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Reducing Epilepsy-Related Stigma: Teachers' Implementation of an Epilepsy Education Program

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Graduate Program in Education

A thesis submitted in partial fulfillment of the requirements for the degree in Master of Education

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REDUCING EPILEPSY-RELATED STIGMA:
TEACHERS' IMPLEMENTATION OF AN EPILEPSY EDUCATION PROGRAM

(Thesis format: Monograph)

by

Gayle Michelle Gibson

Graduate Program in Education

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Education

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Abstract

This thesis presents an investigation of teachers' implementation of *Brain Matters*, an education program designed to reduce the stigma associated with epilepsy. Five local Grade 12 Biology teachers were interviewed to examine their implementation and consistent with previous research, a multilevel ecological framework was used to understand the factors affecting their implementation. The findings indicate that there were three factors that worked to either facilitate or limit teachers' implementation of *Brain Matters*: pedagogical content knowledge and beliefs, characteristics of the resource, and professional development. The results of this study offer developers of stigma-reduction programs insight into the challenges that teachers encounter when implementing innovative resources.

Keywords: *Brain Matters*, implementation, epilepsy, neuroscience, stigma, secondary school students

Dedication

Dedicated to my heroes, Mom and Dad.

Acknowledgements

*It is good to have an end to journey toward;
but it is the journey that matters, in the end
(Ursula K. Le Guin, 1969, p. 220).*

I would like to acknowledge and extend gratitude to all of the people who influenced my journey. Firstly, I would like to thank my supervisor, Dr. Jacqueline Specht, for her flexibility, understanding, and constant support. Thank you for believing in me! I would also like to thank my committee member, Dr. Elizabeth Nowicki, and my examiners who provided considerable expertise in the area and read this thesis carefully and thoughtfully. I would also like to thank the teachers who participated in this study and the Epilepsy Support Centre. Thank you to Asmita Persaud who extended her time to double code the data of this study. Thank you to my brother and all of my family and friends that supported me throughout this journey and lent an understanding ear throughout the ups and downs.

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Introduction

Background and Justification

Epilepsy is the most common neurological disorder in the world: it affects about 50 million people worldwide with 2 million new cases each year (World Health Organization, 2005). Epilepsy is also one of the most stigmatized illnesses in the world (Bandstra, Camfield, & Camfield, 2008; Fernandes et al., 2007) largely due to lack of knowledge and negative attitudes about the disorder (Bandstra et al., 2008; Jacoby & Austin, 2007; Jacoby, 2008; Martiniuk, Speechley, Secco, Campbell, & Donner, 2007; Martiniuk, Secco, Yake, & Speechley, 2010; Morrell, 2002; Roberts & Suhaimi, 2010; Young et al., 2002). This stigma has a profoundly negative effect on quality of life (de Boer, Mula, & Sander, 2008; Jacoby, 2002; Jacoby & Austin, 2007; World Health Organization, 2005) and contributes to mental health issues (Jacoby, 2002), social isolation (Jacoby, 1994), lower quality of care (Jacoby, 2002), higher direct and indirect socioeconomic costs (Jennum, Gyllenberg, & Kjellberg, 2011), fewer employment opportunities (Fisher, 2000), and lower educational attainment (Fisher, 2000). To address the adverse effects of epilepsy-related stigma, the World Health Organization (WHO), International League Against Epilepsy (ILAE), and International Bureau for Epilepsy (IBE) initiated *Out of the Shadows*, a global campaign against epilepsy. One of the objectives of this global campaign is to improve acceptability of epilepsy. To achieve this goal, the WHO, ILAE, and IBE advocate for the need to increase awareness of, promote public and professional

education about, and develop and evaluate interventions to dispel myths about epilepsy (World Health Organization, 2003).

In response to this global campaign against epilepsy, the Epilepsy Support Centre of London, Ontario initiated a series of pilot projects to assess students' knowledge of and attitudes towards people with epilepsy. Results from surveys and focus groups conducted with local secondary school students confirmed the pervasiveness of misunderstanding and negative attitudes towards this group (Epilepsy Support Centre, 2004). In light of these findings and in support of the global campaign against epilepsy, the Epilepsy Support Centre created a curricular resource, *Brain Matters: An Introduction to Neuroscience (Brain Matters; Nurse, 2010)*. *Brain Matters* focuses on informing secondary school students about the neurology of epilepsy and dispelling myths associated with the disorder in an attempt to increase knowledge of and promote positive attitudes towards epilepsy and people with epilepsy. *Brain Matters* aligns with the Grade 12 Biology neuroscience curriculum and teachers are urged to use inquiry-based strategies with the resource. Consistent with research on stigma reduction strategies, the Epilepsy Support Centre proposes that, because of the relationship between knowledge, attitudes, and behaviour, *Brain Matters* will ultimately lead to a decrease in epilepsy-related stigma.

While *Brain Matters* affords promising outcomes, Fullan states that “educational change fails many more times than it succeeds. One of the main reasons is that implementation—or the process of achieving something new into practice—has been neglected” (Fullan, 1992, p. vii). Teachers are central to

curriculum implementation because they determine what materials are used and how these materials are used. Thus, a large part of the success of curricular innovations hinges on teachers and it is, therefore, important to examine their implementation of innovative resources. This project will investigate teachers' implementation to identify the barriers and facilitators to teachers' use of *Brain Matters*. This feedback is essential to the early monitoring of innovative curricular resources like *Brain Matters* and will provide the curriculum developers with feedback relevant to curriculum design to ensure that teachers continue to use the resource with their students. Continued use will further promote epilepsy-related stigma prevention and help reduce the current stigma.

Outline of Thesis

This study draws on literature related to epilepsy, stigma, and curriculum implementation to investigate teachers' implementation of *Brain Matters*. The first section presents background information relevant to this thesis and provides an overview of the impetus to investigate the implementation of school-based epilepsy education programs. The following literature review unites several bodies of research. It begins with a discussion of the information necessary to understand epilepsy and the stigma associated with this disorder. Next is a review of knowledge and attitudes towards epilepsy as well as behaviours towards this group. The section on decreasing epilepsy-related stigma explicates the rationale for school-based epilepsy education programs. The section on evaluating school-based epilepsy education programs discusses the need to understand implementation and is followed by an examination of the factors

affecting teachers' implementation. This literature review is followed by a description of the method and results. The discussion explores the results in relation to the stigma and implementation literature previously reviewed.

Literature Review

Understanding Epilepsy

Historically, epilepsy has been shrouded in mystery, myth, and superstition. Epilepsy was thought to be caused by demonic possession because of seizures and other characteristics associated with the disorder (Temkin, 1971; World Health Organization, 2003). However, in the last 100 years, enormous advances have been made in understanding the etiology, prognosis, and treatment of epilepsy. We now know that epilepsy is a disorder that affects the nervous system; it is also referred to as a seizure disorder. Epilepsy is usually diagnosed after a person has had two or more seizures that cannot be explained by another medical condition. In rare circumstances, epilepsy can also be diagnosed after a person has had one seizure if the person has a predisposing condition (Nurse, 2010).

A seizure occurs when there is a sudden surge of electrical activity in the brain which usually affects a person's movement or consciousness. Some seizures can hardly be noticed, while others are disabling. Symptoms vary among individuals and according to the specific type of seizure. Seizures are not a disease in themselves; they are a symptom of many different disorders that affect the brain. There are several types of seizures, which are classified into two groups: (a) primary generalized seizures, which begin with electrical discharge in

both lobes of the brain; and, (b) partial seizures, which begin with electrical discharge in one lobe of the brain. Table 1 outlines the types of seizures and examples of associated characteristics that may manifest. Seizures can be related to brain injury or genetic predisposition, but most of the time the cause is unknown (Nurse, 2010).

Despite the physiological, physical, and psychological symptoms, the stigma associated with epilepsy is often more burdensome than the disease itself (World Health Organization, 2012). Recent studies indicate that over 50% of people with epilepsy report feeling stigmatized (Baker, Brooks, Buck, & Jacoby, 2000; J. Taylor, Baker, & Jacoby, 2011). Comparatively, Jacoby (1994) found that only 14% of people whose epilepsy was in remission reported feeling stigmatized. For a person with epilepsy, the effects of stigma permeate all aspects of their life and this stigma is associated with low quality of life (de Boer et al., 2008; Jacoby, 2002; Jacoby & Austin, 2007; World Health Organization, 2005). Research indicates that epilepsy-related stigma contributes to mental health issues (Jacoby, 2002), social isolation (Jacoby, 1994), lower quality of care (Jacoby, 2002), higher direct and indirect socioeconomic costs (Jennum et al., 2011), fewer employment opportunities (Fisher, 2000), and lower educational attainment (Fisher, 2000). Despite the vast advances in understanding epilepsy, the stigma associated with this disorder is still ubiquitous.

Table 1

Seizure Types and Characteristics

Seizure Type	Characteristics
Partial	
Simple (awareness is retained)	Jerking, muscle rigidity, spasms, head-turning, unusual sensations affecting vision, hearing, smell, taste or touch, stomach sensation, memory or emotional disturbances (e.g., déjà vu, fear)
Complex (impairment of awareness)	Automatisms such as lip smacking, chewing, fidgeting, walking, and other repetitive, stereotyped movements
Generalized	
Tonic-Clonic	Unconsciousness, convulsions, muscle rigidity
Absence	Brief loss of consciousness, blank stare, eyelid fluttering, eyes rolling up, chewing movements
Myoclonic	Sporadic (isolated) jerking movements
Tonic	Muscle stiffness, rigidity
Atonic	Loss of muscle tone that can result in a sudden collapse and fall to the ground

Note. Characteristics are examples only and are not meant to be an exhaustive list. Symptoms vary among individuals and according to the specific type of seizure. Adapted from Benbadis and Tatum (2001, p. 92) and Nurse (2010, p. 35).

Understanding Epilepsy-Related Stigma

In *Stigma: Notes on the management of spoiled identity*, Goffman refers to stigma as an “attribute that is deeply discrediting” (Goffman, 1963, p. 3). Since Goffman’s seminal book, researchers have reconceptualized his stigma theory. In keeping with Goffman’s caveat that a “language of relationships” (Goffman, 1963, p. 3) is needed to conceptualize stigma, Link and Phelan (2001, p. 366)

“propose that stigma be described with reference to the relationships between a set of interrelated concepts.” Link and Phelan define stigma as the co-occurrence of its components—labeling, stereotyping, separation, status loss, and discrimination—and further indicate that, for stigmatization to occur, power must be exercised. Additionally, Fishbein and Ajzen’s (1975) Theory of Reasoned Action explains how these concepts relate. Below Link and Phelan’s stigma concept and Fishbein and Ajzen’s Theory of Reasoned Action are used to conceptualize and understand epilepsy-related stigma.

Fishbein and Ajzen’s Theory of Reasoned Action suggests that knowledge impacts attitudes, attitudes in turn impact behavioural intent, and behavioural intent is a predictor of behaviour. These components, knowledge, attitudes, and behaviour, are important to understanding how labelling, stereotyping, separation, status loss, discrimination, and power, which are the components of Link and Phelan’s stigma concept, converge to produce stigma. According to Link and Phelan, people distinguish and label human differences. People with epilepsy are distinguished based on their neurological, physical, and psychological symptoms. Stereotyping occurs when a stereotype is attached to the label. Stereotypes are cognitive structures that contain the perceiver’s knowledge, beliefs, and expectations about social categories and groups (Hamilton & Sherman, 1994). Stereotypes are also overgeneralizations that are widely shared and they are “frequently, but not always, negative” (Jones & French, 1984, p. 155). According to Fishbein and Ajzen’s Theory of Reasoned Action, since stereotypes contain knowledge and knowledge impacts attitudes,

stereotypes impact attitudes. Petty and Cacioppo (1981, p. 7) define an attitude as “a general and enduring positive or negative feeling.” If perceivers have been exposed to incorrect or biased knowledge about epilepsy or people with epilepsy, this could lead to negative stereotypes and thus negative attitudes towards this group. In the case of people with epilepsy, the stereotypes are overwhelmingly negative. Common negative stereotypes include foaming at the mouth during a seizure (Baxendale & O’Toole, 2007) and the inability to do well in school (Prpic et al., 2003). These types of stereotypes can lead to negative attitudes, which can affect behavioural intent, which can in turn affect behaviour. According to Link and Phelan the behaviours relevant to the stigma concept are separation, devaluation, and discrimination. When groups of people are associated with negative attitudes, a rationale is constructed to separate “us” from “them.” Link and Phelan explain that efforts to separate “us” from “them” is evidenced in the labels used to describe social groups.

Incumbents are thought to "be" the thing they are labeled (Estroff 1989). For example, some people speak of persons as being "epileptics" or "schizophrenics" rather than describing them as having epilepsy or schizophrenia. This practice is revealing regarding this component of stigma because it is different for other diseases. A person has cancer, heart disease, or the flu—such a person is one of "us," a person who just happens to be beset by a serious illness. But a person is a "schizophrenic" (Link & Phelan, 2001, p. 370).

Negative attitudes can also result in devaluing a person or group's status. Additionally, negative attitudes can lead to discrimination. Discrimination refers to inappropriate treatment of or negative behaviours towards individuals because of their group membership (Dovidio, Brigham, Johnson, & Gaertner, 1996). Link and Phelan describe three types of discrimination: individual, structural, and perceived. Individual discrimination occurs when people overtly engage in discrimination directed at people with epilepsy, for example, refusing to date someone with epilepsy. Structural discrimination reflects policies and procedures whether intentional or unintentional, but whose consequences negatively impact people with epilepsy. An example of structural discrimination includes restrictions on driving privileges in many countries despite clear evidence that epilepsy is not associated with a higher accident rate (J. Taylor, Chadwick, & Johnson, 1996). The psychological processes operating through a person with epilepsy can also lead them to believe that they might be discriminated against. This process is commonly referred to as internalized, perceived, or felt stigma (Muhlbauer, 2002). Lastly, Link and Phelan emphasize that labeling, stereotyping, separation, and discrimination, converge to produce stigma in contexts where groups can exercise power over one another. With this understanding of epilepsy-related stigma, the following section examines the public's knowledge of, attitudes about, and behaviour towards people with epilepsy.

Knowledge of, Attitudes about, and Behaviours towards People with Epilepsy

Lack of knowledge about as well as negative attitudes and discriminatory behaviours towards people with epilepsy persist across all ages and levels of education and, consequently, stigma permeates all domains of life for this group. In a representative sample of adults aged 18 to 65 plus in the US population, Kobau and Price (2003) found that just one in five people have seen a seizure and only one third know someone with epilepsy. Just over 50% of participants thought that they would know what to do if someone had a seizure; of this group, participants aged 18 to 24 and 65 plus were the least confident in their ability to help someone having a seizure. Austin, Shafer, and Deering (2002) found similar results in adolescents aged 13 – 18 years. Participants in Austin et al.'s study had a general lack of familiarity and knowledge about epilepsy; students also held perceptions of epilepsy reflective of stigma. This lack of knowledge persists into higher education. Caixeta, Fernandes, Bell, Sander, and Li (2007) found that Arts and Science and first-year medical students had poor knowledge of epilepsy while third- and sixth-year medical students had only adequate knowledge of epilepsy.

Jacoby and colleagues have conducted several studies that investigate the knowledge levels and attitudes towards epilepsy in the workforce. While employers' attitudes to employment of people with epilepsy have improved over the years, misperceptions and negative views still exist. For instance, Jacoby, Gorry, and Baker (2005) found that 16% of employers thought that there were no

jobs suitable for people with epilepsy in their company and 72% thought that employing someone with epilepsy would be an issue. Additionally, employees rated epilepsy as the second most concerning illness that a co-worker could have, after stress/depression (Jacoby, Gorry, Gamble, & Baker, 2004).

Researchers have also found evidence of individual and structural discrimination in employment settings. For instance, individuals with epilepsy have lower employment rates and lower income levels. The employment rate among people with epilepsy is only half that compared to control subjects and employed patients with epilepsy earn only half the income of employed control subjects. Additionally, 75% of people with epilepsy state that they have been harassed and experienced discrimination at work in terms of promotion, termination, and disciplinary practices (West, Dye, & McMahon, 2006).

Misperceptions and negative attitudes towards people with epilepsy are also apparent among teachers. Bishop & Boag (2006) found that the majority of teachers in their study thought that people with epilepsy were more likely to develop and express criminal tendencies compared to individuals without epilepsy. Teachers also reported that they lacked general knowledge about epilepsy, the impact of epilepsy in educational settings, and first aid for epilepsy in the classroom. In another study of teacher perceptions, Dantas, Cariri, Cariri, and Ribeiro Filho (2001) found that 2% of teachers thought that epilepsy was contagious whereas 7% did not know if it was contagious, 4% of teachers would object to having a student with epilepsy in their class, and, in terms of intelligence, 2% of teachers thought that students with epilepsy were not as

intelligent as others and 10% did not know if students with epilepsy were as intelligent as others.

Stigma also impacts the interpersonal relationships of people with epilepsy. Austin et al. found that only 31% of adolescents would date a person with epilepsy. Furthermore, people with epilepsy have lower marriage rates. Fisher (2000) recently reported that 51% of men with epilepsy were married, in contrast to 63% of men without epilepsy. Likewise, only 48% of women with epilepsy were married, compared with 59% of women without epilepsy.

Overall, it is fair to say that the general public has inaccurate information and negative attitudes towards people with epilepsy. Additionally, discriminatory behaviours are prevalent. The stigma affects all areas of life including employment, academic achievement, and interpersonal relationships. Thus, it is critical to investigate ways to decrease the stigma associated with epilepsy.

Decreasing Epilepsy-Related Stigma: School-Based Epilepsy Education Programs

There are several approaches that could potentially increase knowledge and foster positive attitudes about epilepsy. Researchers suggest that school-based epilepsy education is an especially important approach to achieve these goals for several reasons. One reason is that there are more than a billion young people world-wide of school age; they constitute the greatest readily reachable population for health education programs (Kolbe, Tolsma, Dhillon, O'Byrne, & Jones, 1992). Additionally, school-based epilepsy education is a feasible and low cost method to increase knowledge of and promote positive attitudes towards

epilepsy (World Health Organization, 2013). Lastly, research in the area of school-based stigma prevention and reduction demonstrates that these types of programs can be effective in changing knowledge and attitudes (Heijnders & Van Der Meij, 2006; Payne & Smith, 2010; Wahl, Susin, Lax, Kaplan, & Zatina, 2012; Weiss, Ramakrishna, & Somma, 2006). For these reasons, several school-based epilepsy education programs have been created. In addition to developing epilepsy education programs, however, the WHO, ILAE, and IBE indicate the need to evaluate these programs (World Health Organization, 2003).

Evaluating School-Based Epilepsy Education Programs

Evaluation is generally defined as gathering information to make decisions (Gay, 1985). Gay (1985) argues that the aim of school-based program evaluation or curriculum evaluation is to identify the strengths and weaknesses of the program, isolate the issues encountered during implementation, establish the effectiveness of the curriculum, and to determine the cost-effectiveness of the program. The most common approaches to curriculum evaluation are impact, outcome, and implementation evaluations. Impact and outcome evaluations assess a program's effectiveness in achieving change on target variables, such as knowledge, attitudes, beliefs, or behaviour. While these evaluations are instrumental in determining a program's effectiveness, without accompanying implementation data, conclusions about the effectiveness of the program could be invalid (Durlak & DuPre, 2008). Fullan and Pomfret (1977) define implementation as the "actual use of an innovation or what an innovation consists of in practice" (p. 336). Research in the field of curriculum implementation is

positioned in one of two ways. The most popular position focuses on the degree of implementation or fidelity of an innovation. This focus is on investigating the extent to which the actual use of the innovation maps onto intended or planned use. The second position focuses on the implementation process and is concerned with exploring how innovations are used, developed, or changed during implementation (Fullan & Pomfret, 1977). Researchers in the field of implementation often refer to a new program, resource, and the like, as an innovation or change. Implementation is important to investigate for several reasons:

1. *Implementation affects program outcomes.* In the most recent systematic review of research, Durlak and DuPre (2008) examined over 500 studies to ascertain the relationship between implementation and outcomes. They found strong empirical support for the conclusion that implementation affects outcomes; this conclusion is supported by several meta-analyses (DuBois, Holloway, Valentine, & Cooper, 2002; Tobler, 1986; Wilson, Lipsey, & Derzon, 2003; Wilson & Lipsey, 2007).
2. *Implementation data are essential to assessing internal and external validity.* Accurate interpretation of outcomes depends on knowing what aspects of the program were delivered and how they were delivered (Durlak & DuPre, 2008). For instance, in examining changes in knowledge or attitudes due to an epilepsy education program, several outcomes can occur. We can observe no change in knowledge or more negative attitudes, for instance, if the program is not

implemented as intended. Furthermore, we can observe increases in knowledge and attitudes through an innovation that, in practice, was very different from the original resource. Valid judgments about the value of the original program would not be possible in either situation.

3. *Implementation data are important to theory testing.* Theories about programs and their components cannot be appropriately assessed without determining whether the components were effectively administered (Durlak & DuPre, 2008). For instance, Bandura's Social Learning Theory (1977) suggests that individuals modify their behaviors through observation, skill development, and practice. Any changes in behaviour that occur after using a program based on this theory could then conclude that Bandura's theory is valid. However, in reality we do not know if the program was used followed by a discussion, for example. In this case, we would not be certain if the change in behaviour was due to the program, the discussion, or both.
4. *Implementation data are important for early monitoring.* Investigating implementation can identify challenges or barriers to program application that can be corrected to ensure better outcomes (Durlak & DuPre, 2008).

Overall, it is fair to say that implementation is an important aspect of evaluation; however, these types of evaluations are often ignored (Durlak & DuPre, 2008). This is especially true of school-based epilepsy education programs. ERIC and PsycINFO were accessed through ProQuest to explore

search terms and locate all journal articles published between 1983 and 2013 that evaluate primary or secondary school epilepsy education programs that aim to increase the knowledge and/or positive attitudes towards people with epilepsy. A variety of methods were used to compile a list of relevant search terms, including elements of pearl growing (Bell, 2012; Hawkins & Wagers, 1982; Schlosser, Wendt, Bhavnani, & Nail-Chiwetalu, 2006) and pearl harvesting (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson, & Zimmerman, 2010). Keywords were extracted from the bibliographic information—title, abstract, descriptors, and identifiers—of key journal articles to create a comprehensive list of search terms. In total, just four evaluations of school-based epilepsy education programs were retrieved. None of these evaluations investigated implementation or the factors affecting implementation. These studies are reviewed below.

Hands, Millar, Walker, Copeman, and Henderson (2006) evaluated an epilepsy education program used in one class of students aged 9 – 11. The epilepsy education program was developed, implemented, and evaluated within the context of a case study of a health promotion project carried out by nursing students. The nursing students created the epilepsy education program for teachers to deliver to their students; however, the nursing students implemented the program during the evaluation. The program consisted of video clips, factual information, a demonstration, and a take-home learning pack. Although Hands et al. (2006) report gains in students' knowledge and more positive attitudes towards epilepsy, no empirical data are presented to support these claims. Bozkaya et al. (2010) found that their epilepsy education program was

associated with a significant increase in knowledge of and positive attitudes towards epilepsy. The program was delivered by a pediatric neurologist with students aged 11 – 16 years in three schools. The program consisted of a lecture, demonstrations, videos, and a discussion session. There were conflicting results on individual questions in comparison to the overall result. For instance, before the program, 46.0% of the students answered no to the following question: “Do you feel disturbed about having an epileptic friend in your classroom?” However, after the program, this proportion increased to 75.9%.

Two studies investigated scripted programs with Grade 5 students using a cluster randomized approach. In the first study, Mudge and Turner (1987) investigated the effectiveness of an epilepsy education program in increasing students’ knowledge about epilepsy. The program consisted of a 10 minute video that included 3 case studies of young people with absence, complex, and tonic-clonic epilepsy. The program also included three large photographs of the children in the case studies and a teacher's guide, which included activities to follow up the video. The program was delivered in a standard format by the project officer. In the control condition, students did not receive the program and teachers were instructed not to teach students about epilepsy during the intervening six month period. At baseline, there was no difference in knowledge scores between the project and control groups. However, on the post-test questionnaire administered six months later, both groups scored significantly higher, with students who received the epilepsy education program scoring significantly higher than the control group on the post-test questionnaire and on

gain. The effect of the questionnaire on knowledge was investigated using a second control group that did not receive the intervention or the pre-test questionnaire. These students' scores on the post-test questionnaire were comparable to the post-test scores of the students in the control group. This finding indicates that the questionnaire did not contribute to the increased post-test scores observed in the control group. The authors suggest that this increase was due to maturity. Additionally, there were differences between regions and individual schools that were not explained by socioeconomic status or gender.

Similar to Mudge and Turner (1987), Martiniuk (2005) and Martiniuk, Speechley, Secco, Campbell, and Donner (2007)¹ evaluated the short-term effects of *Thinking about Epilepsy*, a 30 minute scripted program that aims to educate Grade 5 students on various knowledge and attitudinal concepts including the role of the brain in epilepsy, epilepsy first aid, and contagiousness. The program was delivered by an epilepsy educator and two epilepsy puppeteers. The intervention group demonstrated a significant increase in knowledge and positive attitudes towards epilepsy compared to the control group. Additionally, the education program accounted for 63% of the variation in post-program knowledge and 28% of the variation in post-program attitudes. Martiniuk (2005) also investigated how the learning environment affected outcomes and found that it significantly predicted post-test knowledge and attitude scores.

¹ A comprehensive account of the study's impact and process evaluations are reported in Martiniuk's (2005) dissertation. An abridged account of the same study (excluding information on the process evaluation) was published by Martiniuk, Speechley, Secco, Campbell, and Donner (2007).

Summary and discussion.

In the last thirty years, only four studies have been published that evaluate school-based epilepsy education programs: Hands, Millar, Walker, Copeman, and Henderson (2006), Bozkaya et al. (2010), Mudge and Turner (1987), and Martiniuk, Speechley, Secco, Campbell, and Donner (2007). While the impact evaluations of these programs show promising results, without implementation data it is difficult to make conclusive judgements about their effectiveness. For instance, Bozkaya et al. (2010) reported that the proportion of students who felt disturbed about having a friend with epilepsy in the classroom increased after the epilepsy education program. This result is the opposite of what one would expect after using an epilepsy education program that aims to increase knowledge and foster positive attitudes towards epilepsy. Because the authors did not investigate the implementation of the program, it is difficult to pinpoint the variables that contributed to this result. For instance, we do not know if the program was implemented as intended. We also do not know what happened during the discussion session where the questions and answers could have influenced the outcomes obtained. Furthermore, although Martiniuk (2005) investigated how the learning environment affected outcomes, she did not explore how the learning environment affects implementation. Information on how the learning environment affects implementation could provide essential information on changes that need to be made to the program or implementation to ensure that the learning environment does not negatively impact outcomes.

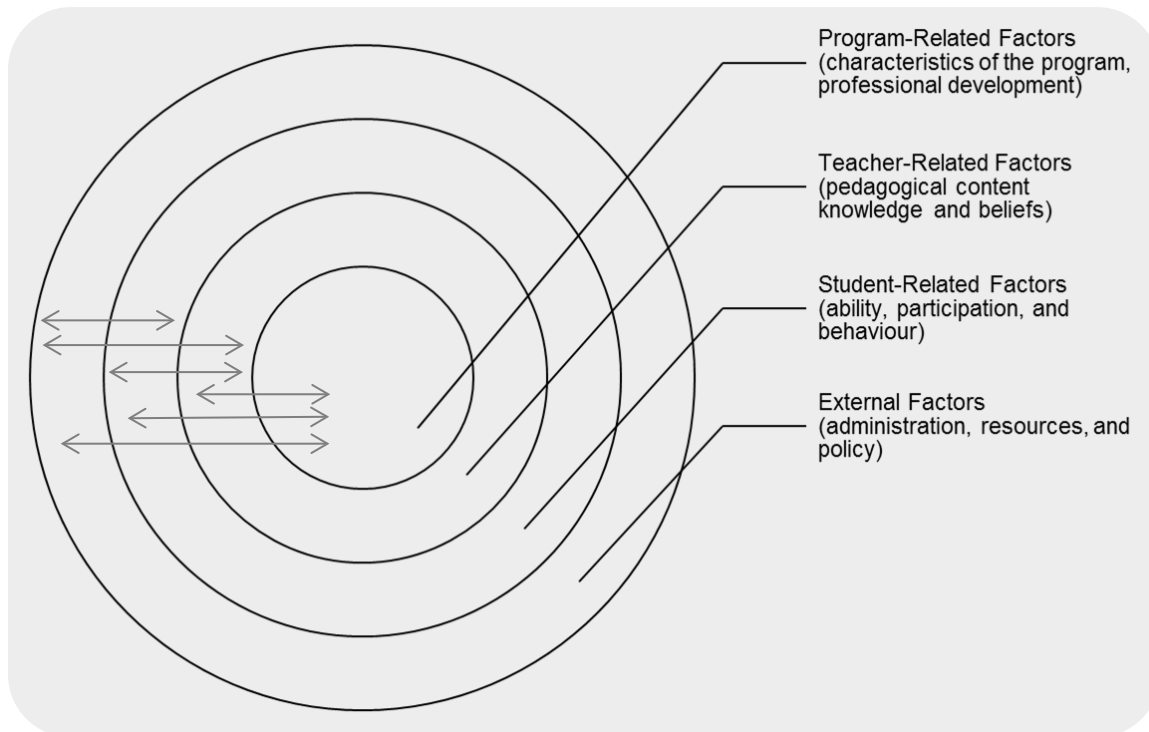
The epilepsy education programs evaluated by Hands, Millar, Walker, Copeman, and Henderson (2006) and Mudge and Turner (1987) are intended for use by teachers; however, in the evaluation, the program was implemented by the researchers instead. Additionally, Mudge and Turner (1987) and Martiniuk, Speechley, Secco, Campbell, and Donner (2007) used scripted programs. While programs with these features eliminate the influence of confounding variables that may influence outcomes, they do not represent the real classroom environment where teachers and students interact to negotiate knowledge acquisition. Additionally, none of the studies reviewed explore the factors affecting implementation. This means that even if the program is successful in increasing knowledge and positive attitudes, there could be barriers and challenges that teachers face in the classroom. Thus, it would be difficult to ascertain if the program would have the same effect. The limitations of these studies demonstrate the pivotal importance of examining implementation and the factors affecting implementation. The following section reviews studies that investigate these concepts.

Factors Affecting Implementation

It is important to investigate the factors affecting curriculum implementation to identify challenges or barriers to program application that can be remediated to ensure better outcomes (Durlak & DuPre, 2008). Several researchers suggest that a multilevel ecological framework is necessary to understand the factors affecting implementation (Altschuld, Kumar, Smith, & Goodway, 1999; Durlak & DuPre, 2008; Riley, Taylor, & Elliott, 2001; Shediac-

Rizkallah & Bone, 1998; Wandersman, 2003). Based on this suggestion and a review of relevant literature, I propose that the ecological framework for understanding the factors affecting teachers' implementation consists of nine factors within four overarching categories (Durlak & DuPre, 2008; Fixsen, Naoom, Blase, Friedman, & Wallace, 2005; Fullan, 1992; Fullan, 1994; Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004; Han & Weiss, 2005; Roehrig, Kruse, & Kern, 2007; Shavelson & Stern, 1981; Stith et al., 2006). This framework is depicted in Figure 1. Program-related factors lie in the centre of the diagram because it is hypothesized that any factors directly related to the program will have the greatest effect on implementation. As the factors labelled in the concentric circles move further away from the centre, they will have less effect on implementation. The arrows represent the interactions between the program, teachers, students, and the external environment. Program-related factors include resource characteristics and professional development, while the teacher-related factors central to implementation are pedagogical content knowledge and beliefs. In comparison, student-related factors, such as ability, participation, and behaviour (Shavelson & Stern, 1981), are also central to implementation, but their investigation is outside the scope of this study. Additionally, several factors external to students, teachers, and programs affect implementation. These factors include administrative support, resources, and policy. Next is a discussion of each factor.

Figure 1

Ecological Framework for Understanding Teacher's Implementation**Program-related factors.*****Characteristics of the program.***

Several reviews of research indicate that characteristics of the program affect implementation (Durlak & DuPre, 2008; Fixsen et al., 2005; Greenhalgh et al., 2004; Stith et al., 2006). These characteristics are compatibility, adaptability, clarity, and complexity. Compatibility refers to the extent to which a program fits with teachers' perceived needs, practices, priorities, and values (Durlak & DuPre, 2008; Fullan, 1992; Fullan, 1994; Greenhalgh et al., 2004; Stith et al., 2006). In this study, I also subsume Fullan's concept of *quality and practicality* within the definition of compatibility because of their overlapping components:

Practical innovations are those that address salient student and teacher needs, that fit well with the teachers' situation (e.g., students, organizational setting, curriculum), and that include or result in concrete *how-to-do-it information*. The practicality of innovations also depends on the trade-off between the personal costs (time, effort, etc.) and actual benefits of getting and staying involved (Fullan, 1992, p. 36).

A review of the relevant literature indicates that the time required to implement a program is a significant component of compatibility that affects teachers' implementation (Crooks, Wolfe, Hughes, Jaffe, & Chiodo, 2008; DeWitt, Lohrmann, O'Neill, & Clark, 2011; Tobin & McRobbie, 1996; Wallace & Kang, 2004). For instance, Tobin and McRobbie (1996) and Wallace and Kang (2004) report that teachers felt rushed and did not have enough time to cover all of the program's content. Similarly, the majority of teachers in Crooks et al.'s (2008) study thought that the time required to implement the program and difficult-to-meet timeframes were the most significant barriers to implementation. In the majority of the instances where teachers felt as if they did not have enough time, they omitted components of the curriculum. Compatibility between programs and teachers leads to readily used practices and results in effective implementation (Durlak & DuPre, 2008; Greenhalgh et al., 2004). According to Stith et al. (2006), programs that have good compatibility tend to be responsive, cost-effective, culturally appropriate, and adaptable.

Adaptability (also referred to as flexibility, reinvention, or modification), is also consistently related to teachers' implementation (Durlak & DuPre, 2008;

Greenhalgh et al., 2004). Durlak and DuPre (2008) define adaptability as the “extent to which the proposed program can be modified to fit provider preferences, organizational practices, and community needs, values, and cultural norms” (p. 337). Programs that can be altered to meet teachers’ needs are more easily implemented and result in stronger implementation (Durlak & DuPre, 2008; Greenhalgh et al., 2004).

Another factor that affects teachers’ implementation is clarity. Fullan (1992; 1994) notes that the clarity of both the goals of a program and the means of implementation has a major impact on implementation. Teachers need to know what to do and how to do it in order to successfully implement innovative resources. Policies, written guides, and professional development can help teachers clarify the goals and means of implementation, but Fullan (1992) cautions that true understanding comes from experience with the resource in the classroom and reflection. However, clarity is not an end in itself: simple, insignificant changes can be very clear and easy to implement, while more challenging, worthwhile changes may not be easily understood. This leads to the fourth factor that affects teachers’ implementation: complexity.

Complexity refers to the “difficulty and extent of change required of the individuals responsible for implementation” (Fullan, 1994, p. 2841). Fullan refers to five elements that impact complexity: difficulty, skill required, and the degree of change in beliefs, teaching strategies, and use of materials. Although simple changes may be easier to enact, they may not result in significant changes in practice (Fullan, 1994; Greenhalgh et al., 2004). Significant changes can be

achieved with complex programs, but they tend to create more issues during implementation and require more effort to implement. To overcome these issues, complex changes can be broken down into more manageable components and implemented incrementally (Fullan, 1994; Greenhalgh et al., 2004).

Professional development.

Professional development refers to approaches to ensure teacher proficiencies in the skills necessary to implement innovative practices (Durlak & DuPre, 2008). A review of relevant literature indicates that professional development impacts teachers' behaviour in the classroom (Capps, Crawford, & Conostas, 2012; Desimone, Porter, Garet, Yoon, & Birman, 2002; Garet, Porter, Desimone, Birman, & Yoon, 2001; Grigg, Kelly, Gamoran, & Borman, 2013; Roehrig, Michlin, Schmitt, MacNabb, & Dubinsky, 2012). Professional development that focuses on specific practices increases teachers' use of those practices in the classroom (Desimone et al., 2002; Grigg et al., 2013). While professional development is considered an essential vehicle for effecting teachers' practice, the effects are moderated by changes in teachers' knowledge and beliefs (Capps et al., 2012; Desimone et al., 2002; Roehrig & Kruse, 2005; Roehrig et al., 2012).

Several studies indicate that specific features of professional development are related to changes in teachers' knowledge, beliefs, and ultimately practice (Desimone et al., 2002; Durlak & DuPre, 2008; Garet et al., 2001; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Garet et al. (2001) identify six features of professional development that had significant, positive effects on teachers'

self-reported increases in knowledge, skills, and changes in classroom practice: (a) emphasis on content knowledge; (b) active learning; (c) coherence with other learning activities; (d) the form of the activity; (e) collective participation of teachers from the same school, grade, or subject; and (f) duration. Durlak and DuPre (2008) also suggest that it is important for professional development programs to attend to teachers' expectations, motivation, and sense of self-efficacy.

Teacher-related factors.

Teacher-related factors refer to the internal, personal characteristics of teachers that influence their implementation of innovative curricular resources.

Pedagogical content knowledge and beliefs.

A review of the literature indicates that teachers' pedagogical content knowledge and beliefs, which includes knowledge and beliefs about students, learning, teaching, and subject matter, influence implementation (Cronin-Jones, 1991; Gess-Newsome, 2002; Han & Weiss, 2005; Levitt, 2002; Roehrig & Kruse, 2005; Roehrig et al., 2007; Tobin & McRobbie, 1996; Wallace & Kang, 2004). For instance, Roehrig & Kruse (2005) found that teachers' beliefs were critical to the implementation of the curriculum and associated instructional strategies. Cronin-Jones (1991) identifies four major categories of beliefs that influence curriculum implementation: beliefs about how students learn, the teacher's role in the classroom, students' ability levels, and the importance of the content. Additionally, Tobin and McRobbie (1996) report that participants in their study subscribed to four "myths" related to the transmission of knowledge, being

efficient, maintaining the rigor of the curriculum, and preparing students to be successful on examinations. Wallace and Kang (2004) also report that teachers felt they had to be efficient in covering the program's content and Han and Weiss (2005) found that teachers prefer time-efficient programs. In addition to efficiency, Wallace and Kang found that the beliefs of teachers in their study mapped onto the beliefs of teachers in Tobin and McRobbie's study, and these beliefs constrained teachers' implementation of inquiry-based science curricula. However, the teachers in Wallace and Kang's study also had beliefs about the value of inquiry that promoted use of the program. Wallace and Kang suggest that teachers have competing belief sets that can act to facilitate or hinder implementation. This occurs because teachers internalize cultural beliefs that permeate the school science culture. These internalized beliefs then act to mediate the implementation of innovative practice.

In another study of teachers' beliefs, Levitt (2002) found that teachers conceptualized teaching and learning science as a student-centred practice. However, teachers in this study also had beliefs and practices that were incongruent with the inquiry-based curriculum. In contrast to Wallace and Kang's conclusion of competing belief sets, Levitt suggests that teachers' beliefs about inquiry can be conceptualized as existing along a continuum that ranges from traditional to transitional to transformational beliefs. Levitt also concluded teachers' position on the continuum was related to their practices in the classroom.

Teachers' subject matter knowledge also influences their interaction with curricular materials. For instance, when teachers are unfamiliar with the subject matter they rely on resources such as textbooks and as they start to master the subject matter they rely less on these types of resources (Lantz & Kass, 1987). Furthermore, when teachers teach outside of their content area they include fewer details and connections to other topics and they also include more inaccurate information (Hashweh, 1987). These teachers also focus less on student understanding and rely more on managing and controlling their students work to stay within the boundaries of their expertise (Carlsen, 1991; Hollon, Roth, & Anderson, 1991). However, when teaching within their area of expertise, teachers include more details and connections to other concepts. Additionally, knowledgeable teachers are more inclined to modify activities or generate new ones (Hashweh, 1987). In her review of the literature, Gess-Newsome (2002) concludes that teachers do not use content that does not match their existing knowledge and beliefs.

External factors.

Several factors external to students, teachers, and the program affect implementation.

Administrative support.

Administrative support refers to the extent to which administrators support and encourage teachers during implementation. Research indicates that administrative support affects implementation (Crooks et al., 2008; DeWitt et al., 2011; Durlak & DuPre, 2008; Fixsen et al., 2005; Fullan, 1992; Greenhalgh et al.,

2004; Han & Weiss, 2005; Stith et al., 2006). In schools, the principal is the most influential administrator affecting teachers' implementation (Fullan, 1992; Fullan, 1994; Han & Weiss, 2005). Principals' attitudes and behaviour can have a significant impact on teachers' implementation of innovative resources (Fullan, Miles, & Taylor, 1980; D. C. Gottfredson, Fink, Skroban, & Gottfredson, 1997; D. C. Gottfredson & Gottfredson, 2002). Furthermore, the principal's support through allocation of resources, such as time devoted to the program and professional development, affects teachers' implementation (Han & Weiss, 2005).

Resources.

Adequate resources are consistently related to implementation (Durlak & DuPre, 2008; Fixsen et al., 2005; Fullan, 1992; Greenhalgh et al., 2004; Han & Weiss, 2005; Stith et al., 2006). The two most influential resources on teacher implementation identified in the literature are funding and release time for professional development (Fullan, 1992). Crooks et al. (2008) report that teachers identified ongoing training and funding as resources integral to sustaining the program. Furthermore, several studies report that programs are more likely to be implemented with dedicated and ongoing funding (Elliott, Taylor, Cameron, & Schabas, 1998; Fitzgerald, Ferlie, Wood, & Hawkins, 2002; Gustafson et al., 2003). Release time for professional development is also important because, as discussed previously, professional development significantly influences teachers' implementation of innovative resources.

Policy.

Policies have also been shown to affect implementation (Durlak & DuPre, 2008; Fixsen et al., 2005; Fullan, 1992; Greenhalgh et al., 2004); however, policies alone are not sufficient to ensure that changes are implemented with integrity. Policies can enhance implementation by securing administrative and financial resources (Durlak & DuPre, 2008). Policies can also impact teachers' behaviour in the classroom by mandating implementation. For instance, the Ontario Ministry of Education curriculum policy documents define what students are taught in Ontario public schools (Ministry of Education, 2008). The curriculum policy documents outline the knowledge and skill expectations for students according to subject and grade level. Several researchers have reported that curriculum expectations influence teachers' implementation (Tobin & McRobbie, 1996; Wallace & Kang, 2004).

Research Context

This thesis presents an evaluation of an epilepsy education program. Specifically, this study explores teachers' implementation of *Brain Matters* and the factors affecting their implementation. This study is part of a larger project that also investigates students' changes in knowledge and attitudes after teachers implement *Brain Matters*.

History and Development of *Brain Matters*

Brain Matters evolved out of the *Thinking about Epilepsy* project, an epilepsy education program for Ontario Grade 5 health and science students (Martiniuk, 2005; Martiniuk, Speechley, Secco, & Campbell, 2007; Martiniuk,

Speechley, Secco, Campbell, & Donner, 2007). The project was previously discussed in the section on evaluating school-based epilepsy education programs. In review, *Thinking about Epilepsy* is a 30-minute, scripted program that uses posters, photographs, a television commercial, a puppet show, and role play to teach about epilepsy. It was developed to address misunderstanding and negative attitudes about epilepsy. Results of the cluster randomized trial indicate significant increases in knowledge and more positive attitudes towards epilepsy.

Following the success of *Thinking about Epilepsy*, the Epilepsy Support Centre of London, Ontario initiated a series of pilot projects to assess secondary school students' knowledge of and attitudes towards people with epilepsy. Results from surveys and focus groups conducted with local secondary school students confirmed the pervasiveness of misunderstanding and negative attitudes towards this group (Epilepsy Support Centre, 2004). In light of these findings and in support of the global campaign against epilepsy, the Epilepsy Support Centre created a curricular resource, *Brain Matters: An Introduction to Neuroscience* (*Brain Matters*; Nurse, 2010). *Brain Matters* is a comprehensive, ready-to-use resource for Grade 12 Biology that examines the field of neuroscience using epilepsy as a way to explore key concepts. There are three overarching goals of *Brain Matters*:

1. increase knowledge about epilepsy and improve attitudes towards individuals with epilepsy in order to decrease the stigma associated with the condition;
2. teach seizure first aid; and

3. attract more students to epilepsy-related careers.

Consistent with research on stigma reduction strategies, the Epilepsy Support Centre proposes that, because of the relationship between knowledge, attitudes, and behaviour, *Brain Matters* will ultimately lead to a decrease in epilepsy-related stigma.

The development of *Brain Matters* was informed by several guiding principles and theories. Firstly, *Brain Matters* is aligned with the Grade 12 Biology curriculum. It is designed to fit within the homeostasis unit, which neuroscience is a part of, but it can also be integrated into other units as well. This allows for seamless integration between the content of *Brain Matters* and the neuroscience expectations of the Grade 12 Biology course. Furthermore, Corrigan's (2004) target-specific stigma change model implies that effective epilepsy education programs should be geared towards a specific influential group. Accordingly, *Brain Matters* targets Grade 12 Biology students who are more likely than their peers to obtain jobs that require contact with people with epilepsy (e.g., physician, neurologist, and dietician). Applying Bandura's Social Learning Theory (1977) to knowledge acquisition suggests that the most effective epilepsy education programs will use observation, skill development, and practice. As such, the development of *Brain Matters* was guided by this theory. Through the use of emotionally engaging videos of teens and young adults with epilepsy talking about their experiences, demonstrations, worksheets, and group activities, *Brain Matters* teaches students about epilepsy causes, manifestations, diagnoses, treatments, and first aid.

A team of university students, teachers, and neuroscientists collaborated to create *Brain Matters*. The resource underwent several revisions based on feedback from three local secondary school teachers, who piloted the unit with their senior science students.

Description of *Brain Matters*

Brain Matters consists of a 107 page Facilitator's Manual, Student's Manual, and companion DVD. Each manual is divided into four sections. Section 1: Basic Science explores concepts that are central to a deep understanding of seizure disorders. It covers neurons, action potentials, synapses as well as the lobes of the brain and their main functions. Section 2: Misfiring Neurons introduces seizure disorders and epilepsy. This section includes information about the causes, types of seizures, symptoms and first aid. Section 3: Careers in Neuroscience introduces epilepsy-related careers by investigating diagnostic and treatment options for people with epilepsy. Section 4: Group Work integrates knowledge from the previous three sections into worksheets, quizzes, and group activities.

The DVD consists of videos to support the material presented in the text. Relating to Section 1, the DVD includes animations of parts of a neuron, excitatory synapses, inhibitory synapses, and action potentials. Section 2 includes videos of teens describing the symptoms of their seizures, videos of teens having an absence seizure, complex partial seizure, and tonic-clonic seizure, as well as youth with epilepsy describing their abilities and accomplishments. Section 2 also has a four minute animation on seizure first aid.

Section 3 presents information on the roles of various neuroscience professionals such as EEG Technologist, Neuroscientist, and Speech Language Pathologist. Section 3 also includes a video on epilepsy surgery.

The Facilitator's Manual is delivered in print to teachers along with one copy of the DVD. The companion DVD also includes a Portable Document Format (PDF) of the Facilitator's Manual as well as a Student's Manual in PDF. The Student's Manual contains everything that the Facilitator's Manual contains, except it does not have the answers to worksheets and quizzes. All of the materials are open access.

Brain Matters was introduced to teachers through a professional development session. The length and structure of the professional development session varied from session to session and teachers volunteered to participate. The focus of the *Brain Matters* professional development session was to increase teachers' curricular knowledge of *Brain Matters* as a tool for teaching students about neuroscience, seizures, and epilepsy. The professional development session also sought to increase teachers' content knowledge of seizures and epilepsy. Inquiry-based strategies were emphasized throughout the sessions. The ultimate aim of the professional development session was to increase teachers' use of epilepsy-related content with their Grade 12 Biology students in order to enhance students' knowledge and positive attitudes towards epilepsy. A large part of the professional development session involved going through the video exercise, *Identifying Seizure Symptoms*, with teachers. The video exercise prescribed by *Brain Matters* consists of watching the video *Teens Describing*

What Their Seizures Look Like, which is included on the *Brain Matters* DVD, and filling out the accompanying worksheet (See Figure 2 for a copy of the worksheet). Based on the information that each teen in the video provided, students (and teachers during the professional development session) were instructed to fill out the worksheet; however, the worksheet could not be completed solely based on the information provided in the video. In the succeeding sections, when I use the terms video exercise or worksheet, I am referring to the items described above unless otherwise stated.

Brain Matters can be taught using a variety of instructional approaches and methods contingent upon teachers' professional judgement and preferences. *Brain Matters* is presented to teachers as a concise, research informed, neuroscience resource that uses seizure disorders to teach students about neuroscience. It is up to the teacher to decide what to teach and how to teach the material.

Figure 2

Video Exercise: Identifying Seizure Symptoms

Watch the video “Teens Describing What Their Seizures Look Like” *Section 2: Misfiring Neurons Cause Seizures*. Identify the seizure symptoms of each person in the video. Using the description that each person provides, complete as much of the table below as possible. Some of the seizure descriptions are more detailed than others. Make use of the information provided to determine as much as you can about each person’s seizure.

Teen	Seizure Symptoms	Focal or Generalized	For focal seizures:		Seizure Duration	Level of Awareness	Seizure Type(s)
			Brain Lobe(s)	Hemisphere L or R			
1. female							
2. female							
3. female							
4. female							
5. female							
6. male							
7. female							
8. female							
9. female							
10. female							
11. female							

Adapted from Nurse (2010, p. 77)

Significance of the Current Study

Several evaluations of school-based epilepsy education programs demonstrate increases in students' knowledge and positive attitudes (Bozkaya et al., 2010; Hands et al., 2006; Martiniuk, Speechley, Secco, Campbell, & Donner, 2007; Mudge & Turner, 1987). Despite the pivotal importance of implementation, none of these studies investigate the factors that affect teachers' implementation. It is important to investigate the factors affecting curriculum implementation to identify challenges or barriers to program application that can be remediated to ensure better outcomes (Durlak & DuPre, 2008). A review of the literature of the factors affecting implementation suggests that program, teacher, student, and external factors affect implementation. However, each curriculum and context is unique and teachers' selection of materials, how they use these materials, and the factors affecting teachers' selection and use of these materials will differ accordingly. Thus it is important to investigate the factors affecting implementation for each curriculum and context.

The purpose of this study is to investigate the factors affecting teachers' implementation of an innovative school-based epilepsy education resource, *Brain Matters: An Introduction to Neuroscience* (Brain Matters; Nurse, 2010). This study is exploratory in nature to identify these factors as they emerge in the natural implementation setting. Investigating the implementation of *Brain Matters* will provide curriculum developers with information crucial to making decisions about program revisions and improvements to ensure continued resource allocation and sustainability within Grade 12 Biology classrooms. Continued use

will further promote epilepsy-related stigma prevention and help reduce the current stigma.

Research Questions

The current study will investigate the factors affecting teachers' implementation. To investigate the factors that affect teachers' implementation of *Brain Matters*, more specific questions that were considered included:

- What factors influence what teachers use from *Brain Matters*?
- What factors influence how teachers use *Brain Matters*?

This study is exploratory in nature to identify these factors as they emerge in the natural implementation setting.

Method

The goal of this study was to investigate teachers' implementation of *Brain Matters* and to identify the factors that affected their implementation. The Epilepsy Support Centre invited Grade 12 Biology teachers to attend a professional development session on *Brain Matters*. Teachers voluntarily selected to attend the professional development session and to use the resource with their Grade 12 Biology class. The research design of this study consisted of semi-structured interviews, which were used to explore teachers' implementation.

Ethical Approval

Before the start of the study, the research design, instruments, and procedures were approved by the Faculty of Education Sub-Research Ethics Board, which operates under the authority of The University of Western Ontario

Research Ethics Board for Non-Medical Research Involving Human Subjects. Ethics approval notices are included in Appendix A.

Participants

Eligibility and recruitment.

Teachers were recruited from a public, urban, school board in Southwestern Ontario. Teachers were contacted by phone to determine if they were eligible for this study. The inclusion criteria for this study were Grade 12 Biology teachers who attended one or more *Brain Matters'* training sessions and:

- had used *Brain Matters* in at least one Grade 12 Biology class; *or*
- had never used *Brain Matters*, but were in the process of using *Brain Matters* in at least one Grade 12 Biology class; *or*
- had never used *Brain Matters*, but intended to use *Brain Matters* in at least one Grade 12 Biology class.

In instances where teachers had never used *Brain Matters*, but were in the process of using *Brain Matters* or intended to use *Brain Matters*, they had to have finished using the resource by the end of the school year to remain eligible to participate in this study. There were no specific criteria regarding the degree of teachers' implementation of *Brain Matters* other than the criteria specified above. That is, if Teacher A used two diagrams from *Brain Matters* and Teacher B used the entire resource, both teachers would have been eligible to participate in this study.

Ten teachers met the inclusion criteria. Eligible teachers were given information about this study and asked if they would like to participate. An

interview time and place was arranged with teachers that agreed to participate in this study ($n = 6$). One participant's interview is not included in the analysis due to technical difficulties during the recording process, making the final number of participants represented in the data analysis five ($n = 5$).

Participant profiles.

All of the demographic information was obtained by self-report. To ensure anonymity, I assigned and referred to each participant by a pseudonym during the interview and during transcription.

Edward. Edward has been teaching secondary level science for five years and he has been teaching Grade 12 Biology for four years. He has used *Brain Matters* more than once and at the time of the interview he was teaching Grade 12 Biology.

Denis. Denis has been teaching Grade 11 and 12 Biology for over 20 years. Denis has used *Brain Matters* with several of his classes. Also, at the time of the interview he was teaching Grade 12 Biology.

Amy. Amy did not provide information about her teaching experience. She has used *Brain Matters* in at least one of her Grade 12 Biology classes. At the time of the interview, Amy was not teaching Grade 12 Biology.

Dhanesari. Dhanesari has been teaching Grade 12 Biology for over 20 years. She has used *Brain Matters* at least once and at the time of the interview she was not teaching Grade 12 Biology.

Maita. Maita has been teaching Grade 12 Biology for 12 years. At the time of our interview, Maita had just completed teaching Grade 12 Biology using *Brain Matters*.

Measures

***Brain Matters* Teacher Checklist.**

The *Brain Matters* Teacher Checklist was developed to help teachers identify the content they used from *Brain Matters* and to help focus the interview (See Appendix B). The components of the checklist correspond to the sections and additional materials of the *Brain Matters* resource (e.g., demonstrations, worksheets, videos, etc.).

Teacher interview guide.

The interview guide consists of a mix of fixed-alternative items that allows the respondent to choose from two or three alternatives and open-ended items. The interview questions focus on broad themes about teachers' implementation choices and rationales (See Appendix C).

Data Collection

Teachers were emailed the *Brain Matters* Teacher Checklist and asked to refer to their lesson plans before the interview to assist in identifying the content that they used. Before commencing the interview I reviewed the study details and obtained informed consent (See Appendix D for a copy of the letter of information and consent form). Interviews were audiotaped and lasted from 35 to 49 minutes. At the beginning of each interview I asked teachers for basic demographic

information. After each interview I recorded field notes to capture details and information not amenable to audiotaping.

Data Analysis

Implementing a new curriculum or curricular resource such as *Brain Matters* involves dynamic, interactive processes between the curriculum, the sociocultural environment of the school, the students, and the teacher's pedagogical perspective that quantitative research cannot adequately capture. For this reason, a qualitative content analysis approach (Krippendorff, 2013) was used to explore the complex interactions within these systems as they relate to teachers' implementation. Data analysis occurred during the data collection process and focused on teachers' implementation choices and rationales. The flexibility allowed within semi-structured interviews allowed me to probe topics that emerged during my discussions with teachers, but were not included in the interview guide. This approach allowed insight into issues that I had not previously considered, continuous meaning-making, and progressive focusing.

Interviews were transcribed verbatim with all personal identifiers removed. The transcripts were checked for accuracy and then loaded into the ATLAS.ti 7 qualitative data analysis program. Interview data were analyzed using a content analysis approach. Content analysis centers around coding statements based on their key concepts, clustering these coded concepts into themes, and delineating and refining these themes (Fiese & Bickham, 1998; Lincoln & Guba, 1985).

I analysed the data in three phases. In the first two phases I took an inductive approach to data analysis. Simply put, "inductive analysis means that

the patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis” (Patton, 1990, p. 390). In my first phase of data analysis, I read all of the transcripts with my research questions in mind. This step allowed me to get a sense of what teachers were saying and I started to think about codes. In the second phase of data analysis I coded statements using ATLAS.ti 7 and clustered these coded concepts into themes and subthemes. Themes and subthemes were generated when codes from three or more participants clustered together.

Next, I went back to my proposed ecological framework for understanding the factors affecting teacher’s implementation depicted in Figure 1. To develop this framework, I looked at literature from the fields of education, mental health, prevention science, and health promotion. Across these fields, the majority of the programs were implemented within the school context. A review of this literature revealed nine factors within four overarching categories (Durlak & DuPre, 2008; Fixsen et al., 2005; Fullan, 1992; Fullan, 1994; Greenhalgh et al., 2004; Han & Weiss, 2005; Shavelson & Stern, 1981; Stith et al., 2006). Additionally, several researchers had suggested that a multilevel ecological framework was necessary to understand the factors affecting implementation (Altschuld et al., 1999; Durlak & DuPre, 2008; Riley et al., 2001; Shediak-Rizkallah & Bone, 1998; Wandersman, 2003). Program-related factors include resource characteristics and professional development, while the teacher-related factors are pedagogical content knowledge and beliefs. Student-related factors are also central to

implementation, but their investigation is outside the scope of this study. The external factors include administrative support, resources, and policy.

In the third phase of data analysis I compared the themes and subthemes that had emerged to the framework that I created to determine if my data conformed to the framework. After reviewing the literature and refining the codes, I coded my data again using ATLAS.ti 7 and clustered the codes into themes. There were three overarching themes that I used to cluster codes: program-related, teacher-related, and external factors.

To ensure validity, the research team read all transcripts and assisted in the identification and definition of codes. A copy of the final version of the code book is included in Appendix E. To ensure codes were applied consistently a second coder independently coded 10% of the transcripts. The second coder was experienced in qualitative data analysis and I trained her to code this data set. Discrepancies were resolved by discussion. Inter-coder reliability was 83% indicating good reliability (Boyatzis, 1998).

Results

The purpose of this study was to explore the implementation of an innovative, school-based epilepsy education resource, *Brain Matters: An Introduction to Neuroscience* (Brain Matters; Nurse, 2010). The research questions that guided this study were:

- What factors influence what teachers use from *Brain Matters*?
- What factors influence how teachers use *Brain Matters*?

This study was exploratory in nature to identify the factors that affect teachers' implementation as they emerge in the natural implementation setting. The factors affecting teacher's implementation of *Brain Matters* fell into two overarching categories: program-related and teacher-related factors.

Program-Related Factors

Teachers explained that program-specific factors affected how they implemented *Brain Matters*. These factors include characteristics of the resource and professional development.

Characteristics of the resource.

Teachers talked about characteristics of *Brain Matters* that influenced their implementation. Teachers emphasized the following three characteristics that influenced their use: compatibility, adaptability, and complexity.

Brain Matters was compatible with teachers' needs, practices, priorities, and values. For instance, teachers discussed that the content was concise and provided the right amount of detail for themselves and their students. Amy explained that:

I liked it because for me it gave me enough detail so I could answer their questions. Some of that went into a lot of detail which is good. I didn't think it was above them. Yeah, I thought it was just where it should be at actually. (Amy)

Additionally, teachers said that their textbook was old and so to keep current in the field of neuroscience generally, including the information about seizures and epilepsy, they referred to *Brain Matters*. As well, teachers thought

of *Brain Matters* as a trustworthy source of information that they could share with their students. Teachers also repeatedly mentioned that *Brain Matters* was high quality. They explained that it was professionally done and the graphics, print and video, were amazing. In describing the DVD Denis said, “The digital media is invaluable I think. It’s just a bonus!” The concise, detailed, current, and refereed material meant that teachers did not have to spend time looking for other resources on neuroscience. These features of the resource were especially important for teachers that had little knowledge of seizures or epilepsy. Another aspect of compatibility that affected implementation was that *Brain Matters* was similar to resources that teachers already had. Teachers expressed that where they had already developed materials or the textbook had similar information they used these other resources instead of *Brain Matters*:

I've developed a lot of materials that I've used to teach this. . . . Again, I guess part of it is because I have done, I have a lot of demos that I've been using. Again with the images of the brain, I have graphics that I've used just like this, exactly like this. I have even images like this up on I have a website that I tend to use. (Denis)

Lastly, teachers explained that the time required for implementation affected their implementation of *Brain Matters* in several ways. Generally, teachers used time to explain why they were not able to use sections of the resource. Teachers discussed having to manage their time and thus prioritize the material that they used from *Brain Matters*. As Dhanesari lamented, “there is no way you can teach this in the amount of time that we traditionally allot to it.”

Teachers described that they only had a few days to one week to cover the nervous system and felt that the entire *Brain Matters* resource had a few weeks' worth of content. Dhanesari called it a "small neurophysiology course." Four teachers expressed running out of time, not having enough time, and the time constraints of the Grade 12 Biology curriculum as a reason for not using specific material from *Brain Matters*; generally, these materials included the demonstrations and the careers section:

The labs they were good ideas, but a lot of the time I find with the Grade 12 course, a lot of this, especially the last part, the careers part, I wanted to use more, but we only have so much time and I like to get the basics out and the extra stuff it's like you're running out of time. (Amy)

In the quote above, Amy makes the distinction between "the basics" and "extra stuff." Amy's distinction illustrates that teachers did not allocate time to certain sections of *Brain Matters* because they thought it was not as important as other material. In order to juggle the amount of material in *Brain Matters* and the curriculum expectations, teachers time management strategy including prioritizing certain sections of *Brain Matters* over others.

Teachers enjoyed the adaptability and flexibility of the resource in terms of being able to choose specific items to include in their lessons and being able to omit others. They also modified activities to better suit their specific teaching style and their students learning styles and preferences. For instance, each teacher who used the video exercise adapted it (See Teacher-Related Factors). Also, teachers were able to vary the amount of detail they shared with their

students based on their academic needs (See Teacher-Related Factors). In terms of the complexity of the resource, teachers thought that *Brain Matters* was easy to use. As Denis describes, “It’s easy to read and get information out of very quickly.” Teachers especially liked that the videos were split into snippets and the time was given for each snippet. This meant that teachers did not have to spend time cueing videos for their students.

Professional development.

Four teachers indicated that the professional development session influenced their implementation of *Brain Matters*:

So I think if we did not have that PD session and they said, “Ok, who wants this?” And I said, “Sure! I will have it.” And they sent it over. Then I would not have used it the same way. I would have probably used a lot less of it. And I don’t know if the students would have gotten as much out of it as they did. (Edward)

Similarly Maita explains:

If this was just sent to my school I wouldn’t have done it. It just takes too much time to try and figure it all out on your own, but in the workshop like she walked us through it and she even showed the videos and talked us through the videos and then you have the knowledge and organization to go ahead and teach it. Now, that’s just me I don’t know, maybe other teachers would take this over the summer and read it, but usually they don’t. (Maita)

Maita also expressed the value of having a model go through the material:

Teachers, we don't really like presenting stuff unless we really know it.

Who wants to present something that you haven't, you know, been walked through. Unless, if you're a physiology person, you're fine with this...

The video exercise² was part of each training session and teachers consistently mentioned that it influenced their implementation of *Brain Matters*. In the video exercise, teachers watched *Teens Describing What Their Seizures Look Like* and tried to fill out the accompanying worksheet with the information provided in the video. Teachers indicated that going through the video exercise influenced their decision to use the exercise with their students. The video exercise was framed using a problem-based approach and teachers indicated that that also influenced how they implemented the video exercise. As Denis explained, "We actually at the workshop used this and this got my brain working. I try to make my teaching more problem-based." Similarly, Edward expressed, "When it was presented to me we did it in a PD session in which we were trying to make this into a problem-based activity. So that's why I did it the way I did it."

Maita, who did not use the video exercise with her students, indicated that during her training session she found the activity challenging and consequently thought it would be difficult for her students:

But now, remembering how I was the first time I saw that, I think the students would have difficulty doing that. But, I haven't gone through it again, but that's my thought. I remember it being really tough and nobody

² The video exercise is described in detail in the section titled Description of *Brain Matters* (pages 38-39).

really knowing, what the heck, what number are we on and what sheet was that. (Maita)

Additionally, teachers only used *Brain Matters* in homeostasis. As Edward explains, this is because that was the way the resource was presented during his training session:

I think the way this was presented initially to me was this is great to use in homeostasis so I was like I guess I'll use this in homeostasis. Depending on how I use it, it would be useful to see how I can tie it into other things. Not necessarily in a direct way, but thinking of this activity, placing clues along the way, placing those little things in the back of their head and then when you come here [homeostasis] it's like, "oh yeah we did talk about that a little bit". So that might be useful just to insert little things in here and there. Also, it's helpful in terms of a lesson plan to say, "oh look here this is all based on stuff that's in the curriculum". (Edward)

The quote above also illustrates that Edward was not introduced to the curriculum ties document during his training session. This document could have helped him incorporate *Brain Matters* into strands other than homeostasis.

Three of the teachers reported that they were not introduced to the PDF material on the DVD during their training session. In fact, they only learned about the PDF material on the DVD through our interview. When asked if this material would have been useful, all teachers stated that the PDF material would have been invaluable. They explained that with the PDF material they would have

shared more with their students by posting the material online as a resource for their students to access as needed. As Amy said:

See no. I didn't know. I'm not very computer savvy. As you say that instead of having photocopied all those handouts I could have just put that up on the screen that one section for the kids like here's a good chart for you to refer to instead of handing them out and then collecting them at the end. I could see using it if I figured out how to. So again no, but it's something to keep in mind for next time.

Teacher-Related Factors

Teacher-related factors refer to the internal, personal characteristics of teachers that influenced their implementation. Teachers' pedagogical content knowledge and beliefs about students, learning, teaching, and subject matter influenced their implementation of *Brain Matters*.

Pedagogical content knowledge and beliefs.

Teachers' knowledge and beliefs about learning and teaching.

Teachers indicated that their knowledge and beliefs about how students learn and teaching methods influenced their implementation. Teachers selected materials from *Brain Matters* based on their potential to develop their students' motivation to learn and inspire an engaging learning experience. For instance, each teacher incorporated videos from the DVD into their teaching. Specifically, all teachers used the video, *Teens Describing What Their Seizures Look Like*³. Teachers used this video because it included "real teens" describing their

³ The video exercise is described in detail in the section titled Description of *Brain Matters* (pages 38-39).

experiences with epilepsy. Teachers believed that this video brought a level of “authenticity” and made learning about epilepsy “real” compared to reading about it in a textbook:

It just helps when they see real life application. It brings all the material, all the informative knowledge part much more to life. I think good application I guess. And I just thought they're going to remember this epilepsy part better than they are if I show them a brain and here're the lobes and here's this. So I just thought that it was really a good application. (Amy)

As Maita describes, another reason why teachers favoured videos was because they aligned with their students' learning preferences. Maita explains that students grasp material better when resources appeal to their visual sense:

I think they like the videos because it was something, it was visual, it was something different, it's not just from the textbook. I would say they preferred that over the textbook. . . . Even the ones of the neurons, the synapsis, were excellent. I think they got it much more watching that than just seeing it 2-D in their textbook. . . . Some of them are fine reading and they get it, but a lot of kids are visual. (Maita)

Amy's and Maita's thoughts above are illustrative of teachers' desires to motivate and engage their students to learn about neuroscience, seizures, and epilepsy. Teachers also strove to create a motivating and engaging learning environment by using inquiry-based strategies in their teaching.

Teachers used inquiry-based strategies to develop intrinsic motivation and engage their students. Teachers explained that inquiry-based strategies also

helped to develop their students' problem solving skills, cultivate their students' self-directed learning skills, and provide opportunities for their students to collaborate. For these reasons, teachers used inquiry-based strategies with the video exercise. In the video exercise, students watched *Teens Describing What Their Seizures Look Like* and filled out a worksheet; however, the worksheet could not be completed solely based on the information provided in the video. Four teachers incorporated a version of the video exercise into their teaching. Teachers presented the video exercise using inquiry-based strategies so that in pairs, students played the role of investigator to determine the questions they needed to ask and the resources they needed to complete the worksheet. Denis modified the worksheet to better align with his adaptation of the video exercise. This is what Denis had to say about using inquiry-based strategies with the video exercise:

They were more engaged. It was more fun for them instead of listening to me talk. They were finding their answers. I personally believe it's a better approach to learn – the problem-based learning. And my students say, by the time I turned them around to this, they don't want me to teach them anymore. Because they learn so much better from each other. And if they've got a question, I'm there. And they know that. But their ability to develop questions, ask questions about their patient [referring to the teens in the video *Teens Describing What Their Seizures Look Like*], about the world around them, and then find the answers for themselves is very rewarding for them. (Denis)

Denis and Edward further adapted the video exercise by creating an online environment for their students to complete a modified version of the worksheet, post questions, and connect with their classmates:

And they would be putting together a Wiki to collaborate as a group. With the Wiki they can put in information in a structure that we had gone over before. What is the problem? The problem is that there is a teen with some sort of seizure and we are trying to figure out more information about it. What do we know? Well, we know some information about what they describe in the video. And then, what do we need to know? Well these are some questions that we have. Post up the questions. (Edward)

Teachers chose materials and instructional strategies based on their potential to develop their students' motivation to learn and inspire an engaging learning experience. As Amy said, "The students they laughed actually they really enjoyed it. . . . So it was something that they paid attention to."

Teachers also thought that teaching should be efficient. For instance, Edward explained that he did not use the demonstrations because the amount of time needed to do a demonstration was disproportional to the learning outcome:

I guess I felt that in terms of the amount of time invested, the amount of outcome didn't sort of match that time. The idea that it was trying to present, I didn't think the time invested was worth that. I felt that there were things that I could do that would be getting the point across in a lot less time in terms of time management. (Edward)

In addition to teachers' knowledge and beliefs about learning and teaching, students' academic needs influenced how teachers implemented *Brain Matters*.

Teachers' knowledge and beliefs about their students' academic needs.

Another factor that affected teachers' implementation of *Brain Matters* was their students' academic needs. I identified three interconnected dimensions of students' academic needs that affected teachers' implementation of *Brain Matters*:

- students' informational needs which includes (a) teachers' perceptions of their students' need for conceptual and factual information related to neuroscience, seizures, and epilepsy (that is, information that teachers believe their students should know about neuroscience, seizures, and epilepsy) and (b) students' inquiries (that is, information for which students' ask);
- students' personal experiences; and
- students' academic ability (that is, their perceived potential to grasp concepts).

Students' informational needs.

Teachers chose to include concepts based on their perception of the neuroscience-related background information their students needed to know. There were several aspects that affected what teachers thought students should know. Teachers informally determined their students' informational needs based on the material students learned in their previous science courses and in other

sections of the course. Dhanesari explains that she did not use the demonstrations because she covered them in previous science courses or earlier in the Grade 12 Biology course:

Some of them are demonstrations I would have covered in previous science courses before grade 12, but others were just ones that I had covered in a different context earlier in the course. So I didn't need to go back. We had already done the cell membrane near to the beginning of the course closer to the biochemistry so I didn't need to go back and redo that. (Dhanesari)

Teachers' decisions to include background information from *Brain Matters* were also based on the Grade 12 Biology curriculum expectations. Below Dhanesari explains that the Grade 12 Biology curriculum emphasizes photosynthesis, cellular respiration, genetics, and biochemistry over homeostasis.

Basically just running out of time and so in the course, as I said we are lucky if we can come up with two weeks to do homeostasis at all and sometimes that's chopped short and because we spend more time on the other units on photosynthesis, and cellular respiration and genetics and bio chemistry those are kind of foundational you need to cover those. So homeostasis I am lucky if I get two weeks, and in those two weeks I usually cover the endocrine system and some components of the kidney as well, which is lucky if it leaves me about four days to do this and so I pick and choose what I could. I probably will use more of this at other

points in the course. I might use that resource on the cell membrane out of context of this and put it elsewhere in the course. (Dhanesari)

As Maita explains, her notion of what students needed to know was based on expectations in university science courses:

Usually we do photosynthesis and cell respiration next because it is the hardest but it is kind of the meat of the course because they see that again in first year university. Then you pick either genetics or this unit [homeostasis] to go next. . . . You can move it. You can change it however you like. The problem though, if you do, you could do this unit first. The problem is, in first and second year, there is really little anatomy in biology. You really wait until you specialize, there might be in second year physiology, if you even take it. So a lot of people think they want to leave it to last because it's not even in next year's curriculum. Photosynthesis and cell respiration is and so everyone always gets those done and then genetics is, so you do the genetics and then you just run out of time. . . . You always try to cover what they're going to need for next year. You want to prepare them well for next year so you end up focusing on those areas.

(Maita)

Another aspect that determined students' informational needs was teachers' personal experiences. Amy related a story that illustrates that her personal experience of witnessing a person having a seizure determined that her students should know seizure first-aid procedures.

The other thing I would talk about was the first aid on page 34 because it occurred to me I was at a restaurant and my waitress had a seizure right in the middle so in that sense I had never seen one before but we were going through this and I thought this is something important for the students to understand so I relayed that story and then went through using the DVD that they had and the good little points the kids thought it was funny but then we discussed it afterwards and how it's important going through the procedure you should follow and all of that. (Amy)

Students' inquires.

In addition to teachers' perceptions of their students' needs for background information, students' inquiries influenced how teachers implemented *Brain Matters*. As Dhanesari said, "my students' questions are very much what I use to prepare the content and teaching." Each teacher explained that students asked questions to clarify or expand concepts. Teachers attended to their students' inquiries by answering individual questions, addressing questions as a class if several students had the same question, and, as Denis explains, he allowed his students to watch relevant sections of the DVD to get the information they needed:

Sometimes in class if students wanted more I kind of put the DVD in and they would sit, because during this part of the course they are really working as groups on their netbooks or computers and they are working at their own pace. (Denis)

However, at times it appeared that there was not enough information on the DVD for students. Specifically, Denis and Edward relayed that their students' had difficulties filling out the video exercise worksheet because there was not enough information in the video *Teens Describing What Their Seizures Look Like*: "...students were saying that there wasn't enough. There wasn't enough to go on." Both teachers allowed their students to use resources in addition to the video to fill out the worksheet. Generally, students used online resources.

Denis also did an online search to find out if there was more information related to the video and found the *End Trash Talk* website (www.endtrashtalk.com). *End Trash Talk* was created by the Epilepsy Support Centre of London, Ontario. The website included *Teens Describing What Their Seizures Look Like*; however, the video was divided into clips so that each teen's experience with epilepsy was a separate clip. In addition, each video clip was longer and included more information. The *End Trash Talk* website also had additional teens talking about their experience with epilepsy. Denis stopped using *Teens Describing What Their Seizures Look Like* and started using the *End Trash Talk* website.

Students' personal experiences.

In addition to students' inquiries, their personal experiences shaped teachers' implementation of *Brain Matters*. Two teachers explained that the topic of concussion was salient in their class. As Dhanesari explains below, she focused on the relationship between concussions and epilepsy because of her students' inquiries and her students' personal experiences. The subject of

concussions was also in the news at the time because Sidney Crosby, a popular Canadian hockey player, had suffered a concussion.

It was basically because it happened in the same time frame within the days of me thinking about putting together the epilepsy activity, of them watching the students with epilepsy, and then of course the questions came from the students about what causes this, how do you get epilepsy. Page 36 answered that. And then because Sidney Crosby's story was on the news – we could have focused on shaking baby, alcohol and seizures, recreational drugs, genetic mutations, they were all in this list, they came up - but the one we spent the most time talking about was head injuries because it related to Sidney Crosby and also because a number of students in my class are in sports like hockey and so it just was a topic that came up. (Dhanesari)

Similarly, Amy explained that, “Even things like a lot of these concussions, again epilepsy is kind of tied to that. And that was something that was happening quite a bit in my class with the hockey right around there as well.” Both Dhanesari and Amy focused on the link between head injuries and epilepsy because students' had questions about the causes of epilepsy and it related to their personal experiences.

Students' academic ability.

Teachers included and omitted concepts based on their student's academic ability. Academic ability refers to students' perceived potential to grasp concepts. Generally, classes with a higher academic ability were given more

material from *Brain Matters*. As well, teachers shared more material and more complex concepts with individual students who had a higher academic ability:

Because sometimes it depends on your class. Like I didn't have a really strong class. So I had to probably slow things down. And when they got into the genetics it got very specific which for a high functioning group that would've been good. So it's nice to have the information close at hand so if I have a low functioning group you know we can work with it this way but right at my fingertips I have specifics that I'm not the expert, but this book is very helpful for me to turn to it. And again if I had students who wanted something extra or interesting we could maybe do a project on the careers or start the information about the careers. (Amy)

Teachers' subject matter knowledge and beliefs.

Teachers' subject matter knowledge and beliefs is comprised of two domains: (a) teachers' knowledge of neuroscience, seizures, and epilepsy; and (b) teachers' experience in teaching neuroscience and in using *Brain Matters*.

Teachers talked about prior knowledge of neuroscience, seizures, and epilepsy as a factor that influenced how they used *Brain Matters*. For instance, when I asked Amy if her knowledge of epilepsy or seizures influenced her decision to use the *Brain Matters* resource, this is what she had to say:

The fact that I knew not a lot. Yes, absolutely. Because just the fact that you think you know a lot about it and then you actually read it and find out, "oh I didn't know that". Absolutely. I thought I knew a lot it's just a genetic

thing that gets passed on and not at all. Yes, so I would say that was a huge factor. (Amy)

Teachers self-identified as having low prior knowledge or high prior knowledge about specific content in *Brain Matters*. In instances where teachers identified as having low prior knowledge, they referred to *Brain Matters* to increase their knowledge and understanding of neuroscience, and specifically about seizures and epilepsy. Many of the teachers did not have much prior knowledge about seizures or epilepsy so they used *Brain Matters* as a resource for themselves. As Amy commented, "Section 2 I really used because I didn't really know about epilepsy." In these instances, teachers referred to the text in two ways: (a) in preparation for their lesson, teachers would read the text and share material with their students; and (b) in response to their students' questions, teachers referred to *Brain Matters* to find the answers. As Edward said, "I kind of read the stuff as more background information for me in case I needed additional information to clarify anything." Additionally, teachers indicated that their knowledge had increased from using the resource and they were also interested in finding out more:

I say my knowledge is better but it just made me almost more curious like to find out a little bit more and read the other parts and the medication and all that. (Amy)

In addition to knowledge levels, teachers explained that their experience in teaching neuroscience and with *Brain Matters* affected how they implemented *Brain Matters*. Teaching experience and self-sufficiency affected teachers'

implementation of *Brain Matters* in several ways. For instance, Denis has been teaching Grade 12 Biology for over 20 years and has teaching aids that he is comfortable with so he did not feel the need to use the sections of *Brain Matters* that overlapped with his existing resources, "I'd been teaching this for quite a few years so I'm quite familiar with a lot of the stuff." Similarly, Edward explained that:

Well, because before I got this resource I taught this course a couple times. And when I taught it before I did teach about the neuron and how that works. So I had kinda some resources that I had developed from that, and I was pretty comfortable using, and it worked pretty well for me. But where I haven't and I don't have a whole lot of experience and haven't really gotten into is sort of the bigger aspect in terms of the brain and that sort of thing. So the reason why I used this is because I don't have a lot of experience with it and it was nice to get a sort of easy to understand take on it. Because I think there can be much more complex ways of looking at it. So it was good to have something that I can understand and my students would understand as well. Some of the other stuff I already had stuff developed. (Edward)

As another example of how teachers' experience with *Brain Matters* affected their implementation, below Denis explains that each time he used the resource, his teaching strategies evolved.

So I guess what evolved here is that I was presented. . . . we actually at the workshop used this [video exercise] and this got my brain working. I try to make my teaching more problem-based and more authentic which

engages the students a lot more. Instead of me teaching here's all the facts blah blah blah now apply it, I give them a problem and then they ask. So it [video exercise worksheet] kind of gave us an introduction the first time I did this [video exercise]. I haven't used this [video exercise worksheet] the second and third time I've done this. Because I kind of morphed it into this [refers to the worksheet he developed entitled "Nervous System Task Worksheet"]. But this [video exercise worksheet] was kind of the inspiration for me to go this way [Nervous System Task worksheet]. So I've changed it. (Denis)

This quote shows how the video exercise during Denis's training session piqued his interest in problem-based learning strategies. After attending the training session and receiving the resource, Denis tried to make his teaching more problem-based. Each time he used *Brain Matters*, his teaching practices evolved to embrace problem-based strategies. Denis also modified the materials presented in *Brain Matters* to align with his teaching goals.

Summary

The purpose of this study was to explore the implementation of an innovative, school-based epilepsy education resource, *Brain Matters: An Introduction to Neuroscience*. This study was exploratory in nature to identify the factors that affect teachers' implementation as they emerge in the natural implementation setting. The factors affecting teacher's implementation of *Brain Matters* fall into two overarching categories: program-related and teacher-related factors. There are two program-related factors important to the implementation of

Brain Matters. Teachers talked about characteristics of *Brain Matters* that influenced their implementation. Teachers emphasized the following three characteristics that influenced their use: compatibility, adaptability, and complexity. Additionally, professional development was important to teachers' implementation. The major teacher-related factor that emerged, pedagogical content knowledge and beliefs, is further divided into teachers' knowledge and beliefs about learning and teaching, teachers' knowledge and beliefs about their students' academic needs, and teachers' subject matter knowledge and beliefs. Three interconnected dimensions of teachers' knowledge and beliefs about their students' academic needs emerged in this study: Students' informational needs, personal experiences, and academic ability. Additionally, teachers' subject matter knowledge and beliefs is comprised of two domains: (a) knowledge of neuroscience, seizures, and epilepsy; and (b) experience in teaching neuroscience and in using *Brain Matters*. The following discussion relates these findings to previous research and discusses the corresponding implications for stigma-reduction programs.

Discussion

The purpose of this study was to explore teachers' implementation and consistent with previous research, a multilevel ecological framework was used to understand the factors affecting teachers' implementation (See Figure 1). Analyses indicate that characteristics of the resource, professional development, and pedagogical content knowledge and beliefs affected implementation; however, there was little indication of the impact of external factors such as

administrative support, resources, and policy. Furthermore, while it was not a focus of this study to determine the complex relationships between factors, the findings do highlight these relationships and they are touched upon throughout this section. Overall, the common thread uniting the factors was teachers' pedagogical content knowledge and beliefs. The following section relates the findings to previous research and discusses the corresponding implications for stigma-reduction programs.

Factors Affecting Implementation

Teacher-related factors.

Pedagogical content knowledge and beliefs.

The results of this study indicate that teachers' pedagogical content knowledge and beliefs, which include knowledge and beliefs about students, learning, teaching, and subject matter, influence implementation. Teachers had three predominant pedagogical content knowledge and belief strands that affected their implementation of *Brain Matters*. The first strand reflected teachers' ideas about motivation, engagement, and their students' academic needs, which functioned to facilitate teachers' use of *Brain Matters*. The second strand reflected ideas about efficiency, preparation, conceptual complexity, and the relative importance of the Grade 12 Biology curriculum content. Generally, these beliefs deterred teachers' from using *Brain Matters*. Teachers' third pedagogical content knowledge and belief strand reflected the importance of learning new subject matter and previous teaching experience. These pedagogical content knowledge and belief strands are discussed next.

Teachers in this study had thoughts and practices that reflected their pedagogical content knowledge and beliefs about motivation, engagement, and their students' academic needs. Each teacher believed that engaging and developing intrinsic motivation are important. This finding is in line with previous research. Teachers in Levitt's (2002) study thought that teaching and learning science should be student-centered and Wallace and Kang (2004) found that teachers believed that students are learning science when they are engaged. This knowledge and belief system functioned to facilitate teachers' use of *Brain Matters*. For instance, teachers indicated that they selected videos to engage their students and they specifically used the video exercise, *Identifying Seizure Symptoms*, for this reason. Teachers also modified components of *Brain Matters* to fit with their knowledge and beliefs that inquiry-based strategies were best for developing students' intrinsic motivation and engaging them with the material to promote academic achievement. Roehrig and Kruse (2005) and Roehrig, Kruse, and Kern (2007) also found that teachers with inquiry beliefs had classroom practices that supported these beliefs. Moreover, teachers' pedagogical content knowledge and beliefs about motivation and engagement are validated by the literature. Inquiry-based science instruction provides for pedagogical practices that motivate and engage students as a means to increase their conceptual understanding (Minner, Levy, & Century, 2010). Additionally, teachers' perceptions of the outcomes of using inquiry-based strategies is validated by Minner et al., (2010) synthesis of inquiry-based science instruction: They conclude that inquiry-based science instruction is more likely to increase

conceptual understanding than passive techniques. Furthermore, Fredricks, Blumenfeld, and Paris's (2004) review of the outcomes of engagement conclude that there is a positive correlation between engagement and achievement-related outcomes. Teachers in this study also reported that their students were actually more motivated and engaged when using components of *Brain Matters* with inquiry-based strategies. This information provides evidence that students are engaged since teacher and student reports of engagement agree (Fredricks et al., 2004). Teachers in the current study also believed that accommodating their students' academic needs was important. Teachers attended to students' informational needs, questions, personal experiences, and academic abilities. Similarly, teachers in Cronin-Jones' (1991) study conveyed beliefs about their student's academic abilities and teachers in Levitt's study expressed that learning science should be personally meaningful to students. Overall, this knowledge and belief system functioned to facilitate teachers' use of *Brain Matters*. Similar studies also found that teachers' knowledge and beliefs about their students' academic needs affect their practice (Cronin-Jones, 1991; Gess-Newsome, 2002; Han & Weiss, 2005; Levitt, 2002; Tobin & McRobbie, 1996; Wallace & Kang, 2004).

The second pedagogical content knowledge and belief strand that emerged reflected views of efficiency, preparation, conceptual complexity, and the relative importance of the Grade 12 Biology curriculum content. For the most part, this pedagogical content knowledge and belief system worked to override teachers' implementation of *Brain Matters*, a finding that is in line with Wallace

and Kang's (2004) findings. Teachers in the current study indicated that they did not use the demonstrations because they were not an efficient teaching strategy. This conception of efficiency is also reflected in previous studies by Tobin and McRobbie (1996), Wallace and Kang (2004), and Han and Weiss (2005). Additionally, teachers' conceptions about preparing students for university meant that they excluded the demonstrations and careers section because they did not align with the content taught in first year university science courses. This finding is somewhat different from the findings of Tobin and McRobbie (1996) and Wallace and Kang (2004) who found that teachers held beliefs about preparing students for examinations. Another component of this belief strand includes teachers' views of the difficulty of the concepts included in *Brain Matters*. In instances where teachers thought that their students would not be able to grasp the concepts, teachers omitted the material entirely. Teachers' decisions about content that would be challenging for their students may in fact indicate gaps in their own knowledge. For example, teachers in Carlsen's (1991) study omitted material that was categorized as high-knowledge in order to control the topic of conversation within the confines of their own knowledge. Another component of this pedagogical content knowledge and belief strand that acted to constrain teachers' use of *Brain Matters* was teachers' ideas about the relative importance of the overall Grade 12 Biology curriculum content, a finding that is in line with findings from Cronin-Jones (1991). Teachers' emphasized photosynthesis, cellular respiration, genetics, and biochemistry over homeostasis, which meant that material from *Brain Matters* was also lower priority.

The third pedagogical content knowledge and belief strand reflected teachers' thoughts about learning new subject matter and previous teaching experience. Teachers' subject matter knowledge and beliefs are comprised of two domains: (a) knowledge of neuroscience, seizures, and epilepsy; and (b) experience in teaching neuroscience and in using *Brain Matters*. Teachers' beliefs about their knowledge of neuroscience, seizures, and epilepsy influenced how they used *Brain Matters* as a resource for themselves. In instances where teachers believed that they had low knowledge levels, but still wanted to include information about seizures and epilepsy, this facilitated their use of *Brain Matters*, whereas, when teachers believed that they had adequate levels of knowledge, they were less likely to use *Brain Matters*. Most of the teachers said that they did not have much prior knowledge about seizures or epilepsy so they used *Brain Matters* as a resource for themselves. This finding is in line with the findings from Lantz and Kass's (1987) study where teachers that were unfamiliar with the subject matter relied on resources such as textbooks. Teachers in the current study referred to *Brain Matters* in order to prepare for their lessons, provide their students with background information, and equip themselves with the knowledge to answer their students' questions. Teachers in Schneider and Krajcik's (2002) study used inquiry-based curriculum materials in a similar manner. This finding is also supported by Sherin and Drake (2009) who developed a curriculum strategy framework based on their study of teachers' use of a reform-based elementary mathematics curriculum. Sherin and Drake explicated various strategies that teachers used in reading the curriculum that map onto the strategies used by

teachers in this study. According to Sherin and Drake's curriculum strategy framework, teachers in this study read the curriculum for big ideas prior to instruction and read for details prior to and during instruction. Additionally, teachers explained that their experience in teaching neuroscience meant that they did not need to use components of *Brain Matters* with their students because they already had similar materials. Lantz and Kass (1987) also found that, as teachers gained more content background and teaching experience, they became more self-sufficient and relied less on innovative curriculum materials. Furthermore, each time teachers used *Brain Matters*, their lessons evolved to better align with their teaching philosophies. This finding illustrates that teachers' implementation is not a static process but instead a dynamic one that hinges on previous teaching experience. Teachers may include material one year, but omit it the following year or modify the material to fit with the needs of their students.

Program-Related Factors

Characteristics of the resource.

Compatibility, adaptability, and complexity all influenced teachers' implementation of *Brain Matters*. This finding is supported by several lines of research (Durlak & DuPre, 2008; Fullan, 1992; Fullan, 1994; Greenhalgh et al., 2004; Stith et al., 2006). Contrary to Fullan's (1992; 1994) findings, however, clarity did not emerge as a significant characteristic of the resource affecting teachers' implementation. Overall, *Brain Matters* was compatible with teachers' needs, practices, priorities, and values. Teachers in the current study valued that *Brain Matters* was concise, yet provided the right amount of detail for themselves

and their students. *Brain Matters* fulfilled teachers' need for an up-to-date neuroscience resource and the refereed material was essential to their practice. Additionally, teachers repeatedly mentioned that *Brain Matters* was high quality. They explained that it was professionally done and the graphics, print and video, were invaluable. These characteristics facilitated teachers' use of *Brain Matters*. However, some components of *Brain Matters* were comparable to and overlapped with other materials to which teachers' had access. This aspect again highlights how the factors interact and the importance of teachers' pedagogical content knowledge and beliefs. Teachers' experiences and beliefs about their self-sufficiency contributed to the conclusion that components of *Brain Matters* were similar to other resources. In these cases, teachers did not use *Brain Matters*. Time also illustrates how the various factors interact. Aspects of time, such as efficiency, which is described in the section on teacher-related factors, reflect teachers' knowledge and beliefs, but time is also an aspect of the program. In the latter case, the focus is on the time required to implement the resource. Teachers repeatedly expressed the fact that they ran out of time, did not have enough time, and the time constraints of the Grade 12 Biology curriculum as reasons for not using specific components of *Brain Matters*; generally, these components included the demonstrations and the careers section. Previous research also shows that the time required to implement a program created a challenge for teachers' implementation of the program (Crooks et al., 2008; DeWitt et al., 2011; Gess-Newsome, 2002; Han & Weiss, 2005; Tobin & McRobbie, 1996; Wallace & Kang, 2004).

Another characteristic that affected teachers' implementation was adaptability. Teachers enjoyed the flexibility of the resource in terms of being able to choose specific items to include in their lessons while omitting others. They also modified activities to better suit their specific teaching styles and their students' learning styles and preferences. Teachers also valued that *Brain Matters* was not complex to use. Adaptability and ease of use facilitated teachers' use of *Brain Matters*, a finding that is in line with previous research (Durlak & DuPre, 2008; Fullan, 1992; Fullan, 1994; Greenhalgh et al., 2004).

Professional development.

The findings of this study indicate that professional development had a significant impact on teachers' implementation of *Brain Matters*. This finding is corroborated by previous research (Capps et al., 2012; Desimone et al., 2002; Garet et al., 2001; Grigg et al., 2013; Roehrig et al., 2012). Four teachers explained that using the video exercise with inquiry-based strategies was a focus of the professional development session and this is why they decided to use this exercise with their students. This finding is in line with previous research, which indicates that professional development that focuses on specific practices increases teachers' use of those practices in the classroom (Desimone et al., 2002; Grigg et al., 2013). However, the one teacher who did not use the video exercise indicated that during her training session she found the activity challenging and consequently thought it would be difficult for her students. Additionally, teachers only used *Brain Matters* in their homeostasis units because it was presented as a resource for this unit and teachers did not use the PDF

material on the DVD because they were not introduced to it during their professional development sessions. However, teachers' reflected that, if they had not attended the professional development session, they would not have used the resource.

Summary and implications.

In the current study, the most important teacher-related factor that emerged was pedagogical content knowledge and beliefs. Teachers had three pedagogical content knowledge and belief strands. The first two strands reflect how teachers implemented *Brain Matters* with their students, while the third strand reflects how teachers used *Brain Matters* as a resource for themselves. The first pedagogical content knowledge and belief strand reflects teachers' views about motivation, engagement, and their students' academic needs, which generally facilitated teachers' use of *Brain Matters*. However, the second strand reflected views of efficiency, preparation, conceptual complexity, and the relative importance of the Grade 12 Biology curriculum content. This second strand generally presented a barrier to teachers' use of *Brain Matters* and is in opposition to teachers' views about motivation, engagement, and their students' academic needs. For instance, teachers' did not use the demonstrations because they were not efficient, but demonstrations can inspire motivation and create an engaging learning environment. This finding is similar to Wallace and Kang (2004) who also found that teachers had competing belief strands. Teachers' third pedagogical content knowledge and belief strand was comprised of their subject matter knowledge and beliefs and is further divided into (a) knowledge of

neuroscience, seizures, and epilepsy; and (b) experience in teaching neuroscience and in using *Brain Matters*. In instances where teachers believed that they had low knowledge levels, they were more inclined to use *Brain Matters* as a resource for themselves, whereas when teachers believed that they had adequate levels of knowledge, their use of *Brain Matters* as a resource for themselves was limited. A similar pattern was observed for teachers' conceptions of their teaching experience and self-sufficiency. Additionally, each time teachers used *Brain Matters*, their implementation evolved.

Teachers' pedagogical content knowledge and beliefs have significant implications for implementing school-based stigma-reduction programs like *Brain Matters*. The findings of this study illustrate that teachers have contradictory pedagogical content knowledge and belief systems that can act to facilitate or limit use of innovative curricular resources. It is important for school-based stigma-reduction programs to address teachers' pedagogical content knowledge and beliefs systems and ways of reconciling competing systems to promote implementation and, potentially, successful outcomes. In her review of the literature, Gess-Newsome (2002) concludes that teachers do not use that which does not match their existing knowledge and beliefs. Thus, one way to promote implementation is to align stigma-reduction programs with teachers' current pedagogical content knowledge and beliefs. For instance, further aligning *Brain Matters* with teachers' pedagogical content knowledge and beliefs about motivation and engagement by including inquiry-based lesson plans and activities could facilitate implementation and promote positive outcomes.

The findings of this study also indicate an unanticipated effect of *Brain Matters*: increased knowledge of seizures and epilepsy in teachers. Because teachers were unfamiliar with the content on seizures and epilepsy, they referred to *Brain Matters* to increase their knowledge of these topics. Materials that promote both teacher and student learning are referred to as educative curriculum materials and appear to be a promising approach to facilitate teacher learning that is necessary for improved practice (Schneider & Krajcik, 2002). Teachers' increases in knowledge could equip them with the facts and conceptual understanding to confidently and appropriately instruct students. This is important because, when teachers teach outside of their content area, they include fewer details and connections to other topics and they also include inaccurate information (Hashweh, 1987). These teachers also focus less on student understanding and rely more on managing and controlling their students' work to stay within the boundaries of their expertise (Carlsen, 1991; Hollon et al., 1991). Moreover, increased knowledge of seizures and epilepsy could affect teachers' attitudes, which could in turn affect their behaviour and lead to stigma-reduction in teachers. This is especially important because previous research has shown that teachers have misperceptions and negative attitudes towards students with epilepsy (Bishop & Boag, 2006; Dantas et al., 2001; Prpic et al., 2003).

In terms of the program-related factors that affected teachers' implementation, characteristics of the program and professional development were the most influential. Teachers emphasized the following three program

characteristics that influenced their use: compatibility, adaptability, and complexity. Two aspects of compatibility limited teachers' use of *Brain Matters*. The first characteristic was that *Brain Matters* was comparable to and overlapped with other available resources. While this characteristic limited teachers' use of *Brain Matters*, it may not have affected the overarching goal of *Brain Matters*, which is to increase students' knowledge of the neuroscience of epilepsy to decrease the stigma associated with the disorder. The second characteristic that limited teachers' use of *Brain Matters* was the amount of time needed to implement the program. This is also a challenge described by teachers in other studies of implementation (Crooks et al., 2008; DeWitt et al., 2011; Han & Weiss, 2005; Tobin & McRobbie, 1996; Wallace & Kang, 2004). As described in the section on teacher-related factors, homeostasis was not a priority and came at the end of the course. This usually meant that teachers felt rushed to finish the unit before the course ended. One way to overcome this barrier is to make explicit how *Brain Matters* connects to other units of the Grade 12 Biology course.

Overall, the professional development session served to facilitate teachers' use of the specific components of *Brain Matters* that were the focus of the session. The one teacher who did not use the video exercise believed that it was too difficult for her students. Similar to the findings of Durlak and DuPre (2008) and Garet et al. (2001), this finding suggests the importance of increasing teachers' subject matter knowledge and their sense of self-efficacy during professional development. This teacher's decision about content that would be

difficult for her students may in fact indicate gaps in her own knowledge. Therefore, focussing on the knowledge needed to complete the exercise and increasing teachers' self-efficacy beliefs could facilitate teachers' implementation. Additionally, increasing teachers' knowledge of the various features of the resource, for instance the curriculum ties document and the PDF material, could facilitate use of these components.

Limitations

There are several limitations to the current study. The first limitation of this study is that some teachers who participated in the professional development session did not use *Brain Matters* and were, therefore, ineligible to participate. Consequently, the results of this study do not represent the views of teachers who did not use the resource. The perspectives of teachers who did not use the resource could have contributed to a deeper understanding of teachers' decisions not to use the resource and the barriers to implementing innovative curricular resources such as *Brain Matters*. Another limitation to this study is that teachers voluntarily participated in the *Brain Matters*' professional development session and voluntarily chose to use *Brain Matters* in their Grade 12 Biology classes. This could mean that teachers in this study are more willing to use and engage with *Brain Matters* compared to teachers that have new curricular materials imposed on them. Thus, caution should be used in generalizing the results of this study to other groups of teachers.

Additionally, the retrospective interview used in this study poses some measurement challenges (Fang, 1996). Because the interview elicited teachers'

thoughts after using *Brain Matters*, issues of information retrieval come into play. Four teachers were interviewed about a year after using *Brain Matters*, while one teacher was interviewed about a week after using *Brain Matters*. Newly acquired information is stored in short-term memory and is readily available, whereas information stored in long-term memory is not directly available for processing and may be incomplete, reconstructed, or even invented (Ericsson & Simon, 1980). While this poses a challenge to data collection, efforts were taken in the current study to circumvent this issue. Specifically, teachers were emailed the *Brain Matters* Teacher Checklist and were encouraged to consult their lesson plans before the interview to assist them in identifying the content they had actually used.

Future Research

The findings of this study have several implications for future research on the implementation of non-mandated, innovative resources. Several studies have established that implementation affects program outcomes (DuBois et al., 2002; Durlak & DuPre, 2008; Tobler, 1986; Wilson et al., 2003; Wilson & Lipsey, 2007). As such, the next step in this program of research is to examine the relationship between teachers' implementation and changes in students' knowledge and attitudes. Another topic of inquiry concerns the framework used to conceptualize the factors affecting implementation. Consistent with previous research, a multilevel ecological framework was used to understand the factors affecting teachers' implementation (Altschuld et al., 1999; Durlak & DuPre, 2008; Riley et al., 2001; Shediak-Rizkallah & Bone, 1998; Wandersman, 2003). Future research

investigating the interactions between the factors and the relative influence of the factors on implementation would provide useful information to curriculum developers. Lastly, teachers' pedagogical content knowledge and beliefs were a common thread among the factors affecting implementation. Therefore, measuring teachers' knowledge of and beliefs about epilepsy and people with epilepsy to assess their impact on implementation would provide useful information for developers of stigma-reduction programs.

Conclusion

This study explored teachers' implementation of a school-based epilepsy education program and the factors affecting their implementation. Three factors emerged: pedagogical content knowledge and beliefs, characteristics of the resource, and professional development. The findings of this study suggest that the characteristics of the resource and professional development are moderated by teachers' pedagogical content knowledge and beliefs. These three factors worked to either facilitate or limit teachers' implementation. To ensure that teachers continue to use *Brain Matters* with their students to further promote epilepsy-related stigma prevention and to help reduce the current stigma, it is important to address these challenges to teachers' implementation. This can be achieved by further aligning *Brain Matters* with teachers' current pedagogical content knowledge and beliefs and by addressing pedagogical content knowledge and beliefs in professional development sessions.

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Appendix A: Ethical Approval



THE UNIVERSITY OF WESTERN ONTARIO FACULTY OF EDUCATION

USE OF HUMAN SUBJECTS - ETHICS APPROVAL NOTICE

Review Number: 1110-4
 Principal Investigator: Jacqueline Specht
 Student Name:
 Title: *Evaluation of Brain Matters, a neuroscience and epilepsy education program*
 Expiry Date: August 31, 2012
 Type: Faculty
 Ethics Approval Date: October 31, 2011
 Revision #:
 Documents Reviewed &
 Approved: UWO Protocol, Letters of Information & Consent

This is to notify you that the Faculty of Education Sub-Research Ethics Board (REB), which operates under the authority of The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects, according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario has granted approval to the above named research study on the date noted above. The approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the REB's periodic requests for surveillance and monitoring information.

During the course of the research, no deviations from, or changes to, the study or information/consent documents may be initiated without prior written approval from the REB, except for minor administrative aspects. Participants must receive a copy of the signed information/consent documentation. Investigators must promptly report to the Chair of the Faculty Sub-REB any adverse or unexpected experiences or events that are both serious and unexpected, and any new information which may adversely affect the safety of the subjects or the conduct of the study. In the event that any changes require a change in the information/consent documentation and/or recruitment advertisement, newly revised documents must be submitted to the Sub-REB for approval.

Dr. Alan Edmunds (Chair)

2011-2012 Faculty of Education Sub-Research Ethics Board

Dr. Alan Edmunds	Faculty of Education (Chair)
Dr. John Barnett	Faculty of Education
Dr. Farahnaz Faez	Faculty of Education
Dr. Wayne Martino	Faculty of Education
Dr. George Gadanidis	Faculty of Education
Dr. Elizabeth Nowicki	Faculty of Education
Dr. Immaculate Namukasa	Faculty of Education
Dr. Kari Veblen	Faculty of Music
Dr. Ruth Wright	Faculty of Music
Dr. Kevin Watson	Faculty of Music
Dr. Jason Brown	Faculty of Education, Associate Dean, Research (<i>ex officio</i>)
Dr. Goli Rezai-Rashti	Faculty of Education, Associate Dean, Graduate Programs (<i>ex officio</i>)
Dr. Susan Rodger	Faculty of Education, UWO Non-Medical Research Ethics Board (<i>ex officio</i>)

Western Education
WESTERN UNIVERSITY
FACULTY OF EDUCATION
USE OF HUMAN SUBJECTS - ETHICS APPROVAL NOTICE

Review Number: 1110-4
Principal Investigator: Jacqueline Specht
Student Name:
 Title: *Evaluation of Brain Matters, a neuroscience and epilepsy education program*
 Expiry Date: August 31, 2012
 Type: Faculty
Ethics Approval Date: March 1, 2012.
 Revision #: 1
Documents Reviewed &
 Approved: Revised Study Method, Revised Letter of Information for Teachers.

This is to notify you that the Faculty of Education Sub-Research Ethics Board (REB), which operates under the authority of the Western University Research Ethics Board for Non-Medical Research Involving Human Subjects, according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario has granted approval to the above named research study on the date noted above. The approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the REB's periodic requests for surveillance and monitoring information.

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Dr. Susan Rodger	Faculty of Education, Western Non-Medical Research Ethics Board (<i>ex officio</i>)

Appendix B: *Brain Matters* Teacher Checklist

Name: _____

Brain Matters Teacher Checklist

Instructions: Please check off the sections of the *Brain Matters* resource that you used with your Grade 12 biology class. Page references to the teacher manual are given in brackets.

Text	DVD	Demonstrations & Knowledge Application
Section 1: Basic Science		
The Brain		
<input type="checkbox"/> Overview of the brain (p. 2)		
Brain Function at the Cellular Level		
<input type="checkbox"/> Neurons (p. 3-10) <input type="checkbox"/> Glia (p. 3) <input type="checkbox"/> Diagram: Parts of a neuron (p. 4) <input type="checkbox"/> Action potentials (p. 14) <input type="checkbox"/> Synapses (p. 15)	<input type="checkbox"/> Overview of the human brain <input type="checkbox"/> Introduction to brain cells <input type="checkbox"/> Parts of the neuron (p. 4) <input type="checkbox"/> Excitatory synapse (p. 4) <input type="checkbox"/> Inhibitory synapse <input type="checkbox"/> Summation of synaptic Input <input type="checkbox"/> Action potentials (p.8) <input type="checkbox"/> Neuronal Networks <input type="checkbox"/> Seizures and epilepsy <input type="checkbox"/> Conclusion	<input type="checkbox"/> Demo #1: Membrane potential (p.11) <input type="checkbox"/> Demo #2: Cell membrane (p. 12) <input type="checkbox"/> Demo #3: Membrane transport (p.13) <input type="checkbox"/> Demo #4: Excitatory synapse (p. 16) <input type="checkbox"/> Demo #5: Inhibitory synapse (p. 17) <input type="checkbox"/> Worksheet: Parts of a neuron (p. 65)
Brain Function at the Whole Brain Level		
<input type="checkbox"/> Lobes of the brain and their functions (p. 18-27) <input type="checkbox"/> Diagram: Lobes of the brain (p. 19) <input type="checkbox"/> Historical background: Dr. Wilder Penfield (p. 26) <input type="checkbox"/> Summary table: Lobes of the brain (p. 27)	<input type="checkbox"/> Dr. Wilder Penfield (p. 24)	<input type="checkbox"/> Demo #6: Cortex (p. 20-21) <input type="checkbox"/> Worksheet: Brain lobe functions (p. 66)

Brain Matters Teacher Checklist

Instructions: Please check off the sections of the *Brain Matters* resource that you used with your Grade 12 biology class. Page references to the teacher manual are given in brackets.

Text	DVD	Demonstrations & Knowledge Application
Section 2: Misfiring Neurons Cause Seizures		
<input type="checkbox"/> Overview of seizures and epilepsy (p. 30)		
Seizures		
<input type="checkbox"/> Focal seizures (31-33) <input type="checkbox"/> Diagram: Lobes of the brain (p. 32) <input type="checkbox"/> Table: Manifestations of focal seizures (p. 33) <input type="checkbox"/> Generalized seizures (p. 34) <input type="checkbox"/> Table: Review of seizure types (p. 35)	<input type="checkbox"/> Teens describing what their seizures look like (p. 30) <input type="checkbox"/> Complex partial seizure (p. 31) <input type="checkbox"/> Absence seizure (p. 34) <input type="checkbox"/> Tonic-clonic seizure (p. 34)	<input type="checkbox"/> Quiz #1: Investigating seizures (p. 67-68) <input type="checkbox"/> Quiz #2: Types of seizures and associated syndromes (p. 69-74)
Epilepsy		
<input type="checkbox"/> General overview and causes (p. 36) <input type="checkbox"/> Post-traumatic epilepsy (p. 37-38) <input type="checkbox"/> Alcohol and drugs (p. 38) <input type="checkbox"/> Genetic mutations (p. 39-42) <input type="checkbox"/> Severe epilepsy syndromes (p. 42) <input type="checkbox"/> The faces of epilepsy & Impact of epilepsy (p. 43) <input type="checkbox"/> SUDEP (p. 48)	<input type="checkbox"/> Real world examples: Teens describing what it's like to live with epilepsy	<input type="checkbox"/> Quiz #3: General epilepsy (p. 75-76) <input type="checkbox"/> Video exercise: Identifying seizure symptoms (p. 77-81)
Seizure First Aid		
<input type="checkbox"/> First aid procedures (p. 44-45) <input type="checkbox"/> Seizure first aid review (p. 46-47)	<input type="checkbox"/> Do you know what to do? (stick person; p. 44)	

Brain Matters Teacher Checklist

Instructions: Please check off the sections of the *Brain Matters* resource that you used with your Grade 12 biology class. Page references to the teacher manual are given in brackets.

Text	DVD	Demonstrations & Knowledge Application
Section 3: Careers in Neuroscience – Diagnosing and Treating Epilepsy		
The Story of H.M.		
<input type="checkbox"/> H.M.: The man with no memory (p. 50-52)		
Diagnosing Epilepsy		
<input type="checkbox"/> Overview (p. 53) <input type="checkbox"/> EEG (p. 54-55) <input type="checkbox"/> Historical background: Herbert Jasper (p. 56) <input type="checkbox"/> Brain imaging (p. 57)	<input type="checkbox"/> Herbert Jasper video (p. 56)	<input type="checkbox"/> Quiz #4: Diagnosing and treating epilepsy (p. 82-87)
Treating Epilepsy		
<input type="checkbox"/> Medication (p. 58-59) <input type="checkbox"/> Brain surgery (p. 59 – 61) <input type="checkbox"/> Ketogenic diet (p. 62-63)	<input type="checkbox"/> Epilepsy surgery video (p. 59) <input type="checkbox"/> Real world examples: Nicole's story	<input type="checkbox"/> Case study #1: Diagnosing Mr. X <input type="checkbox"/> Case study #2: Diagnosing Diana <input type="checkbox"/> Case study #3: Diagnosing Alexis <input type="checkbox"/> Case study #4: Diagnosing John <input type="checkbox"/> Thinking in-depth about seizures and epilepsy (p. 96)
Career Connections		
<input type="checkbox"/> Epileptologist (p. 53) <input type="checkbox"/> EEG technician (p. 54) <input type="checkbox"/> Pharmacist (p. 58) <input type="checkbox"/> Pharmacologist (p. 58) <input type="checkbox"/> Neurosurgeon (p. 59) <input type="checkbox"/> Neuropsychologist (p. 61) <input type="checkbox"/> Dietician (p. 62)	<input type="checkbox"/> What is epilepsy <input type="checkbox"/> What causes epilepsy? <input type="checkbox"/> Neuroscientist <input type="checkbox"/> EEG technologist (p. 53) <input type="checkbox"/> Neuropsychologist (p. 52) <input type="checkbox"/> Psychologist <input type="checkbox"/> Treatments for epilepsy <input type="checkbox"/> Speech-language pathologist <input type="checkbox"/> Neuropathologist	

Appendix C: Teacher Interview Guide

1. What classes do you teach and how long have you taught these classes?

Name of Class	# of Years

2. There are 3 major sections in *Brain Matters*, each with subsections in blue. Using, the text as a guide, I want to talk with you about the sections that you used and the sections that you didn't use. If you can't remember if you used a section or not, please let me know that as well.

Did you use the _____ section? (Interviewer will use the *Brain Matters* Checklist and facilitator's manual to help focus the interview.)

→ **If yes,**

- How did you teach this section?
- What instructional methods did you use? (e.g., lecture, problem-based learning, case study, teacher presentation, etc.)
- Demonstrations
- Multimedia (DVD)
- Worksheets
- Tables
- Diagrams
- Quizzes
- Group work
- Case studies
- Why did you use _____. E.g., Demonstrations, multimedia, etc.
- Why didn't you use _____. E.g., Demonstrations, multimedia, etc.
- Did you adapt or modify *Brain Matters* in any way?
 - How adapted/modified?
 - Why adapted/modified?
- Did you use any other resources to teach this section?
 - E.g. textbook
 - Why/why not?

- How much time did you spend teaching this section?
- How did you decide how much time to spend on each section/subsection?
- Why did you decide to teach this section?
- How could this section be improved?
- Did you use the Glossary?
 - Yes or No
 - Why/Why not?
 - How did you use it?
- Did you share the PDF material (E.g., the student manual) included on the DVD with your students?
 - Yes or No
 - Why/Why not?
 - How did you share the PDF material?

→ **If no,**

- Why didn't you use this section?
- Is there a better place for this text in the Biology Curriculum? What about other courses?
- Where would you put it?

3. Did you use *Brain Matters* in Strand E (homeostasis)?

- Yes No
- Why/Why not?
- In what other Strands did you use the *Brain Matters* resource?
 - Refer to *Brain Matters* Curriculum Ties

4. Tell me what you think about the use of *Brain Matters* as a neuroscience resource.

- Is *Brain Matters* an effective way to teach neuroscience? Why? Why not?
- Does *Brain Matters* aid in the delivery of the Grade 12 Biology curriculum? How?
- Is *Brain Matters* a novel way of teaching neuroscience? Why? Why not?
- Do you think all teachers should use *Brain Matters*? Should it be incorporated into the Ontario Biology curriculum?
- What would you remove from *Brain Matters*?
- What do you think about the level of detail?
- If you could design your own neuroscience unit, what would it look like? Or If you could redesign *Brain Matters*, what would it look like?
 - Would it look like *Brain Matters*?
 - Would you use any sections from *Brain Matters*?
 - How would it differ from *Brain Matters*?
 - How long would it take to teach?
 - Which students would you use it with? Grade? Class?

5. **What is your level of familiarity with seizures or epilepsy?**
 - Do you know someone with epilepsy? Yes No
 - Have you ever witnessed a person having a seizure other than on a video? (Yes No Don't know)
6. **Did your knowledge of or attitudes towards seizures or epilepsy influence your decision to use *Brain Matters*?**
 - How?
7. **Tell me about your students' reaction/response to *Brain Matters*.** (E.g., If the teacher used the first aid video, ask what their students' reaction was to the video).
 - Can you give me some examples? Go through the sections that the teachers used and ask for student reactions.
8. **Tell me about your student's knowledge of seizures or epilepsy after using *Brain Matters*.**
 - Did you observe a change in your student's knowledge of seizures or epilepsy?
 - How do you think your student's knowledge of seizures or epilepsy changed?
 - Can you describe the change?
 - Can you give me some examples?
 - What indicated to you that there was a change in your student's knowledge of seizures or epilepsy? (i.e., How do you know there was a change?)
 - One of the goals of *Brain Matters* is to teach students about seizure first aid. Can you comment on your students' knowledge of seizure first aid?
 - Another goal of *Brain Matters* is to attract future scientists and health care professionals to epilepsy-related careers. Can you tell me about your students' knowledge of epilepsy-related career choices after using *Brain Matters*?
9. **Tell me about your student's attitudes toward seizures or epilepsy after using *Brain Matters*.**
 - Did you observe a change in your student's attitudes toward seizures or epilepsy?
 - How do you think your student's attitudes toward seizures or epilepsy changed?
 - Can you describe the change?
 - Can you give me some examples?
 - What indicated to you that there was a change in your student's attitudes toward seizures or epilepsy? (i.e., How do you know there was a change?)

Appendix D: Teacher Letter of Information and Consent Form

Teacher Letter of Information

Evaluation of *Brain Matters*, a neuroscience and epilepsy education program

Purpose of this study

We would like to invite you to participate in a research study that evaluates the *Brain Matters: An Introduction to Neuroscience* resource you have used or will be using in your Grade 12 Biology class(es). We are asking all teachers in Southwestern Ontario that have used or intend to use the *Brain Matters* resource to participate in this study.

Who are the investigators?

Jacqueline Specht, PhD	Faculty of Education The University of Western Ontario
Suzanne Nurse, PhD	Education Liaison Epilepsy Support Centre
Terry Spencer, MA	Research Officer London District Catholic School Board
Mary Secco, BA	Executive Director Epilepsy Support Centre
Gayle Michelle Gibson, HBSc	Faculty of Education The University of Western Ontario

What will happen if you agree to participate?

If you agree to participate, you will receive a phone call to answer any questions you may have about the study and to set up an initial meeting time.

There are two parts to this study:

The first part is about your experience using the Brain Matter resource. If you have already used the *Brain Matters* resource in your Grade 12 Biology class, we will interview you to learn about your experience using the Brain Matter resource. For example, we will ask you questions about the content you used and how you used it. The interview will take *approximately 45 minutes*. In order to assist with the interviews, we will ask you to complete a quick checklist indicating the sections you used from the resource.

If you have *not* used *Brain Matters* in your Grade 12 Biology class, we will *not* interview you.

- A. In the second part of the study, we will ask your Grade 12 Biology class to fill out a questionnaire before and after you teach your homeostasis unit. The questionnaire asks students about their knowledge of and attitudes towards seizures and epilepsy and takes *approximately 20 minutes to complete*. Total time (both sessions combined) to participate is 40 minutes.

Before your students participate in the study they will be asked to take home a letter informing their parents. If parents do not want their son/daughter to participate, they are asked to return a form indicating this. Your role will be to hand out letters to your students and to collect any forms returned by parents who do not wish their son/daughter to complete the questionnaire. Copies of the letter to be sent home to parents *will be* provided.

We are asking *all* teachers that have used or intend to use the *Brain Matters* resource to participate in the second part of the study.

Confidentiality

The information collected will be used for research purposes only, and neither your name nor information which could identify you will be used in any publication or presentation of the study results. Confidentiality will be protected by providing a unique identifying number for each classroom as well as a separate unique identifying number for each individual student and teacher. All research data will be kept in a locked file accessible only to the investigating team.

Risks

There are no known risks to participating in this study.

Benefits

You, and the students in your class, will be helping to improve our understanding of high school students' knowledge and attitudes towards epilepsy as well as evaluating an epilepsy education program.

Voluntary Participation

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time with no effect on your employment status or in your ability to use the *Brain Matters* resource.

Any Questions?

If you have any questions about this study, please contact Jacqueline Specht, Principal Investigator at . If you have any questions about your rights as a research participant, you may contact Office of Research Ethics, The University of Western Ontario at .

This letter is yours to keep for future reference.

*Teacher Consent Form***Evaluation of *Brain Matters*, a neuroscience and epilepsy education
program**

I have read the Letter of Information, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Name (please print)

Signature

Date

Appendix E: Code Book

1. What Teachers Use/Implement Or Did Not Use/Implement From *Brain Matters* (Question 2)

- Refers to anything from *Brain Matters* that teachers talked about using or not using.
- Examples:
 - DVD - Refers to specific instances when teachers' talked about when they used or did not use the DVD.
 - Videos - Refers to specific instances when teachers' talked about when they used or did not use a video from the *Brain Matters* DVD.
 - PDF material - Refers to specific instances when teachers' talked about when they used or did not use the PDF material on the *Brain Matters* DVD.
 - Text - Refers to specific instances when teachers' talked about when they used or did not use material from within the boundaries of the physical *Brain Matters* binder. Text can be further subdivided into:
 - Diagram - Refers to specific instances when teachers' talked about when they used or did not use a diagram.
 - Summary table - Refers to specific instances when teachers' talked about when they used or did not use a summary table.
 - Historical background - Refers to specific instances when teachers' talked about when they used or did not use historical background information.
 - Glossary - Refers to specific instances when teachers' talked about when they used or did not use the glossary.
 - Demonstrations and Knowledge Application:
 - Case studies
 - Demonstrations
 - Quizzes
 - Video exercise
 - Worksheets

2. How Teachers Used/Implemented *Brain Matters*. Ways that teachers used/implemented *Brain Matters* (Questions 2 and 3)

- Refers to how teachers used *Brain Matters*/The ways that teachers used *Brain Matters*
- Examples:
 - Teacher Resource – Refers to teachers' use of *Brain Matters* to increase their own knowledge of neuroscience (to teach

themselves). Includes instances when teachers used *Brain Matters* to learn more about neuroscience so that he/she could inform their students about neuroscience concepts.

- Teaching Aid – Refers to how *Brain Matters* was used by teachers to teach their students. Refers to teacher's use of *Brain Matters* to increase their student's knowledge of neuroscience. Teachers' use of *Brain Matters* to help them teach neuroscience.

3. Factors Affecting Implementation

This section answers why teachers use/did not use components of *Brain Matters* and why teachers used it the way they did (how teachers used *Brain Matters*).

A. Teacher-Related Factors

Pedagogical Content Knowledge and Beliefs

- Refers to teachers knowledge and beliefs about students, learning, teaching, and subject matter that influenced implementation.
- Examples:
 - Teachers' knowledge and beliefs about students, learning, and teaching:
 - Students learn with problem-based approaches.
 - Students need for background information - Refers to teacher's use of *Brain Matters* to increase their student's knowledge of neuroscience.
 - Students' abilities to understand and grasp concepts.
 - Teachers' knowledge and beliefs about subject matter:
 - Level of experience:
 - Refers to teachers' experience in teaching neuroscience that influenced their implementation of *Brain Matters*. For example, teachers that have experience in teaching neuroscience may already have diagrams of the brain and, therefore, do not use the diagram of the brain in the *Brain Matters* resource.
 - Refers to teachers' experience in using *Brain Matters* that influenced their implementation.
 - Level of knowledge:
 - Refers to teachers' use of *Brain Matters* (as a teacher resource) to increase their own knowledge of epilepsy, seizures, and/or neuroscience.

B. Program-Related Factors

Characteristics of the Resource

- Refers to features of *Brain Matters* (features of the DVD and the printed material in the binder, not including anything external e.g. training) that influenced teachers' implementation of *Brain Matters*.
- Examples:
 - Compatibility refers to the extent to which *Brain Matters* fits with teachers' perceived needs, practices, priorities, and values.
 - Adaptability refers to the "extent to which the proposed program can be modified to fit provider preferences, organizational practices, and community needs, values, and cultural norms" (Durlak & DuPre, 2008, p. 337).
 - Clarity refers to clarity of both the goals of a program and the means of implementation.
 - Complexity refers to the "difficulty and extent of change required of the individuals responsible for implementation" (Fullan, 1994, p. 2841).

Professional Development

- Refers to characteristics specific to the professional development session that influenced teachers' implementation of *Brain Matters*
- Examples:
 - Video exercise using problem-based learning.

C. External Factors

- Administrative support refers to the extent to which administrators support and encourage teachers during implementation.
- Resources (e.g., funding).
- Policy (e.g., curriculum expectations).

Gayle Michelle Gibson

Curriculum Vitae

EDUCATION

- 2010-2013 **Master of Education**
Educational Psychology/Special Education
University of Western Ontario, Faculty of Education
London, Ontario, Canada
- 2001-2006 **Honours Bachelor of Science**
Psychology Major, Biology and Anthropology Minors
University of Toronto, Faculty of Arts and Science
Toronto, Ontario, Canada

HONOURS & AWARDS

- 2011 **Master's Award, Ontario Graduate Scholarship** (\$15,000)
Government of Ontario
- 2011 **Western Graduate Research Scholarship** (\$8,000 - declined)
The University of Western Ontario
London, Ontario, Canada
- 2010 **Western Graduate Research Scholarship** (\$8,000)
The University of Western Ontario
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RELATED WORK EXPERIENCE

- 2011-Present **Educational Researcher**
Epilepsy Support Centre
London, Ontario, Canada
- 2012-2013 **Program Evaluator**
Independent Consulting
- 2009-2010 **Research Assistant**
Bloorview Kids Rehab
Toronto, Ontario, Canada

RELATED WORK EXPERIENCE (continued)

2007-2009 **Clinical Research Project Assistant**
 The Hospital for Sick Children
 Toronto, Ontario, Canada

2006-2007 **Lab Coordinator**
 University of Toronto
 Toronto, Ontario, Canada

PRESENTATIONS & PUBLICATIONS

Gibson, G. M., Secco, M., Nurse, S., Spencer, T., & Specht, J. (2012, May). *Demystifying epilepsy: Can a school-based education program increase knowledge of and improve attitudes about epilepsy?* Poster presented at the Canadian Society for the Study of Education, Wilfred Laurier University/Waterloo University, Waterloo, Ontario, Canada.

Gibson, G. M. (2012, April). *Out of the shadows: Decreasing epilepsy-related stigma.* Paper presented at the Graduate Research in Education Symposium, Faculty of Education, University of Western Ontario, London, Ontario, Canada.

Gibson, G. M. (2012, March). *Out of the shadows: Decreasing epilepsy-related stigma.* Paper presented at the Western Research Forum, Society of Graduate Students, University of Western Ontario, London, Ontario, Canada.