices, participants described that they tend to recreate a similar classroom environment to what they experienced. Some participants recalled that some of their teachers used to be friendly and caring, show them that they believe in them, and encourage all students to do well and succeed in Algebra. Participants described how much this was important for them to love the subject, feel good about themselves, and feel relaxed inside the classroom to do well and study harder. For these reasons, they try to interact with their students in the same way their teachers interacted with them. For example, one participant described that she tends to reproduce the relaxed classroom environment that encourages students to do well in Algebra, just as her teacher used to do. She recalled the following memory:

In general, I was lucky with my math teachers, both in middle and high school. The memories that keep coming to my mind are related to the general mood of the class. I remember having an algebra teacher who was so relaxed, and encouraged his students all the time. He became my role model, and he use to express his belief in all his students. He used to tell us that everyone can succeed in Algebra - I can still remember his encouraging words. Those memories influenced my teaching, because I'm strong believer

91

of being relaxed and help your students be relaxed in class. Students need to learn without putting a lot of pressure on them. They have to feel safe and enjoy learning. (P38)

Participants also reported that they reproduce some of the practices they repeatedly experienced as students but without describing how they felt about these experiences. They said that they reproduce some of the activities their teachers used, such warm-up activities. They give extra drilling exercises as a practice, and they assess their students in the same way they were assessed, but sometimes they use questions that are even more challenging. One participant also remembered how they used to discuss algebraic problems in the classroom where her teacher gave them the chance to give their opinion and to build on each other reasoning. She commented

> Honestly in math, I feel that what was stuck in my mind up till now are the scenarios when there was a lot of reasoning based on repetition, reasoning based on other people's reasoning. So when we follow up on students, and let's say we are working on a project and some of the kids are presenting their project, when you follow up on that and have the chance to comment on this and build up on what they did and expand. That is when things are really stuck in our brains and that is exactly what I do remember. The cases and examples that influence me the most back then when I was a student is when problems were discussed in depth and we were given the chance to give our opinion, expand, analyze. I do the same [in my teaching today] to keep my learning based on activities; projects-based learning, a lot of focus on real life situations that will make sense to them, that will last in their brains more than just procedural understanding and tricks, and methods. (P37)

While remembering these experiences, the participant did not express how they felt about these practices but they described that they tend to follow these practices with their students.

In all of the abovementioned examples, the participants described that they tend to follow the same practices that they enjoyed, benefited from, and repeatedly experienced while they were students. In other responses, participants described that they also follow some of the practices that they benefited from and enjoyed even though they experienced them once, we will present these results in the next section.

Reproducing teaching practices recalled through specific positive and neutral memories. Results show that the majority of the specific positive memories (58.82%) and specific neutral memories (75%), recalled by participants in this study, contained descriptions of practices that participants reported that they reproduce in their classrooms. Participants described through these memories, teaching practices that their teachers followed in a particular instant or in a particular session. The participants described that they liked and found these practices to be helpful, and therefore, they use them with their students as well. Some participants described that they reproduce the exact same practices, while other participants described that they reproduce the practices with some adjustments.

Participants reported that they reproduce some of the specific activities that their teachers used to explain some algebraic topics. One participant recalled when her teacher used a two-armed balance to explain equations to show equilibrium between two sides:

I still remember the activity done when explaining equations in grade 7 by the teacher. The teacher showed us a balance (2 arms) where she placed one object on the right hand

93

and 3 objects on the left hand and the balance showed equilibrium state. That activity helped us to understand what is meant by equations since the mass of the object on the right side was equal to the mass of the three objects on the left side and the purpose was to find the mass of one ball (found on the left side). That activity helped to overcome a lot of misconceptions. I used it with my grade 7 students as an entrance activity, it was nice, it was good. (P29)

Another participant recalled when a teacher created a mock market where students could sell and buy items and calculate prices to explain operations. Other participants remembered activities such as finding prime numbers by crossing the numbers that are divisible by 2 to 10 in a hundred-number grid, explaining division by distributing fruits into plates, and comparing decimals by cutting the same paper size into a different number of pieces and comparing them. In their responses, participants described how much they enjoyed these activities and how much these activities helped them understand the lessons; therefore, whenever they teach these lessons, they make sure to use these activities with their students.

Other participants described that they reproduce some of the specific practices that their teachers followed when explaining certain lessons. For instance, one participant recalled how her mathematics teacher referred to real-life objects (such as fruits) when explaining the addition of numbers and grouping of similar variables; she mentioned that this approach helped her to deal with this algebraic topic and that is why she follows the same approach in her teaching. Another participant remembered that her teacher taught them the rules of multiplication of signed numbers through a statement, "friend of my friend is my friend, enemy of my enemy is my friend, and so on". She described that this was helpful for her, so now she use it with her students

94

and she also looks for other songs and rhyming statements for other rules to teach them to her students.

In one memory, a participant remembered a positive specific incident of interaction she had with her mathematics teacher. She recalled that when she got a full score on an exam in algebra. Her teacher announced her name, shared the result with the whole class and showed her how proud she was of her. The participant then described that this memory pushes her to interact in a similar way with her students, to motivate them to do better and reach high results.

> In grade 9, my favorite subject was mathematics as usual. However, in this specific year, my passion increased dramatically because of the math teacher.. I can recall that her remarkable way of explanation made me love the material more and more, especially algebra. In fact at the time in the final exam, I was the only student in the 4 sections that was able to score full mark. As a result, the teacher announced my name and shared my results in all classrooms and showed how proud she was. This occasion never leaves my mind and it always pushes me further to teach from my heart and motivate any successful student that aims to reach high results. (P27)

Other than the specific positive memories, the majority of the specific neutral memories also directed participants into reproducing the practices recalled through them. Participants remembered several teaching practices that they experienced in particular sessions and they reported that they tend to reproduce these practices in their teaching; however, they did not describe how they felt about these practices or memories. Some participants said that they reproduce some of the specific activities they experienced such as drawing and coloring a pizza like shape to learn fractions, using small glass balls to learn addition and subtraction, using an egg box with marshmallows to learn about multiplication, in addition to other activities to learn

95

about the remarkable identities and factorization. The participants described these activities and stated that they use them with their students. For example, one participant commented that she uses the same activities her teacher used with her but with some modern touches like the use of technology to carry out the activity.

Some participants described that they reproduce some of the specific practices their teachers followed while explaining lessons. One participant recalled how her teachers taught her how to evaluate an expression by replacing the variables with parenthesis. Another participant recalled that her teacher taught her how to avoid dealing with negative exponents by moving the number to the numerator or denominator. A third participant described that he never forgets how his teacher warned him from canceling unknown letters in an equation, and he makes sure to show this common mistake to his students, so they avoid doing it. He recalled the following memory:

> In 1980, my math algebra teacher warned us about not canceling unknown letters in an equation otherwise we mess with the whole world and 1+1 becomes equal 1 not 2. For example, to solve the equation $x^2 = x$, so students cancelled x from both sides and got $x = 1$, where in fact the correct answer is $x = 0$ or $x = 1$. […] I never forget this and I always show it to all my students in all classes to avoid this common mistake. (P23)

A fourth participant recalled some rhyming sentences her teacher taught her to remember certain rules, then she said that she uses these sentences with her students as well:

> My high-grade math teacher used to teach us a lot of the concepts as a song or rhyming sentences. Ex. In lesson of powers (multiplication) he used to say "same base different power, keep the base add the power" and in fact I teach this sentence to my students

every year in the lesson of powers. Same as some sentences that can replace theorem and are more likely to be used by students "adding equals to equal keep them equal". (P24)

Producing different practices than those remembered through autobiographical memories. Results show that 25.89% of the recalled memories in this study, (which corresponds to 32.81% of the general memories, 16.67% of the specific memories and 70.97% of the negative memories and 17.95% of the neutral memories) directed participants into producing practices that are different from those practiced by their teachers and which they experienced as students.

When participants explained why they do not reproduce the practices they recalled from their school memories about learning algebra, they provided some reasoning for doing so. Many memories contained a justification from an educational perspective more than an emotional one. Many participants mentioned that they chose to follow different teaching practices because they believe that they facilitate students' learning of algebra in better ways. For example, one participant remembered that her teachers used to promote a lot of repetition of exercises to master the algebraic lessons. She described that she believes in the saying "repetition makes perfect" but she also knows that this practice is not beneficial for all students. For this participant, such a practice may lead to negative results with good students where they may feel demotivated to learn. For this reason, she tries her best to differentiate the tasks she gives to her students to maximize their learning. The participant gave the following response when she was asked if she recalls something that her teachers used to tell her:

Yes, it is like "repetition, repetition, repetition, it makes perfect", I agree with that to a certain extent. But I think that as well a lot of drilling will be boring for students who are fast learners and could be demotivating them, so I don't give a lot of homework for

97

everyone, and I try to differentiate. Some kids need and require a lot of practice while the rest, or some may feel very bored so I try to give them another kind of task, where they can extend their learning and they can apply what they learned in new situations. (P37)

Producing different practices than those recalled through general negative and neutral memories. Results show that 93.75% of the general negative memories and 26.09% of the general neutral memories, recalled by the participants in this study, contained descriptions of practices that participants do not reproduce in their teaching. Instead, they produce other practices that they believe are more beneficial for the students. Participants described through these memories, teaching practices their teachers used to do repeatedly in the class that they did not like or did not benefit from when they were students, and thus, they tend to produce different practices that what they experienced.

More specifically, the participants reported that they tend to explain some algebraic topics in a different way than how their teachers explained for them. For example, one participant recalled that her teacher's teaching was focused on procedural understanding rather than conceptual understanding. She described that her teacher used to teach them many tricks to solve algebraic exercises without explaining the mathematical reasoning behind them. She recalled a trick used in solving equations where they were taught to take a number from one side to the other and just flip the sign:

I learnt how to solve equations by using tricks instead of balancing equations, which frustrated me as a student because I never understood the mathematical reasoning behind those tricks. I currently use tiles and the balance in class to model equations and teach it

98

to my students. […] I completely force my students to show their work, and use colors to show the steps of solving an equation. (P37)

This participant described that she resorts to other methods to teach the balancing of equations. She focuses more on conceptual understanding by using algebra tiles to model and then asks the students to explain the balancing steps in solving an equation. In her response, she described that she prefers to explain in this way because the concept of balancing is something that students experience in their daily lives and therefore it is important for them to understand the concept behind it rather than only learn tricks to solve mathematical equations:

Solving equations is revolving around a very important concept in math and in real life, which is balancing. If you just balance things by just taking things from one side to the other that is not realistic. […] when it comes to math, they have to learn what is the reason, why does it maintain a balance when you divide both sides by two, why does it maintain the balance when you add to both sides two kilograms, or 2 dollars. (P37)

Another participant recalled that her teachers used to promote memorization of so many rules and formulas in algebra without explaining the origin behind them. She described that this was a bad experience for her, and for this she tries to prove or tell the story of each formula she gives to her students. Other participants also remembered that their teachers did not relate algebra to real life. For instance, one participant commented, "this raised so many questions in my head, like why do we learn that lesson, and where are we going to see it in real life?" (P11). These participants described than in their current teaching of algebra they insist on showing their students a real life application of each lesson, and to give problems that are close to students' real life.

Other participants remembered that during algebra sessions, their teachers did not give them enough time to share ideas with each other, discuss together, and to think and answer the questions that teachers posed. For example, one participant recalled the following memory:

> We were never given time to answer the teacher's questions during instruction class. The teachers would ask the question, then answer it herself right ahead. As a teacher, I ask a question, I pause, I ask how much time they need to respond, and then get "their" responses. (P36).

These participants then described that as teachers they try to provide students with enough time to share their responses, and to share ideas with each other. Another participant also provided a reason for allowing students to discuss and share their ideas. She said that this practice is very important to learn from each other:

> I believe that sharing ideas of how students understand, what people think, makes them aware of other people's mistakes and by then they wouldn't repeat the same mistakes. You reach higher level of critical thinking when you allow people to build on your reasoning or add or correct or develop a certain concept by making connections with different ideas, I think you develop a better understanding of any math concept. (P37)

In another memory, a participant remembered that her teacher did not give enough time for warm-up activities. Instead, she used to carry out the warm-up activities in a fast manner. Then she introduced the rule or formula and moved directly to solving exercises. This participant then commented that with her students, she tries to give enough time for the warm-up activities:

> Now as a teacher I give more time for hands on activities, for the warm-up activities, I like building up relationships, I always try to use prerequisites to start new things, and as

100

you use prerequisites and new things and as you use warm-up activities, you have to give time, so I give more time than I used to take. (P29)

Other participants recalled other practices that they do not reproduce. For instance, one participant described that she does not encourage a competitive spirit in algebra classes because it creates some anxiety between students. Another participant illustrated that she prefers to give feedback to students one-to-one and not in front of the whole class so that the student does not feel humiliated in front of others.

The previous examples were practices from general negative memories that the participants did not reproduce in their teaching. In addition, in some of the general neutral memories, participants described some practices they repeatedly experienced as students and decided not to reproduce as teachers, but they did not describe how they felt about these practices or memories. The following examples provide evidence for this finding.

One participant recalled her teacher using only paper-pencil quizzes and tests for assessment while she attempts to use a variety of assessment methods such as projects and performance tasks. Another participant described that her teachers did not use any material while explaining algebra; they only relied on drawing and imagining things, while she uses hands-on materials such as bricks to teach lessons such as fractions. In another memory, a participant recalled having to do many drilling exercises; however, in her teaching she tries to differentiate between students' needs, by giving students the exercises that suit their level to support those in need, and to extend the learning of those who are fast learners.

Producing different practices than those recalled through specific negative memories. Results show that in 46.67% of the specific negative memories, the participants described

particular experiences they remember about certain practices that they do not want to repeat with their students.

Some participants recalled when their teachers did not explain clearly certain topics in algebra and then they said that these memories guided them into explaining these lessons to their students in a clear and detailed way. One participant recalled that her teacher did not explain well how to find the value of "x" in a certain problem; another participant recalled that her teacher promoted memorization of the cases for the change of the sense of the inequality without explaining why it should be changed when dividing or multiplying by a negative number. The participants described that when they have to explain these lessons now, they make sure that their explanation is clear to their students.

Another participant recalled an incident where she found algebra to be very abstract and not related to real-life. So, she asked her mathematics teacher "why are we learning fractions", and his response was as follows "because we have to and end of discussion". The participant commented that this incident pushed her as a teacher to do her best to involve real life practices in teaching algebra:

> As a teacher, I do my best to involve real life practices in teaching algebra to my students. I always look for examples and most of the times I give examples to learn as a new topic for example. (P7)

Other participants recalled some of the difficulties they had with learning certain algebraic topics. They described that they did not understand the concepts being taught. Therefore, in their teaching they make sure that they provide their students with good explanation and necessary examples so that they do not face the same difficulties they had. One

102

participant, for example, mentioned that negative numbers never made sense to her as a student. For this reason, she tries as a teacher to relate negative numbers to real life situations such as negative temperatures, negative altitude in the context of below sea level or underground in elevator, or in debt if it is a bank account example. Another participant recalled that she did not understand the meaning of prime numbers and she did not know how to find them. Now in her teaching she makes sure that her students know how to find out prime numbers.

Other influences of autobiographical memories. Our analysis showed that autobiographical memories of learning algebra at school did not only influence participants teaching of algebra; these memories had other influences on the teachers. Some of these memories helped participants understand their students' difficulties and reactions to lessons, while other memories guided participants into becoming mathematics teachers.

Understanding students' reaction based on experiences recalled through general and specific negative memories. Some participants recalled some negative memories about their experiences of learning algebra at school; however, the influence of these memories was not translated in active teaching practices, these memories guided participants into understanding their students because they passed through the same experiences as students. The memories that had this influence were mainly about the participants' difficulties they used to have while learning algebra and the mistakes they used to do.

Several participants recalled how they suffered from learning remarkable identities, they recalled that they found this lesson to be confusing, challenging, and that it took them some time to understand them and know how to deal with them:

In remarkable identities, I took this is grade 8 and it was really challenging for me as a student, I remember that day I went home and started crying because I did not understand and my dad explained it for me. So once I explained it, […] I felt that students were looking at the board, what is this, it is something new. […] So I told them at the beginning that it is normal if you didn't know how to do the homework today but don't stop, reread the lesson and memorize the identities that I am giving you. […] So I tell them how I used to suffer and I found that they have the same issues to suffer from, things did not change. (P5)

They then described that now when they teach this lesson, their students show the same reaction they had, and for this, they understand how their students react. They described that when they explain identities, they share with their students that they felt the same about this lesson at the beginning, they would give their students time to practice to understand the lesson, and they would give them certain tips and advices to study for it. Other participants recalled that they had difficulties in learning fractions, one participant described that she used to confuse the numerator and the denominator, while another participant recalled that she had a difficulty in adding and subtracting fractions with different denominators. They then described that when they became teachers, they would understand how their students react, they accept any form of question from them even if it was so simple, and it motivates them to explain the lesson in an easy way:

Fractions, I can still remember that when we started fractions it was very hard to know that the numerator is up and the denominator is down, the words are confusing, that is why I can now understand the students because I still remember these things, they were really hard. I understand them, I mean whenever they ask me a question, I am fine with

the question, even if it was simple question it is find with me, I know that they can forget they have a lot of material. (P1)

Pursuing a major or career in mathematics teaching based on experiences recalled through general and specific positive memories. Some participants recalled some positive incident of their interaction with their mathematics teachers that influenced them into becoming mathematics teachers. One participant recalled that her teacher used to ask her to prepare a chapter ahead of time and gave her the chance to play his role and explain the lesson to her classmates; she commented that he build in her the skills to become a teacher, and this motivated her to become a mathematics teacher:

> I found myself as a mathematics teacher since my childhood. I used to help my friends and the teacher counted on me and gave me many responsibilities that motivated me to accomplish my goal. In grade 12 (general science), we were only four students in the class. The instructor used to give me the syllable of the chapter he plans to start with one week ahead; I prepare it by myself and play his role in class. He built in me the skills to be a teacher and my friends learned the objectives in a simple way. (P22)

Another participant recalled that her teacher also used to give her some responsibilities in class and asked her to help her friends; she also remembered that her teacher used to tell her "you were born to be a teacher" and this helped her choose her career as a mathematics teacher.

> She always used to tell me, you were born to be a teacher, let's say she really helped me to choose my career. When we used to sit in groups and to solve a problem, mainly in the elementary classes, multistep problems, subtract, add, multiply, and then find the price of one item, we used to work a lot, maybe full period to solve this problem. I used to be the

boss of the group I used to explain, write the solution, and check the copybooks of my

friends, and as she circulates in class and looks around us what are we doing, what we are

solving. She waits until the end, and she always used to say, you were born a math

teacher, I still remember this. (P29)

Autobiographical memories with no described influence. Results show that in 23.22%

of the recalled memories in this study, (which corresponds to 26.19% of the positive memories,

28.21% of the neutral memories, and 6.45% of the negative memories, 22.92% of the specific

memories and 20.31% of the general memories) the participants described only the experience

they remember without mentioning whether these memories influence their teaching and how.

In the general positive memories, the participants described positive experiences with

some teaching practices that their teachers used to follow inside the algebra classroom. They

recalled that they liked how their teachers explained algebra in an organized, detailed and

simplified way, and how their teachers used to check constantly if they understood what is being

explained during the session. One participant remembered the following practice:

I remember from the teacher of grade 12 something very important which was that he

was very cautious that at the end of each lesson, he would ask "is it ok?". He had a very

good eye contact with every student, and ask "is it ok, is it ok, do you have any

question?" I used to think that this is something very important. (P14)

In the specific positive memories, the participants described unique incidents they

experienced with their teachers that they enjoyed. One participant recalled that her teacher

wanted to take a photo with her because she did well on the test, another participant recalled that

106

her teacher got hear a meal because she was able to solve a difficult exercise in expansion and factorization. Another participant recalled that her teacher took her to another a higher class to solve for them a factorization exercise that they were not able to solve, and she still remembers the algebraic expression ($x^4 - 16$) even after 25 years.

In the general neutral memories, the participants described some teaching practices they experienced without mentioning how they felt about these practices. One participant recalled that her teacher used to introduce formula in algebra and then teach them how to apply it; another recalled that his teachers used to give them some real-life situations related to some topics in algebra, and problems that require analysis and deduction. Other participants recalled that their teachers used to ask them to work in groups during algebra classes to solve certain exercises and problems, and give them a huge load drilling exercises as homework. In specific neutral memories, one participant recalled how her teacher explained for them how to solve a system of equalities; she provided a detailed description of how she recalls the method to solve by elimination or by substitution.

There were very few incidents were the teachers recalled a negative memory without mentioning how these memories influence their teaching, one participant recalled that her teacher once hit a student in class, and another recalled that she once cried at home because she was not able to solve the homework they were assigned.

In all of these memories, whether specific or general, positive, neutral or negative, the participants only described what they remember without mentioning how these memories influence their teaching.

Influence of memories with respect to expertise

In this research, we were not only interested in studying how the influence of memories on participants' teaching of algebra varied with respect to the memory characteristics (emotional content and structure), we were also interested in examining how the influence of memories vary with respect to some of the participants individual's characteristics. Consequently, the third research question was how does the influence of autobiographical memories differ between novice and expert teachers, and between teachers who have a teaching diploma and those who do not? The individual characteristics considered in this study were related to the participants' expertise, which included their years of experience (novice or expert) and their teacher preparation training (having a TD or not). To answer the third research question, the participants were divided into 4 categories, novice teachers who have a TD, novice teachers who do not have a TD, expert teachers who have a TD, and expert teachers who do not have a TD. In this section, we will report the results on how each category of participants was influenced by their school memories. Table 9 shows the distribution of memories recalled by the participants across the various influences that emerged.

Table 9

Distribution of participants' memories over the influence categories

Memories of participants who are:	Reproduce practices experienced as a student		Produce practices different than those experienced as a student		Other		No influence		Total	
	F	%	F	%	F	%	F	%	F	%
Novice with TD	10	58.82	2	11.76	3	17.65	2	11.76	17	100
Novice with no TD	10	47.62	7	33.33	3	14.29	1	4.76	21	100
Expert with TD	21	38.18	16	29.09	4	7.27	14	25.45	55	100
Expert with no TD	5	26.32	4	21.05	1	5.26	9	47.37	19	100

F: Frequency

Novice teachers who have a TD. The novice teachers who are TD holders in this study were 3 participants. These participants provided a total of 17 memories. Results show that 58.82% of these memories directed participants into reproducing the same practices they experienced as students, while 11.76% directed participants into producing different practices. Moreover, 17.65% directed participants into understanding their students (other influence), while 11.76% did not contain a description of how the recalled memories influence their teaching. The participants described in most of their memories that they reproduce some of the methods their teachers used to explain lessons and that they also use the same activities their teachers used with them. The participants recalled few incidents in which they experienced practices that they do not reproduce in their teaching. Additionally, they recalled few incidents that made them understand their students' reactions to the explained lessons.

Two of the three participants were interviewed. Both participants had 2 years of experience; however, one (P5) started teaching directly after getting her BS in mathematics, while the other (P3) worked for some time in a different domain before she decided to become a mathematics teacher. Table 10 shows the distribution of memories of the two interviewed teachers across the influence categories that emerged.

Table 10
Distribution of memory influence for novice teachers (TD holders)

	Influence									
	Reproduce practices experienced as a student		Produce practices different than those experienced as a student		Other		No influence		Total	
	F	%	F	%	F	%	F	%	F	%
P3	6	75.00	1	12.50	0	0.00	1	12.50	8	100
P5	4	50.00	1	12.50	3	37.50	0	0.00	8	100

F: Frequency

P5 graduated from school 5 years ago and is currently teaching in the same school she graduated from. She recalled a total of 8 memories. In 75% of her memories, she described that she reproduced the same practices that she experienced as a student. Her responses to the interview questions validated that she tends to reproduce the practices she remembers. She said that, as a novice teacher, she relies a lot on her school memories. She recalled what her teachers used to do and how they used to explain the lessons and that she would teach in a similar manner. She added that as a novice teacher, she doesn't have experience in what mistakes students can do. For this reason, she relies on the mistakes that she used to do as a student, to warn students from committing them. This participant started teaching before she got her TD. She completed her TD in her second year of teaching. For her the TD did not make much difference in her teaching practices since most of the TD courses were very theoretical:

Since I started the practicing before the teaching diploma I felt that the teaching diploma did not add that much to my teaching journey, because when I was studying the theory thing, I used to say to myself, oh yeah, I already saw that while teaching, I practiced before the TD. (P5)

The second novice teacher (P3) graduated from school 12 years ago and she is also currently teaching in the same school she graduated from. P3 recalled a total of 8 memories. Results show that in 50% of her memories she described that she produce the same practices she experienced as a student. However, in the interview, she said that she doesn't depend much on her school memories to guide her teaching, but she depends more on what she learned from her TD. She described that during her practicum course, she experienced different practices than those she experienced as a student and this had a major influence on her teaching practices. In one of her recalled memories, she described the instructional approach that her teachers used to follow. She said, "The focus wasn't student centered, we used to sit and the teacher would introduce the concept and we do exercises and problems". In another memory, she stated the following: "Since I was a student, I saw the teacher lectures and you take note and apply and that's it, then you have quizzes". After that, she commented that she hated the lecturing approach that many of her mathematics teachers followed in the classroom. As a result, she tries in her teaching to follow a different approach where she doesn't "give the information to the student", but she engages them in the process of discovering information.

Those findings show that the influence of memories on teaching practices of both participants was different despite being novice teachers with a TD. P5 refers more to her school memories to guide her teaching while P3 does not. This was attributed to their experience in their

111

teacher preparation training programs where P5 mentioned that she did not learn much from her TD courses while P3 said that her TD courses exposed her to different teaching practices that she prefers to follow in her teaching.

Novice teachers who do not have a TD. The novice teachers who are non-TD holders in this study were 3 participants; they provided a total of 21 memories. Table 9 shows that 47.62% of these memories directed participants into reproducing the same practices they experienced as students, while 33.33% directed participants into producing different practices. On the other hand, 14.29% directed participants into understanding their students (other influence) whereas 4.76% did not contain a description of how the recalled memories influence their teaching. The participants described some of the activities and methods that their teachers deployed during their teaching of lessons. Some of these explanation methods and activities were reproduced while others were not.

Two of the three participants were interviewed. Both of them graduated from school 5 years ago and got a BS in mathematics. One of them (P10) has one year of experience while the other (P1) has two years of experience. Table 11 shows the distribution of memories of the two interviewed teachers across the influence categories that emerged.

Table 11

Distribution of memory influence for novice teachers (non-TD holders)

	Influence									
	Reproduce practices experienced as a student		Produce practices different than those experienced as a student		Other		No influence		Total	
	F	%	F	%	F	%	F	%	F	%
P10	9	75.00	1	8.33	1	8.33	1	8.33	12	100
P1	1	14.29	4	57.14	2	28.57	0	0.00	7	100

F: Frequency

P10 recalled a total of 12 memories; the results show that she described practices that she reproduces in her teaching in 75% of her memories. Her response to the interview explained how her memories of her experiences of learning algebra influence her teaching. She said that, as a novice teacher she occasionally reproduce the practices she experienced without thinking that she is using them even though sometimes she is aware of that and she intends to teach the students the same way she was taught the concept. She added that since she does not have a TD, which exposes her to different teaching practices, then most of the times she tries to recall how she was taught, how she understood when she was in school. In addition, she sometimes tries to get other ideas from the internet:

> There are some chapters that I wonder how the students are going to understand this, I go back to YouTube to get some tips on how to do this, but most of the times I try to recall how I understood it when I was in school I struggled a lot at the beginning of the year. I wondered what I do, but by the end of the year, I became a pro with experience. Now I am willing to do something in education, because I liked it. (P10)

The second novice teacher who does not have a TD (P1) recalled a total of 7 memories. Results show that in 57.14% of her memories, she described that she produces different practices in her teaching that those she experienced as a student. In the interview. , she said that she doesn't usually link her school experiences to her own teaching. She explained that she does not remember much of her school experience and she did not pay attention to the details of teaching her teachers used to carry. For this reason, she does not refer to her school experiences in her teaching:

> When I entered class to teach the first time, I had no experience it was hard, but I didn't think about any strategy that my teachers followed in school, I did a strategy on my own. I don't know why I didn't link it, maybe because I don't remember a lot, or maybe because as a student I didn't pay attention to those details, I used to hear the explanation and study, and that's it. (P1)

The results that we illustrated in the previous paragraphs show that the influence that school memories had on the two participants' teaching was different despite being novice teachers with no TD. P10 found herself as a novice teacher without a TD lacking experience in teaching certain concepts and this made her remember her teacher's practices in order to imitate them. However, P1 did not have big a recollection of her school experiences of how she was taught. She noted that she does not tend to reproduce the same practices, based on the few memories that she could recall, but she teaches in a different way.

114

Expert teachers who have a TD. The expert teachers who are TD holders in this study were 23 participants; they provided a total of 55 memories. Table 9 shows that 38.18% of these memories directed participants into reproducing the same practices they experienced as students, while 29.09% directed participants into producing different practices. On the other hand 7.27% directed participants into understanding their students or pursuing a career as a mathematics teacher (other influence), whereas 25.45% did not contain a description of how the recalled memories influence their teaching. Participants recalled a wide variety of teaching practices that they tend to reproduce or not reproduce.

Two of the 23 participants were interviewed. Both participants have a BS in Mathematics; one (P29) graduated from school 12 years ago and has 12 years of experience, while the other (P37) graduated from school 16 years ago and has 14 years of experience. Table 12 shows the distribution of memories of the two interviewed teachers across the influence categories that emerged.

Table 12
Distribution of memory influence for expert teachers (TD holders)

	Influence									
	Reproduce practices experienced as a student		Produce practices different than those experienced as a student		Other		No influence		Total	
	F	%	F	%	F	%	F	%	F	%
P29	10	71.43	1	7.14	1	7.14	2	14.29	14	100
P37	2	14.29	8	57.14	0	0.00	4	28.57	14	100

F: Frequency

P29 started teaching in the same school she graduated from, directly after she finished school. P29 recalled a total of 12 memories. The results show that in 71.43% of her memories, she described practices that she reproduces in her teaching of algebra. In the interview, she

115

described that since she first started teaching she referred a lot in her teaching to her experiences of learning algebra at school, and with time, she learned to modify her teaching to incorporate some other techniques such as using technology and giving examples from new topics that are more relevant to her students. P29 started teaching before she got her teaching diploma, and she got her degree later on; she said that the TD did not add much to her practices, the courses taught her the vocabulary related to education and the terminology of the practices that she was already following:

> We used to take the course, assume it is a course about methodology, the course provided me with all the methods to explain mathematics, the inductive and deductive, lecturing, etc. I figured out that I was applying it all but I did not know what it was called. So I was able to specify my work better, it added for me the vocab that I didn't know. (P29)

P29 also noted that since she is teaching the same curriculum, she was taught in the same school she graduated from. This directed her to follow several similar practices that she experienced as a student; she said that she remembered all the materials that were available in school for the mathematics teachers to use so she used the same material for the same activities. She also added that she remembers all the examples, exercise, and problems that were given to her, and since the material did not change so she gives her students similar examples, exercise, and problems.

The second expert teacher (P37) decided to major in mathematics and become a mathematics teacher because of the influence her mathematics teachers had on her. In this study, she recalled a total of 14 memories; in 57.14% of these memories, she described practices that she does not reproduce in her teaching. In the interview, she said that in her first years of

teaching, she used to follow the same practices she experienced as a student, but with time, she noticed that some of these practices are no longer suitable for her students:

> I struggled a lot to be honest with you, because I was used to the teacher being the center of the class. I wanted everyone to be quite, no body talking at all, everybody having their eyes on me, when they were supposed to take notes that had to be really focused and not wasting ant time. But I noticed that with this generation, you cannot use the old style anymore, they are very exposed, they have access to information everywhere, they don't wait for the teacher to give them information, while for us the only source of information long ago was the teacher and the book. […] So I feel to engage them, I just cannot be the focus of the class, I cannot be the person providing them with information, I am actually the activator of their thinking. I am activating I am triggering their thinking making them reach higher levels of thinking, like analyzing, describing things in different ways, and communicating properly using math terminology. (P37)

She added that in her TD, she learned various practices that she did not experience as a student, such as using technology, manipulatives, hands-on activities, etc. Moreover, in one of the schools that she taught in, the school provided her with a lot of professional training where she got the chance to learn from many professional people in the field of education. All of these experiences shaped her teaching practices, and that is one of the reasons why she does not reproduce the same practices that she deemed as unbeneficial for the students.

This shows that despite these two teachers being expert teachers with a TD, the impact their expertise had on how they are influenced by their memories was different. Results show that P29 tended more to reproduce the practices she experienced as a student, while P37 tended more to produce different practices than what she experienced. Even though both had a TD, but

117

P29 did not find what she learned in the provided courses any benefit to her teaching, while P37 mentioned that what she learned on the TD shaped her teaching practices a lot.

Expert teachers who do not have a TD. The expert teachers who are non-TD holders in this study were 7 participants; they provided a total of 19 memories. Table 9 shows that 26.32% of these memories directed participants into reproducing the same practices they experienced as students, while 21.05% directed participants into producing different practices. On the other hand, 5.26% directed participants into becoming mathematics teachers (other influence), whereas 47.37% did not contain a description of how the recalled memories influence their teaching.

Two of the seven participants were interviewed. Both participants have a BS in Mathematics; one (P14) graduated from school 15 years ago and has 10 years of experience, while the other (P28) graduated from school 27 years ago and has more than 20 years of experience. Table 13 shows the distribution of memories of the two interviewed teachers across the influence categories that emerged.

Table 13

Distribution of memory influence for expert teachers (non-TD holders)

	Influence									
	Reproduce practices experienced as a student		Produce practices different than those experienced as a student		Other		No influence		Total	
	F	%	F	%	F	%	F	%	F	%
P14	1	14.29	2	28.57	0	0.00	4	57.14	7	100
P28	2	33.33	1	16.67	0	0.00	3	50.00	6	100

F: Frequency

P14 recalled a total of 7 memories. The results show that she did not describe how these memories influence her teaching in most of her recalled memories (57.14%). In few of her recalled memories (28.57%) she described that she produces different practices that those she experienced. In the interview, she described that during her first years of teaching and since she did not have a TD, she started teaching in the same way she was taught, "When I started teaching, I taught like I saw my teachers teaching, the role model for a teacher was a teacher who stands and lecture" (P14). She mentioned that she kept on teaching the same way she was taught, until someone from the school administration visited her class and advised her to change some of her teaching practices and told her to attend other teachers' sessions. This taught her other practices that the ones she experienced as a student, and thus she started teaching in a different way. She described that now in her teaching, she plans to use projects, give real life examples related to the mathematics lessons, and conduct performance assessments for the students.

The second expert teacher who does not have a TD (P28) recalled a total of 6 memories. In 50% of the memories, she did not describe how these memories influenced her, and in 33.33%, she described that she does reproduce the same practices she experienced. She described that she faced difficulties in teaching at the beginning of her career since she did not have a TD. For this reason, she was influenced by her experiences of learning algebra at school. However, later, she started building her own teaching style that was different from how she was taught. Now and since it has been almost 27 years since she graduated from school, she rarely still remember her school experiences.

Both of these expert teachers recalled very few memories related to their experiences of learning algebra at school. Both of them mentioned that they started teaching the same way they

were taught, but later on, they learned other practices from other teachers that they now follow in their teaching.

In summary, our results show that teachers' expertise impacted how teachers were influenced by their memories in various ways. The results show that some of the novice teachers depended a lot on their school memories to guide their teaching, while others did not refer to the practices they experienced as students. On the other hand, expert teachers said that when they started teaching, they had to recall their school memories to guide them in their teaching, but later on with experience, they learned several other practices that they now follow. As for how the TD affected the influence of memories, the participants' responses showed that not all participants were impacted by what they learned in the TD to change or reinforce the practices they follow. Some teachers mentioned that the courses were very theoretical, and others mentioned that they were already practicing before the TD. They conclude that what they were exposed to in their TD courses did not influence their teaching practices. On the other hand, other teachers said that the TD courses provided them with teaching practices that they did not experience as students, and thus they tend to follow the new practices that they learned rather than referring to how their teachers taught

CHAPTER V

Discussion

A review of literature showed that there is a gap in research in studying the autobiographical school memories of practicing teachers, the memories of learning algebra at school, and the examination of the influence of these memories from the autobiographical memories framework perspective. For this in this study, we aimed at examining the memories of the practicing mathematics teachers about their learning of algebra at school from the perspective of the autobiographical memories framework and to study the influence of these memories by being guided by the theory of the directive function of autobiographical memories.

This study was guided by three research questions (1) what are the content and structure of practicing mathematics teachers' autobiographical memories of learning of algebra at school? (2) How do the emotional content and structure of autobiographical memories of learning algebra influence the practicing mathematics teachers' teaching of algebra? (3) How the influence of autobiographical memories differs between novice and expert teachers, and between teachers who have a teaching diploma and those who do not?

In this chapter, we will discuss and explain the results of this study in light of what was presented previously in literature related to autobiographical memories and literature related to the teaching and learning of algebra. We will discuss what teachers remembered and how their teaching practices were influenced by their school memories. Moreover, we will discuss and interpret the relationship between the influence of these memories and some of the characteristics of these memories and the teachers recalling them. First, we will discuss the practices that teachers remembered, then we will examine the variations in the influence these memories had on teachers' teaching of algebra and the reasons behind this influence. After that,

we will discuss the relationship between the influence of memories and the emotional content of the memories, the structure of the memories, and teachers' expertise. Finally, we present some recommendations for practice and future research.

Remembering repeated and unique experiences with learning algebra.

One characteristic of memories that we examined in this study was the structure of the recalled memories. Results of this study show that participants recalled slightly more general memories (repeated events) than specific memories (particular incidents). One explanation for this finding is that in most of the memories the participants described teaching practices that their teachers followed repetitively inside the classroom. Therefore, due to the repetitive nature of these experiences, it was more likely that they persist in individual's memories and remembered later on as general memories. On the other hand, some of the experiences were memorable because they represent specific personal events that carry special feelings, a symbolic value, or a significant impact on the individuals' lives (Pillemer, 2000). In literature, there aren't many studies that looked into the structure of memories about learning experiences school. However, in one study done by Pillemer et al. (1996) where they asked college students and alumni about influential experiences while they were at college, results showed that the participants recalled more specific memories than general memories.

Remembering positive and negative experiences with learning algebra.

Another aspect of the memories that we examined in this study was the emotional content of the recalled memories. In their memories, the participants expressed different emotions towards the experiences that they were describing. Results of our study show that participants

recalled positive, negative, and neutral memories about their learning of algebra, though they recalled more positive than negative memories. Through their positive memories, the participants remembered how much they enjoyed and benefited from their teachers' teaching, how good their teachers treated them, and how well they did in algebra. While through the negative memories the participants recalled the unbeneficial teaching practices that their teachers used to follow, the unpleasant way their teachers treated them, and the difficulties they faced when they were learning algebra.

Our results are similar to what is presented in the literature regarding memories of learning at school in general, and memories of algebra in specific. Several studies showed that prospective and practicing teachers recalled both positive and negative memories about how they were taught and about their teachers, and in most of these studies more positive memories were recalled than negative memories (Dolan et al., 2014; Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010; McGarr & Ganaldon, 2019, Miller & Shifflet, 2016; Sexton, 2004). In these studies, positive memories referred to enjoyment of learning, social interaction, and achievements, while negative memories referred to social isolation, embarrassment, or difficult experiences (McGarr & Ganaldon, 2019).

Our results are also in line to the literature about memories of teaching and learning algebra. We note that previous studies did not target memories of algebra in specific but there are several studies that target memories of mathematics teaching and learning, which included memories related to algebraic settings. These studies showed that students' memories of learning algebra at school could be positive and negative depending on the individual experiences with learning it. Some individuals recalled positive experiences with learning algebra, they remember it as a challenging topic that they enjoyed (Millsaps, 2000; Van Amerom, 2002). However, many

123

students have negative memories of algebra (Greenes et al. 2001; Lee and Freiman 2004 as cited in Wilkie, 2016), because of the difficulties they face while learning it. Most students find algebra a difficult abstract topic that makes no sense and have no connection to real life (Van Amerom, 2002; Wilkie, 2016).

Remembering prevalent practices in the teaching and learning of algebra.

In this study, the participants recalled a range of experiences how their teachers taught them algebra and how they learned algebra as students. They recalled how their teachers explained lessons, what activities they were engaged in, how their teachers assessed them, how the discussion was carried out inside the classroom, and how their teachers interacted with them. In addition to that, they remembered their own achievements, difficulties, and ways of studying algebra. The practices recalled by the participants in this study were common with the practices of teaching mathematics that were recalled by prospective and practicing teachers in other studies. These practices represent the observable practices in the act of teaching. Lortie (1975) argued, when he discussed the notion of the apprenticeship of observation, that students observe what is acted on the 'front stage' but are not aware or exposed to what happens in the 'backstage' of teaching (Lortie, 2002 as cited in Rayati Damavandi & Roshdi, 2013).

The majority of the recalled teaching practices were related to teachers' explanation of content, their interaction with the students, and to the activities and assignments used in the classroom. In few memories, the participants described experiences related to assessment and feedback, discussion technique followed, and the instructional material and resources used. One way to explain this is that the participants had more experiences with the first three category of practices; in other words, their teachers followed these practices more than the rest. Therefore,

124

because of the abundance of these memories in their minds, and the variation of experiences related to these categories, the participants could describe more of their experiences about how their teachers explained lessons, used activities, and interacted with them. On the other hand, because they did not have many or various experience related to the other practices (assessment, discussion, and use of materials), then they had less to describe through their memories. Another explanation is that these practices represent what students pay more attention to while in class. In other words, as students, the participants paid attention to how their teachers explained lessons, what activities they were engaged in, what assignments they had to solve, and how their teachers interacted with them and treated them. While they paid less attention to how and what kind of discussion were carried out in the classroom, what were the materials and resources that were used, and how they were assessed. As students, they might have been more aware of the practices that were more directly involved with themselves and the content of the lessons, rather than on the other practices.

Reviewing the memorable practices that the participants recalled in this study and comparing them to what was discussed in literature before could give us an insight into what practices are prevalent in the teaching and learning of mathematics in general and algebra in specific. In the following section, we will discuss some of these practices.

Following a direct instruction approach. Some participants in this study recalled that they were taught algebra through a direct instructional approach where the teacher was the center of attention in the classroom. They described that their teachers used to teach algebra through lectures; teachers would introduce the concept, present the rules, model how to solve an exercise and then give the students a list of exercise as to practice and solve as an application to the

lesson. The prevalence of teaching algebra in this way may be attributed many factors. One of

those factors is the way algebra is presented in the Lebanese curriculum as a set of rules and

processes that the students have to master. This is also emphasized in the type of exercises

presented in the used textbooks and the huge amount of topics that should be covered in a short

amount of time. This could lead teachers to resolve to a direct approach where they could cover

several ideas in a short amount of time effectively. This issue is similar to what prospective and

practicing mathematics teachers in other studies reported about how they were taught

mathematics (Barrantes & Blanco, 2006; Guillaume & Kirtman, 2010; Scott, 2005). In

Guillaume and Kirtman (2010) where they investigated the mathematics stories of preservice

teachers, the participants consistently mentioned direct instruction where their teachers used to

lecture throughout the session. Similarly, the participants in Scott's (2005) study commonly

described that a typical lesson in numeracy would start with a teacher demonstration, where the

teacher would show the students how to do things or how to solve an exercise or problem. In

literature, despite the call to allow students to discover and construct their knowledge by

interacting with their environment (Draper, 2002 as stated in White-Clark, et al., 2008), and to

work cooperatively on investigations and problems (Boaler & Greeno, 2000 as stated in Frost,

2007); there still seem to be a prevalence in teaching algebra in a traditional way as an abstract

subject with set of formulas and procedures to be memorized and followed (Kaput, 2000 as

stated in Alsaeed, 2017; Van Amerom, 2002).

Learning through memorization and practice. In our study, the participants recalled

that their learning of algebra depended on a lot of drilling exercises and memorization of rules

and formulas. The participants mentioned that they used to solve many exercises as practice and

that they used to memorize the multiplication table, prime numbers, and other rules and formulas. Prospective and practicing teachers that participated in different studies also remembered that their school learning of mathematics was filled with moments of doing exercises and practice and that great emphasis was being put on rote learning memorization of concepts and procedures (Barrantes & Blanco, 2006; Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010). In particular, the learning of algebra was associated with memorizing multiplication facts (Guillaume & Kirtman, 2010), formulas, concepts, processes (Barrantes & Blanco, 2006), and other mathematics material. This could be attributed to the direct instructional approach that teachers follow in teaching, where teachers tend to emphasize the memorization of definitions and procedures, and give students a list of drilling and repetitive exercises for practice (Bacevich et al., 2004 as stated in Frost, 2007; Prestage & Perks, 2006 as stated in Foster, 2014). Although, research recommends that teaching should focus on developing students conceptual understanding of algebra rather than only on procedural knowledge (Rakes et al., 2010 as stated in Wilkie, 2016), teaching is still dominated by a focus on procedural understandings due to the kind of curriculum and assessment standards pursued.

Giving time to understand and discuss. The practice of giving enough time to students to understand and discuss ideas and concepts was also an issue that several participants in this study described in their memories. Some participants remembered that their teachers used to give them time to discuss problems in depth and to reason by building on each other's' responses and that this had a very positive impact on their learning. On the other hand, some participants recalled that their teachers did not give them enough time to share ideas and answer questions, or even to explore the warm-up activities. This issue was also recurrent in other studies (Ellsworth

& Buss, 2000; Scott, 2005). In Ellsworth and Buss (2000) study, some participants expressed their frustration about their teachers moving too fast, not spending enough time on concepts, and giving students enough time to understand the concepts. This shows that the importance of the practice of carrying out discussion in the classroom where teachers give students time to communicate their mathematical ideas, justify their reasoning, and respond to each other's ideas. The importance of this practice was evident in the fact that teachers found the moments were they were involved in discussion or were not involved in discussion to be memorable.

Relating lessons to real life. Several participants in this study described the issue of relating the lesson to real life, the participants memories varied regarding this issue depending on the kind of experience they went through. Some remembered that their teachers used to relate the algebraic lessons they were learning to their lives. While others remembered that their teachers did not show them any real-life connection and this made them always wonder why they were learning these lessons and where could they see or use them in their lives. One explanation for why this issue was recurrent in the memories of participants is its impact on students learning. Students often ask their teacher about the relevance of what they are learning to their lives in order to make sense of what they are learning. Being exposed or not being exposed to how algebra is related to real life were both memorable experiences for the students for the value it has on their understanding. This issue was also evident in what participants in other studies remembered about their learning of mathematics at school (Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010). In Ellsworth and Buss (2000) study, the preservice teachers that participated in their study described that they felt frustrated when the content had no clear connection to real

life, and they felt satisfied when they were able to see the practical application, relevance, and usefulness of what they are studying and everyday life.

Using different teaching strategies to explain and help students retain information. Participants in this study also recounted some strategies that their teachers used while explaining lessons, such as referring to rules as a song or rhyming statement, using multiple representation to cater to students learning styles, and warning students from committing common mistakes. Even though the participants have graduated from school some time ago (at least 4 years), they still remember the rules and representations that they usually deployed in algebra classrooms when they were students. They also remember the common mistakes in algebra that they used to commit. This shows that these strategies are helpful for students to retain information related to certain algebraic lessons.

These specific practices were not found among the practices that participants in other studies remembered. However, the research on the teaching and learning of algebra highlighted the benefit of these practices in teaching. For example, Zbeik and Larson (2015) recommended using multiple representations for algebraic expressions as strategies to improve algebra learning. Moreover, the use of mnemonic in mathematics in general and in algebra in specific is also very common. For example, teachers teach certain rules using these mnemonics such as PEMDAS (Parentheses, exponent, multiplication, division, addition, subtraction) that is used for the rule of the order of operations, and FOIL (first, outer, inner, last) that is used to help students to multiply binomials.

Using instructional activities to engage students in learning. Another memorable

practice for the participants was the activities that their teachers used. The participants in this

study recalled a wide range of activities that their teachers used to engage them in learning.

These activities included challenging questions, games, warm-up activities, and other activities

used to explain concepts or show applications of lessons. In most of the memories about

activities, the participants described that they enjoyed and benefitted from these activities in their

learning, and this is probably why this practice was remembered a lot by them. The use of

activities in mathematics was also highlighted in the memories of participants in other studies

(Barrantes & Blanco, 2006; Guillaume & Kirtman, 2010; Millsaps, 2000; Oleson & Hora, 2014).

The participants recalled a variety of instructional activities, games, challenges, projects

worksheets, and other seatwork. The use of activities is indeed a prevalent practice in the

teaching of algebra, and some of these activities were considered as iconic practices or rituals in

mathematics classrooms (McCloskey, 2014).

Using instructional materials and resources. Manipulatives and calculators are among

the common tools that are used in algebra classroom (Dion et al., 2001). They can be used to

raise students' interest (Takor et al., 2015), enhance their engagement in learning (Danielson,

2007), and to improve their understanding (Satsani et al., 2016; West, 2016). Nevertheless, the

majority of participants in this study did not describe much the materials and resources that their

teachers used inside the classroom. Only few participants were able to recall some of the

cardboard materials used for certain activities, while others mentioned that their teachers did not

use any hands-on materials in the explanation of lessons. The infrequency in the memories about

materials and resources may be because the participants did not experience hands-on activities in

algebra classrooms when they were students. Instead, most of the activities that they recalled required only a paper and a pencil, or where activities that were demonstrated by the teacher. This finding is unlike what was reported in other studies, where the participants remembered a variety of materials and resources that their teachers used in mathematics classes. Some participants mentioned the textbook as the primary resource for learning and for exercises. Some talked about the chalkboard, while others mentioned the use of technology and manipulatives (Barrantes & Blanco, 2006; Guillaume & Kirtman, 2010; Scott, 2005, Sexton, 2004).

Depending on written exams for assessment. Although the memories about assessment were not many in this study, but from the few that the participants recalled, they described that for assessment they used to have challenging exams and many quizzes, and that assessment was based on paper-pencil exams only, while few recalled being assessed during group work. The scarcity in memories about assessment may be due to that fact that these experiences were not significant to the participants and instead they preferred to recall and describe experiences that are more valuable about their learning of algebra.

In other studies, memories about assessment were also scarce. In Scott (2005), the participants did not mention anything related to being assessed in numeracy. In Barrantes and Blanco (2006), the participants were prompted to recalled memories about evaluation. In their study, when the participants were asked about their school memories, some participants could just remember exams and quizzes, and some responses showed that examination was the most dominant tool for evaluation (Barrantes & Blanco, 2006). This is also a prevalent practice that is found in mathematics classrooms; Senk et al. (1997) found that in mathematics classrooms, the most frequent tools for assessment were tests and quizzes, while written projects and other

instruments were used less frequently. Tests and quizzes determined a high percentage of students' grades, while other tools counted for a very little percentage (Senk et al., 1997).

Interacting with students. A major portion of the participants' memories in this study described how teachers used to interact with students and what characteristics facilitated or impeded this interaction. The participants remembered whether teachers were friendly or not, supporting or not, and encouraging or not in algebra sessions. Through their memories, participants acknowledged that these practices were central to teaching algebra. They remembered their teachers providing a safe environment, acknowledging their performance, rewarding them, supporting them, motivating them, etc. Then they described how these practices facilitated their participation in the classroom, made them feel proud of themselves, and motivated them to study harder and perform better. On the other hand, some participants remembered having teachers who were demotivating, offensive, not supportive, and encouraged negative competition between students. These positive and negative aspects of teachers' practices and how they interacted with students was also very evident in the memories of participants in other studies. These characteristics were not only relevant to mathematics teachers, but also to teachers of other subjects (Ellsworth & Buss, 2000; Guillaume & Kirtman, 2010; Heikkilä et al., 2012; McGarr & Gavaldon, 2019; Miller & Shifflet, 2016; Sexton, 2007). In these studies, the participants recalled positive and negative teacher examples; these teachers showed personal and professional characteristics that participants evaluated as good or bad. The good characteristics included being kind, caring, fair, passionate, dedicated, self-confident, had the ability to motivate their students, encourage, inspire, support, challenge, and engage them in the lessons to make the class more interesting and enjoyable. The negative characteristics

included being boring, unenthusiastic, aggressive, impatient, unpassionate, chaotic, over strict or over lenient, give negative and discouraging comments or feedback, and in some cases carried out physical punishments.

The different ways in which autobiographical memories influence teaching

Results show that memories of learning at school served a directive function on the teachers' teaching. The directive function of autobiographical memories states that autobiographical memories serve as guides for people's behaviors; and one way that memories inform current actions is by analogy (Pillemer, 2000; Pillemer, 2003; Pillemer & Kuwabara, 2012). When individuals find themselves in a situation that is similar to a situation they experienced in the past, they are reminded of the past experience and this old situation direct or guide the individual to what or what not to do (Schank, 1990 as cited in Pillemer, 2000).

In the case of teachers, this can be translated by saying that in their teaching, teachers face many similar situations to the one they experienced as students. For this, they are reminded of their past experiences of learning (how their teachers explained, what activities were used, how their teacher interacted, etc.), and the memories of these past experiences guide the teachers into how to teach or how not to teach. This was evident in the results of our study, the autobiographical memories that teachers recalled about their experiences of learning at school had an influence on how they teach algebra in several ways. Some memories guided the participants into reproducing the experienced practices, while other memories guided the participants into avoiding the repetition of other practices. Few memories motivated the participants to understand how their students react when they learn certain lessons, while other memories inspired the participants to become mathematics teachers.

Reproducing "pleasant" and "good" practices. One major theme for the influence of autobiographical memories is that participants tend to reproduce the practices described through these memories. Participants described that they reproduce how their teachers used to explain the lessons for them, engage them in activities, and interact with them during the algebra classes. The theme of reproducing practices was recurrent in findings of different studies that investigated the influence of teachers' previous school experiences. This theme of influence was evident in studies that targeted prospective mathematics teachers (Barrantes & Blanco, 2006; Scott, 2005) and teachers of other subjects as well (Cancino et al., 2020; McGarr & Gavaldon, 2019; Miller & Shifflet, 2016). Barrantes and Blanco (2006) found that some prospective teachers are imitators of their past teachers and they are fully convinced of how they were teaching them. Cancino et al (2020) found that some prospective teachers intend to replicate the previous experiences they went through during their school years. Miller and Shifflet (2016) found that prospective teachers recalled certain qualities and practices that their previous teachers exhibited and that these qualities and practices served as a model for the kind of teacher they desired to be. These studies gave an insight into the prospective teachers' intentions to reproduce the practices they experienced as students. The results of our study show that when teachers start teaching, i.e. when they become practicing teachers, they still do actually reproduce some of the practices that they experience.

We argue that teachers' decisions to reproduce certain practices were not directed by their memories thoughtlessly. One explanation for why teachers decided to reproduce certain practices could be interpreted to their lack of knowledge and skills of other practices, some emotional reasons, or based on an educational evaluation of the practice. Our claim is based on

participants' responses regarding their reproduction of practices. Even though they were not asked why they reproduce some practices, some participants expressed their reasons for choosing to reproduce the practices that they experienced. Specifically, they attributed their reproduction of practices to the reasons we state above.

Within the same perspective, we further argue that some participants teach the same way they were taught because they do not know how to teach in a different way. This issue was also discussed in the literature. For instance, Barrantes and Blanco (2006) conclude that the reason why the prospective teachers expectations to teach are similar to the teaching they experienced when they were students is their lack of knowledge of other methods. The researchers proposed that teachers should get a better preparation before they go into the classroom. Our study showed that this issue was not only evident with prospective teachers (as indicated in previous studies) but also novice practicing teachers who are in their first three years of teaching, regardless of their acquisition of a TD or not. They tended to reproduce certain practices because they lacked knowledge about other practices.

Other participants reproduce certain practices because they found these practices to be emotionally "pleasant" or educationally "good"; i.e. because they liked, enjoyed, and benefitted from these practices or because they realized that these practices are pedagogically sound to be used in the classrooms. Even though both emotional and educational justifications were present in the participants' responses, the emotional reasons were slightly more evident when the participants explained why they reproduce certain practices. When teachers decide to reproduce a practice based on their emotional experiences, this might imply that they are judging the practice from 'student-oriented perspective' rather than a 'pedagogically-oriented perspective'

135

(Lortie, 2002). This means that teachers evaluate the appropriateness of a certain practice based on their own emotional response as students to the practice they experienced.

Teachers intended to use the same practices they experienced because they believed that their students would like and benefit from these practices as well. However, some participants described that their students did not actually like or benefit the practices that they reproduce. So, what worked for them as students did not work for their students. Some researchers have already warned from having teachers fall into this illusion. For example, Holt-Reynold (1992) concluded in her study that student teachers tend to believe that if a strategy worked for them it may also work for others (Holt-Reynold, 1992 as cited in Miller & Shifflet, 2016). This makes teachers fall into the impression that what worked or did not work for them, will work or not work for their students without taking into consideration their students' needs.

Avoid the reproduction of "unpleasant" and "bad" practices. Another major theme that emerged in this study for the influence of autobiographical memories is that participants tend to not reproduce the practices described through these memories, but instead produce different practices than those they experiences as students. Participants reported that they tend to follow a different way than their teachers when it comes to explaining lessons, carrying out activities and discussions, assessing their students, and interacting with them.

The theme of not reproducing practices was also recurrent in findings of different studies as well; this influence was also evident in studies that targeted prospective mathematics teachers (Barrantes & Blanco, 2006; Scott, 2005) and teachers of other subjects as well (Cancino et al., 2020; McGarr & Gavaldon, 2019; Miller & Shifflet, 2016). These studies gave an insight into the prospective teachers' intentions to avoid repeating the practices they experienced as students. For

136

instance, Barrantes and Blanco (2006) found that some prospective teachers openly showed a rejection to the practices that their past teachers followed. Cancino et al (2020) found that some prospective teachers intend to avoid replicating the previous experiences they went through while learning. Miller and Shifflet (2016) found that participants recalled certain qualities and practices that served as a model of what not to do and the kind of teacher they do not want to be. Other studies showed that teachers showed dissatisfaction with the methods they were taught through and wanted to adopt different teaching practices (Albaba, 2017; Moodie, 2016).

Teachers do not blindly oppose the practices that they remember their teachers used. One explanation for why teachers decided to reject some of the practices that they experienced and develop different practices could be interpreted from the participants' responses. Participants did not reproduce practices they judge as being emotionally "unpleasant" or educationally "bad". This shows that the opposition of practices could be attributed to the participants' emotional response or an educational evaluation of the practice.

Participants avoid the reproduction of certain practices because they did not like or did not benefit from them when they were students. They teach in a different way than their teachers because they do not want their students to experience the same practices that they did not like, or because they want to provide their students what they did not get. This was also noted in Cancino et al (2020) study, where they found that prospective teachers expressed that they desire to be different than their teachers and that their desire was based on emotional responses to the feelings experienced in their schooling, rather than based on sound pedagogical principles.

When the participants described why they do not reproduce certain practices, the educational evaluation of the practices was more evident. They assessed the practices as teachers from a pedagogical perspective. When they considered the practices to be pedagogically not

137

appropriate they resorted to follow different practices. For example, some participants provided a reason from an educational perspective for not reproducing the practice of teaching students certain tricks to solve equations such as taking the number from one side to the other and changing its sign. They describe that students are usually taught to memorize this trick without understanding the reason behind it, which would yield more emphasis on the procedural understanding of concepts rather than having a good conceptual understanding behind solving equations. For this reason, these participants noted that in their teaching they make sure to have their students understand the process of solving equations conceptually, i.e. understand the concept of operating on both sides of the equation to maintain equality of the equation.

Understand students' difficulties. Another theme of influence that emerged in this study, but was not much discussed in literature, is that teachers understand what their students pass through concerning the difficulties they face when learning certain topics without necessarily taking action. These participants reported that they could identify with their students' difficulties in understanding certain topics because they experienced similar difficulties. Teachers tend to empathize with their students because they were once students and they understand that students might be frustrated because of the difficulties they are having. For this reason, teachers show students that they understand them and they share with them some personal stories from their own experiences with such difficulties in order to decrease their frustration. This creates a positive classroom environment and could have significant implications on students' attention, well-being, and their learning.

This theme of influence was not evident in literature in studies related to the influence of school memories; this might be because few studies were made on the influence of memories of

138

practicing teachers so such an influence did not emerge. Furthermore, the studies that targeted prospective teachers could not capture such an influence because prospective teachers may not experience such situations because they do not accompany students throughout their learning.

Choosing to become mathematics teachers. The last theme of influence that emerged in our study was that memories of learning experienced directed participants into choosing to become mathematics teachers. The participants remembered that their teachers used to encourage them to be mathematics teachers, and that these teachers used to give them role in the sessions as a teacher. When they grew up, the participants chose mathematics as a major to study in university and chose to become mathematics teachers. The participants attributed their decision to become mathematics teachers to their memories of their teachers.

The theory of the directive function of autobiographical memories proposed that some memories motivate and inspire individuals' decisions to pursue a certain life path (Pillemer, 2000; 2001). These memories are referred to as memories of originating events; Pillemer (2000) described that memories of originating events do not carry an explicit, rule-structured directive; they inspire rather than prescribe. Therefore, these memories create or at least contribute to a new life course for individuals, in this case the memories that the participants had about their learning experiences, guided them into choosing teaching mathematics as their career path.

Relationship between the influence and emotional content of autobiographical memories

Results of our study showed that both positive and negative memories had a role in directing teachers' teaching. However, the way positive and negative memories directed behavior was different. Participants tended to reproduce the practices recalled through positive

139

memories, while they did not reproduce the practices they recalled through the negative memories. These results are consistent with findings from other studies on the influence of prospective teachers' positive and negative memories. Miller and Shifflet (2016) also found that prospective teachers were guided by their positive memories to describe the kind of teacher they desire to be and by their negative memories to describe the kind of teacher they fear to become. Moodie (2016) discussed the idea of the anti-apprenticeship of observation, he described that the negative school memories that teachers have motivate them to teach in an opposite or different way than what they experienced as students. Results of the study of Cancino et al. (2020) also noted that prospective teachers expressed their intentions to replicate the positive experiences they went through, and they conveyed that they are not willing to imitate their schoolteachers' practices due to their negative experiences as learners. Positive memories direct individuals into reproducing certain practices because they have the power to provide continuous inspiration and motivation for individuals (Biondolillo & Pillemer, 2015; Pillemer & Kuwabara, 2012). The good feelings that come from remembering positive experiences inspire teachers to follow practices similar to what they experienced because they believe that these experiences will be positive for their students as well. On the other hand, negative memories direct individuals into avoiding the reproduction of certain practice because they provide a kind of warning that prevent them into falling into mistakes (Pasupathi, Lucas, & Coombs, 2002; Rasmussen & Berntsen, 2009). The bad feelings that come from remembering negative experiences alert the teachers into not reproducing what they thought their teaching to be doing wrong or doing insufficiently. Therefore, they choose to follow other practices that they deem as better and more beneficial for the students.

In our study, we found that neutral memories also served a directive function; the influence of neutral memories was more like the influence of positive memories. In other words, for most of the neutral memories, where the participants did not explicitly express their emotions, they described that they reproduce the practices recalled through these memories. There were only few incident when the participants described that they do not reproduce the practices they remember. The influence of these memories may be attributed to an implicit emotional response or an educational evaluation of the practice without the interference of feelings. This means that it could be that the participants had some kind of emotions related to the practice that were not explicitly expressed and these emotions have played a role in how they were influenced. Or else, the participants evaluated the practice objectively and the influence was based purely on that evaluation. So, they reproduced the practices that they found to be pleasant or good and did not reproduce the practices that were unpleasant or bad. For example, when one participant described that she remembers that her teacher used to teach some concepts as a song or rhyming sentence, she did not describe how she felt about this practice but she mentioned that she uses the same method with her students. In this example, we can attribute the influence to the participants' positive emotions towards the practice, i.e. because she liked or benefited from the practice, or it could be because she judged this practice as being a good practice to use with students. We note that, according to our knowledge, the influence of neutral memories was not an issue discussed in literature.

Relationship between the influence and the structure of autobiographical memories

Results of our study showed that both specific and general memories played a role on directing teacher's teaching; however, there were no clear differences in how specific and

general memories influenced behavior. Our results are similar to those of Kuwabara and Pillemer (2010), where they found that there was no clear advantage for either memory type in influencing people's behaviors. Both general and specific memories direct behavior because of the characteristics they exhibit. General memories direct behavior frequently because they represent routines and repeated events that often fit recurrent situations (Abelson, 1981; Nelson 1993 as cited in Pillemer 2003). While specific memories direct behavior because they have the potential to provide persistent inspiration and motivation or a continuous warning (Pillemer, 2003). Therefore, teachers' general memories direct their teaching because they represent the frequent practices that a teacher carry out inside the classroom, so teachers are more likely to face similar situations to those they experienced as students and be influenced by them for teaching. On the other hand, teachers' specific memories direct their teaching because they describe particular experiences that teachers experienced as students and found to be very inspiring and beneficial or very alerting and inappropriate. These specific incidents are not frequently encountered. However, their specificity and significance to the teachers provide them with guidance of what practices they should follow or should not follow based on their own experiences.

Relationship between the influence of memories and teachers' expertise

In an attempt to examine how teachers' expertise interfere with how teachers are influenced by their memories, we compared the responses of novice and expert practicing mathematics teachers some of which are TD-holders while others are not. Our results showed that most of the novice teachers usually refer their school memories when deciding on how to teach; also, expert teachers reported that in their first years of teaching they relied on their school memories to guide them in their teaching. This is similar to what has been discussed in literature;

many studies have found that novice teachers tend to return back to their school memories and reproduce the instructional practices they experienced as students (Cochran-Smith et al., 2010 as cited in Strom, 2015; Frost, 2010; Zeichner & Tabachnick, 1981). This result might be attributed to the type of preparation that teachers get. Teacher who do not get any formal preparation or they get insufficient training might find themselves lacking the needed knowledge and skills to run a classroom. Therefore, they chose to recall how they were taught to get guidance from these memories. Even teachers who receive good training might find a difficulty in transferring what they learned in their TD courses into the actual teaching settings. This is why they fall back on the kind of practices that they have already experienced in real classrooms.

Nevertheless, our results show that expert teachers reported that later on in their teaching, they started to develop teaching strategies other than those they experienced as students. They said that they started learning from their own interaction with their students, from other teachers, and from professional development workshops that they attended. However, this did not erase the influence of teachers' school memories on their teaching, but it changed the way teachers look back at their memories. Findings in several studies (Davin et al., 2018; Frost, 2010; Millsaps, 2000; Oleson & Hora, 2014; Rayati Damavandi & Roshdi, 2013) suggest that the influence of school memories was still evident in teachers' instructional decisions after spending years of teaching. The studies that targeted expert practicing teachers, found that teachers are constantly reflecting on their school memories and acting in light of them (Oleson & Hora, 2014). On-job training and experience are one of the most important factors shaping teachers' knowledge, Kolb (1984) referred to this as experiential learning, while Shulman (1987) referred to this as craft knowledge that comes with the wisdom of practice (as cited in Oleson & Hora,

143

2014). Experiences such as teacher education courses, field training, and teaching experience could play a significant role in altering these conceptions and shaping teachers practices.

Regarding how the influence of memories differ between teachers who have a TD and those who do not, our results showed that teachers who did not have a TD reported that their first years of teaching were hard because they did not have knowledge about how to teach. Therefore, they relied on their school memories to guide them through their teaching and for this; they started to teach the same way they were taught. This category of teachers was not present in studies about teachers' memories and their practices; this might be because in other countries teachers are not allowed to teach before they get a diploma in teaching.

Teachers who got the TD after they started teaching reported that what they learned in the TD courses did not affect the way they were teaching because the knowledge that they got from the TD was very theoretical and it did not apply to their actual practice. Thus, what they learnt in the TD courses did not interfere with how they were influenced by their memories and how they decided to teach. This category of teachers was also not present in literature, also may be due to the same reason mentioned before. This category of teachers may not have benefitted from what they learnt in TD courses because they have formed their conceptions of how to teach from their school memories and during their teaching experiences. Therefore, when they received their formal training, they filtered what they are learning in teacher education courses through their school memories and their school experiences. Consequently, they would approve on some methods and reject other methods depending on what they have already tested in the classrooms with their students in actual teaching settings. These teachers might have discovered that what they learnt in teacher education courses does not work in real classrooms (Shin, 2012 as cited in

Farrell, 2012), therefore they resorted to the only other source of knowledge for teaching -that could work in actual classrooms- they have is their prior experience in the school (Frost, 2010).

Teachers who got the TD before they started teaching reported that through their TD courses and the time they spent in the classrooms during the practicum they were exposed to a variety of practices (use of technology, manipulatives, hands-on activities…) that were different that those they experiences as students. Therefore, in their teaching they chose not to reproduce some of the practices that they experienced because they learnt that they are better practices to be followed. These teachers represent what teacher education programs aim for, that is to provide teachers with good pedagogical skills to be followed in the classrooms and suitable knowledge to assess and reconsider what they already know. Therefore, teachers' personal experiences that involve the kind of school memories that teachers have, the timing of when they take TD courses, and the type of knowledge they are exposed in these courses might play a role on how teachers are influenced by their school memories.

Conclusion

Our study showed that the practicing mathematics teachers remembered how they were taught algebra and how they learned algebra, most of these memories were positive, and they mainly represented the frequent routines that are practiced in teaching and learning of algebra. The influence of the recalled memories was manifested in several ways. Positive memories guided the participants into reproducing the good practices that they have experienced when they were students. In contrast, negative memories guided the participants into avoiding the repetition of bad practices that they have experienced. Teachers' decisions to reproduce similar practices or to produce different practices were sometimes unintentional and in most of the times based on an

emotional response or an educational evaluation of the practice. Our results also show that there were differences in the influence of memories in relation to teachers' expertise. The kind of school memories remembered, the timing of when they take TD courses (before or after starting teaching), and the type of knowledge they are exposed in these courses, and the kind of teaching experience the teacher went through, all these factors play a role on how teachers are influenced by their school memories. The results of this study have some implications and recommendation on practice and research, these implications and recommendations will be discussed in the next section.

Implications and Recommendations

The variety of practices remembered by the participants in this study, the variation in the emotions expressed about these practices, and the kind of influence the memories had on participants' teaching, show us the power of teachers' instructional decisions and pedagogical practices on students' learning. Teachers should never underestimate their behaviors and the role they have in influencing students' lives. Our results show that individuals still remember certain practices and incidents even though a long time has passed since they have experienced. For this reason, teachers should be aware of what kind of practices they follow in the classroom, and make conscious decisions to follow practices that would be valuable to students learning in specific and lives in general.

Memories of teaching practices can also provide suggestions to inform pedagogical improvement (Pillemer, 2001). Examining the learning experiences of students might give us certain implications about what practices are significant and effective for students' learning and what practices are impractical and could hinder students' learning. This information can be used

146

then to evaluate the prevalent practices and to develop and promote the use of more innovative practices.

Moreover, the results of this study show that teachers are in no doubt influenced by their memories in different ways and to different degrees. Therefore, more actions should be taken to deal with this issue; the main recommendation to be made is to train teachers to develop the skill of "critically reflecting" on their memories and teaching practices.

Prospective, novice practicing and expert practicing teachers, whether in teacher training programs, in professional development workshops, or even in teachers meetings and discussions should be encouraged to reflect critically on their school memories and their actual teaching practices. Other researchers who have studied the memories of teachers and their influence have also suggested a similar recommendation (e.g. Barantes & Blanco, 2006; Guillaume & Kirtman, 2010; Miller & Shifflet, 2016; Rayati Damavandi & Roshdi, 2013; Scott, 2005).

Teachers should be provided with the needed knowledge and skills to develop the habit of critically reflecting and evaluating their decisions to follow certain practices. Teachers should be given the time to think about and share their memories of their experiences of learning at school and about their teaching practices. Then they should be prompted to examine and analyze these practices from a critical pedagogical lens and based on educational theories in order to assess the validity of these practices and reconsider their appropriateness for catering to students' needs. The reflection should not end here; teachers should also be prompted to present and explicitly suggest alternative strategies for the practices that they deemed as unbeneficial for their learners.

This reflective practice could be used for teachers' school memories and practices about teaching in general or regarding specific topics. In the context of teaching of algebra, teachers can be prompted to recall how they were taught certain topics or how they teach certain topics and to assess the usefulness of these practices. For instance, this will be similar to the discussion we presented before about the example of the teachers who recalled that their teachers used to teach them the "inverse method" instead of the "balance method" to solve equations, and how these teachers evaluated this practice and made an informed instructional decision based on that. This could also be a recommendation for future research, to explore teachers' memories about how they studied certain topics (in algebra), how they actually teach these topics, and how do they evaluate the effectiveness of these practices.

Other suggestions for future research include (1) studying in depth the reasons behind why teachers are influenced by their memories, by explicitly asking the participants about the reasons underlying their instructional choices and decisions; and (2) investigating other contextual factors that interfere (support or hinder) in how teachers are influenced by their memories. Furthermore, (3) examining the extent to which it is beneficial to ask teachers to become aware and reflect on their memories and their influence, (4) studying how the influence of memories change over time from when teachers are novice to when they are experts. Moreover, (5) comparing the influence of memories between male and female teachers, and (6) investigating further how the structure of memories influence behavior.

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APPENDIX I

Questionnaire

Part 1: *For each of the following questions, please check the response that best describe(s) you:*

1. Gender:　　□ Male　　　□ Female

2. Age: _____

3. Which of the following high school degree have you earned?

□ Lebanese Baccalaureate　　　　　□ French Baccalaureate

□ High School (American system)　　□ International Baccalaureate (IB)

4. Which of the following degree(s) have you earned?

□ B.A./B.S. specify area/major: _____

□ Masters, specify area/ major: _____

□ Ph.D., specify area/major: _____

5. What is your teacher education specialization?

　□ I do not have a teaching diploma.　　　　□ Elementary

　□ Secondary mathematics　　　　　　　　□ Other, (*Please specify*): _____

6. Which grade level are you currently teaching?

□ Upper Elementary (Grades 4, 5, 6)

□ Intermediate (Grades 7, 8, 9)

□ Secondary (Grades 10, 11, 12)

7. Which curriculum/curricula are you currently teaching?

□ Lebanese curriculum　　　　　□ American curriculum

□ International Baccalaureate　　□ Other, please specify: _____

8. How long have you been teaching?

□ 1 - 3 years　　　　□ 4 – 5 years　　　　□ 6 - 10 years　　　　□ More than 10 years

Part 2: Kindly answer the following questions:

1. How often do you recall your experiences of learning <u>algebra</u> at school?

    a. Almost never   b. Occasionally   c. Often   d. Very frequently

2. Do you recall more positive or negative memories of learning algebra at school?

    a. I don't recall any   b. Negative   c. Both positive and   d. Positive
       memories   memories   negative memories   memories

3. To what extent do you think that your teaching of algebra is similar to the way you were taught at school?

    a. Not at all   b. To a small extent   c. To some extent   d. To a great extent

4. To what extent is your teaching of algebra influenced by any of the math teachers you have had as a student?

    a. Not at all   b. To a small extent   c. To some extent   d. To a great extent

5. To what extent do you reproduce the practices of teaching algebra you experienced as a student?

    a. Not at all   b. To a small extent   c. To some extent   d. To a great extent

6. **Think about a memory of an experience with learning algebra that occurred during your school years that had an influence on how you currently teach algebra.**

    In the space below:
    - **Describe this memory: What happened? When did it happen? With whom? How did you feel about it when it happened?**
    - **Describe how this memory influences your teaching of algebra.**

    [Your description can be as long or as short as you deem necessary. Please be as precise as possible; include any remembered details even if they do not seem particularly important now. Write on the back of the page if necessary.]

7. **Are there any other memories that you often recall while teaching, that has an influence on the way you teach algebra? Please describe these memories and how they influence your teaching of algebra** *(as in the previous question)*.

Thank you for completing this questionnaire. Please provide your contact information since you **might** be contacted to participate in an interview to collect more information about the topic being studied. Please note that the time and place of the interview will be planned at your own convenience.

1. Name: _____

2. Phone number: _____

3. Email: _____

APPENDIX II

Interview questions

The purpose of these questions is to get to know the background of the teachers and make them start thinking about their memories of learning algebra at school.

1. When did you first start thinking that you wanted to be a teacher/to teach? Why were you interested in teaching?

2. What where your experiences with learning algebra at school before you became a teacher? Was it easy or hard? What did you like about it? What did you hate about it?

3. How was your relationship with your mathematics teachers? Is there any mathematics teacher that you preferred? What do you remember the most about them?

4. What do you remember about the ways you were taught mathematics at school? Describe them in detail.

In the questionnaire, you talked about a memory that influenced your teaching […]
(The researcher might ask questions about what was written to get more details)

The following questions will be used to probe more memories that influence the teachers' teaching.

5. In the questionnaire you mentioned [one] memory, are there any other memories that you often recall while teaching, that has an influence on the way you teach algebra? Describe these memories and how do they influence your teaching?

For probing:

   i. Do you recall your teachers doing or saying something about teaching and learning algebra that influenced your teaching today? Describe the memory and how does it influence your teaching?

   ii. Do you recall any memory related to activities, assignments, misconceptions, feedback, use of materials, methods of assessment?

   iii. Do you recall any memory related to the learning of prime numbers, negative numbers, algebraic expressions, fractions, decimals, powers, or other topic in algebra?

iv. While being in a classroom, a place similar to that you learned in, do you often recall any memory while teaching? Describe the memory and how does it influence your teaching?

v. Does teaching the same curriculum you were taught; make you recall any memory while teaching? Describe the memory and how does it influence your teaching?

The purpose of these questions is to understand the influence of teachers' memories with respect to their qualifications (novice, experienced, with TD, without TD). The researcher will chose the question that describes the qualifications of the interviewed teacher:

6.

i. As an experienced teacher who has been teaching for several years: Why do you think you still remember your experiences of learning algebra? / Why do they still influence you? / Why you are no longer influenced by them? / Were you influenced by your school experiences before, and how did it change over the years?

ii. As a novice teacher who does not have enough experience in teaching, to what extent do you depend on your school memories to guide your teaching of algebra? Why?

iii. As a teacher who has a teaching diploma, do you think that your experiences in your diploma courses changed the way you might be influenced by your memories? How?

iv. As a teacher who does not have a teaching diploma, to what extent do you rely on your school memories to help you in your teaching of algebra? Why?

Danielson Framework for Teaching (Danielson, 2007)

Domains, Components, and Elements of the Framework for Teaching

Domain 1: Planning and Preparation

Component 1a: Demonstrating Knowledge of Content and Pedagogy
- Knowledge of content and the structure of the discipline
- Knowledge of prerequisite relationships
- Knowledge of content-related pedagogy

Component 1b: Demonstrating Knowledge of Students
- Knowledge of child and adolescent development
- Knowledge of the learning process
- Knowledge of students' skills, knowledge, and language proficiency
- Knowledge of students' interests and cultural heritage
- Knowledge of students' special needs

Component 1c: Setting Instructional Outcomes
- Value, sequence, and alignment
- Clarity
- Balance
- Suitability for diverse learners

Component 1d: Demonstrating Knowledge of Resources
- Resources for classroom use
- Resources to extend content knowledge and pedagogy
- Resources for students

Component 1e: Designing Coherent Instruction
- Learning activities
- Instructional materials and resources
- Instructional groups
- Lesson and unit structure

Component 1f: Designing Student Assessments
- Congruence with instructional outcomes
- Criteria and standards
- Design of formative assessments
- Use for planning

Domain 2: The Classroom Environment

Component 2a: Creating an Environment of Respect and Rapport
- Teacher interaction with students
- Student interactions with other students

Component 2b: Establishing a Culture for Learning
- Importance of the content
- Expectations for learning and achievement
- Student pride in work

Component 2c: Managing Classroom Procedures
- Management of instructional groups
- Management of transitions
- Management of materials and supplies
- Performance of noninstructional duties
- Supervision of volunteers and paraprofessionals

Component 2d: Managing Student Behavior
- Expectations
- Monitoring of student behavior
- Response to student misbehavior

Component 2e: Organizing Physical Space
- Safety and accessibility
- Arrangement of furniture and use of physical resources

(figure continues)

169

Domains, Components, and Elements of the Framework for Teaching (continued)

Domain 3: Instruction

Component 3a: Communicating with Students
- Expectations for learning
- Directions and procedures
- Explanations of content
- Use of oral and written language

Component 3b: Using Questioning and Discussion Techniques
- Quality of questions
- Discussion techniques
- Student participation

Component 3c: Engaging Students in Learning
- Activities and assignments
- Grouping of students
- Instructional materials and resources
- Structure and pacing

Component 3d: Using Assessment in Instruction
- Assessment criteria
- Monitoring of student learning
- Feedback to students
- Student self-assessment and monitoring of progress

Component 3e: Demonstrating Flexibility and Responsiveness
- Lesson adjustment
- Response to students
- Persistence

Domain 4: Professional Responsibilities

Component 4a: Reflecting on Teaching
- Accuracy
- Use in future teaching

Component 4b: Maintaining Accurate Records
- Student completion of assignments
- Student progress in learning
- Noninstructional records

Component 4c: Communicating with Families
- Information about the instructional program
- Information about individual students
- Engagement of families in the instructional program

Component 4d: Participating in a Professional Community
- Relationships with colleagues
- Involvement in a culture of professional inquiry
- Service to the school
- Participation in school and district projects

Component 4e: Growing and Developing Professionally
- Enhancement of content knowledge and pedagogical skill
- Receptivity to feedback from colleagues
- Service to the profession

Component 4f: Showing Professionalism
- Integrity and ethical conduct
- Service to students
- Advocacy
- Decision making
- Compliance with school and district regulations

170