Uplifting Voices of the Unheard: Exploring Students With Learning Disabilities' Perspectives About Their Learning in Science

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Abstract

People with disabilities are underrepresented in the fields of science, technology, engineering, and mathematics (STEM). Given the importance of diversity to achieve a thriving society, increasing the representation of people with disabilities in STEM post-secondary education and careers is necessary. One way that this can be achieved is by incorporating youth students with disabilities' voices in STEM education discourse. Specifically, my study focuses on incorporating students with learning disabilities' (LDs) voices in science education discourse by exploring their perspectives about their science learning. To approach this research, I conduct a phenomenological study where I interview seven students with LDs from a secondary school in Montreal, Quebec. The following two research questions guide my study: (1) What are students with LDs' perspectives on their science learning? and (2) What are students with LDs' perspectives on how they are supported in their science learning? Findings indicate that participants consider science learning to be important and can occur in various ways in and out of science class. Moreover, students with LDs feel supported in their science learning by different educational stakeholders such as parents, teachers, and schools. These findings can inform educational stakeholders on the most effective strategies to use to support students with LDs in their science learning to further encourage them to pursue science fields in the future. In turn, this can increase the representation of people with disabilities in STEM.

Key words: student voice, learning disabilities, science learning, educational stakeholders

Résumé

Les personnes handicapées sont sous-représentées dans les domaines de la science, de la technologie, de l'ingénierie et des mathématiques (STIM). Étant donné que la diversité est importante pour parvenir à une société prospère, il est nécessaire d'augmenter la représentation de ces personnes dans l'enseignement postsecondaire et les carrières en STIM. Une façon d'y parvenir est de faire valoriser la voix des jeunes étudiants handicapés lors du développement de l'éducation en STIM. Plus précisément, ma recherche est concentrée sur l'intégration des perspectives des élèves ayant des difficultés d'apprentissage lors du développement de l'éducation en science en explorant leurs perspectives sur leur apprentissage des sciences. Pour avancer dans ma recherche, j'ai appliqué la méthodologie de phénoménologie: j'ai passée en entrevue sept étudiants ayant des difficultés d'apprentissage qui fréquentent une école secondaire à Montréal, Québec. Les deux questions suivantes ont approfondi ma recherche: (1) Quelles sont les perspectives des élèves ayant des difficultés d'apprentissage quant à leur apprentissage des sciences? et (2) Quelles sont les perspectives des élèves ayant des difficultés d'apprentissage sur la façon dont ils ont été supportés dans leur apprentissage des sciences? Les résultats indiquent que les participants considèrent l'apprentissage des sciences comme étant important et qu'il peut se produire de diverses manières, soit durant ou hors des cours de sciences. De plus, les élèves se sont sentis supportés dans leur apprentissage des sciences par différentes personnes éduquées telles que leurs parents, enseignants et écoles. Ces résultats peuvent informer ces derniers sur les stratégies les plus efficaces à incorporer pour soutenir les élèves ayant des difficultés d'apprentissage dans leur maitrise des sujets de science afin de les encourager à poursuivre des études en sciences. Cela peut augmenter la représentation de ces personnes en STIM.

Mots-clés: voix d'élève, difficultés d'apprentissage, apprendre les sciences, personnes éducatifs

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Contribution of Author

I conducted this research on my own, including the data collection and data analysis. For the recruitment of participants, I received assistance from a teacher at the school in which my study took place. Moreover, I am the sole author of this thesis which includes Chapters 1 through 5.

I would like to acknowledge that my supervisor has assisted me in developing the interview questions and themes from the collected data. Additionally, she provided me with feedback on every chapter of my thesis. Finally, I would like to recognize the contribution of a fellow colleague in DISE who served as a second coder during the data analysis process.

List of Abbreviations

CDT: critical disability theory

DISE: Department of Integrated Studies in Education

IBL: inquiry-based learning

IEPs: individualized education plans

IPA: interpretive phenomenological analysis

LDs: learning disabilities

MA: Master of Arts

MATL: Master of Arts in Teaching and Learning

NOS: nature of science

SSHRC: Social Sciences and Humanities Research Council

STEM: science, technology, engineering, and mathematics

Chapter 1: Introduction

The need to increase diversity in the fields of science, technology, engineering, and mathematics (STEM) is well documented (Botella et al., 2019; Tsui, 2007). Research demonstrates the importance of having populations with differing backgrounds, cultures, and experiences in work, academic, and social environments. For instance, diversity encourages creative and innovative thinking as people with varying perspectives propose ideas, interpretations, and solutions to complex issues (Gassmann, 2001). Furthermore, people feel included, valued, and willing to share ideas when part of diverse populations (Hofhuis et al., 2016). When people feel part of a community which views them as unique, stereotypes may disappear while support, mentorship, and collaboration may increase (Smith & Schonfeld, 2000).

Although the literature highlights benefits of diverse populations, diversity in STEM is still lacking. Indeed, women and people of color are underrepresented in STEM fields with extensive research highlighting this issue (e.g., Beede et al., 2011; Sassler et al., 2017). Moreover, there is an underrepresentation of people with disabilities in STEM professions (Thurston et al., 2017). This underrepresentation of people with disabilities in STEM careers is mostly due to the shortage of people with disabilities entering post-secondary STEM programs. Manly et al. (2020) reveal that the amount of people with disabilities entering post-secondary education is increasing, however, few choose to enter a program in a STEM field. Similarly, Duerstock and Shingledecker (2014) find that people with disabilities are less likely to enroll in STEM courses or majors in post-secondary education.

There are various reasons which have led to the lack of students with disabilities pursuing STEM programs in post-secondary education. Students with disabilities in post-secondary STEM programs face several barriers including minimal accommodations in STEM courses which they

are enrolled in. As such, these students do not have equal access to education and may not be able to actively engage in courses (James et al., 2019). Students with disabilities in K-12 education encounter similar barriers when learning STEM subjects which has an impact on whether they pursue studies in STEM in post-secondary education (Manly et al., 2020). Students with disabilities in K-12 education experience barriers created by various educational stakeholders such as parents, teachers, and schools. For example, a common barrier is the lack of inclusive pedagogies used to support the learning needs of students with disabilities in STEM subjects. K-12 schools may not have programs in place to train their teachers in inclusive pedagogies and are thus unable to accommodate the needs of students with disabilities. This lack of inclusive pedagogies can hinder students with disabilities' learning in STEM subjects (Dunn et al., 2012). Another barrier consists of the negative perceptions that educational stakeholders such as teachers and parents, have on students with disabilities' potential to succeed in STEM subjects. These stakeholders may have lower expectations of students with disabilities which can lower their self-efficacy and confidence toward these subjects, further interfering with their STEM learning (Alston et al., 2002).

Given the underrepresentation of people with disabilities in STEM fields, it should be a priority to increase this representation by encouraging K-12 students to pursue STEM fields in the future (Lindsay et al., 2019). One such way to encourage students with disabilities is by incorporating their voices in education discourse. This can be achieved by gaining insight into students' perspectives on their learning. When defining the term student voice, Cook-Sather (2006) mentions that having a voice means having the capacity to express individual opinions to produce a change in outcomes. Including students with disabilities' voices in education discourse, provides these students with opportunities to share their perspectives on their

understandings, impressions, interests, and experiences of 'school subjects' such as STEM subjects (Cook-Sather, 2006). For instance, Braund and Driver (2005) conducted a study exploring the insights of elementary and secondary students from multiple science classes in different schools, on their experiences with doing practical work in their science class. Results from this study indicate that most students enjoy participating in practical work (e.g., investigations and experiments) in their science class. Gaining insight into students' perspectives about their science learning as done in Braund and Driver's (2005) study, can inform educational stakeholders on how to make students with disabilities' learning in STEM subjects more meaningful to them.

In general, when students are given opportunities to share their perspectives on various aspects of their learning, they feel a sense of empowerment and control over their learning. This can lead to increased motivation and engagement during students' learning process. As a result, students' learning is more likely to improve (Furman & Barton, 2006; Mitra & Gross, 2009). Furthermore, listening to students with disabilities' perspectives on their learning can produce benefits by informing various aspects of education. One such aspect are teacher practices. Teachers can change, adjust, and evolve their practices based on students' perspectives on their own learning. For instance, students can provide their perspectives on how teachers can make the learning environment more inclusive (Robinson & Taylor, 2007). Additionally, students can share their perspectives on how teachers can promote student engagement in their classes (Hagay & Baram-Tsabari, 2015). Essentially, using students with disabilities' perspectives to inform teacher practices allows teachers to foster an environment conducive to learning.

Although there are studies emphasizing the benefits that incorporating students' voices has on education, this does not often occur (Gomez-Arizaga et al., 2016). Indeed, students with

disabilities' voices are rarely incorporated in education discourse because they are infrequently given opportunities to share their perspectives (Byrnes & Rickards, 2011). This is true of students with learning disabilities (LDs), even though more than half of all Canadian students in K-12 education with disabilities have LDs (Statistics Canada, 2015). Since students with LDs make up a large portion of the student population in Canada, it is important that students with LDs' voices are incorporated in education discourse by gaining insight into their perspectives about learning. While gathering these perspectives is important, students with LDs require support in their learning to promote the development of positive perspectives on this learning. Such support is crucial because students with LDs experience various challenges while on their learning journeys (Learning Disability Association of Canada, 2015). By supporting students with LDs in developing positive perspectives on their learning in STEM subjects, and further considering these perspectives in education discourse, there is a greater possibility that students with LDs will pursue STEM fields in the future. Ultimately, this has the potential to increase the representation of people with disabilities in STEM disciplines.

Researcher's Background

As a science teacher, I have had the opportunity to combine my passions for STEM and education. My passion for STEM and particularly for science, began in secondary school where many of my science teachers were encouraging, supportive, and determined. They inspired me to apply myself academically in science class and appreciate the importance of science. With their guidance, I participated in multiple science activities such as science fairs and science clubs. When reflecting on my past experiences with science, I realized that I became confident in my knowledge of and passion for science in secondary school. My curiosity grew and I wanted to learn more about the world and the role that science plays in society. I was most interested in the

functions of the human body. For my undergraduate studies, I decided to pursue a degree in science, majoring in anatomy and cell biology. During this degree, my interest in science grew. I was amazed by the intricate, complex, and efficient nature of the human body. Even though anatomy and cell biology were of most interest to me, I was also eager to learn more about other aspects of science. For example, I was curious about renewable energy sources, medical interventions, and the evolution of different animal species.

After my undergraduate degree, I asked myself a few questions while thinking about my future. How could I share my passion for science with others in a meaningful way? How could I be a life-long learner of science? I thought back to my secondary school experiences with science, especially my secondary five chemistry class. My chemistry teacher fostered a welcoming classroom environment where she developed interesting lessons and continuously encouraged us to share our ideas. After reflecting on these moments, I decided to pursue a teacher certification via a Master of Arts in Teaching and Learning (MATL) in Science and Technology.

The MATL program allowed me to discover multiple ways to engage a group of students and share my passion for science with them. As part of this degree, I completed a Capstone research project. When deciding on the topic of my project, I reflected on my teaching experiences as a student teacher. During my internships, I taught many students with LDs. I noticed that these students encountered academic, social, and emotional challenges. Thus, for my Capstone research project, I decided to focus on the social challenges of students with LDs as research is limited in this area. In doing this research, I learned more about the barriers faced by students with LDs in an educational context. As a current teacher, I believe that it is my

responsibility to foster a classroom environment free of barriers in order for all students to succeed to their highest of abilities.

My Capstone allowed me to gain insight into the world of educational research and to support an underrepresented population of students, which fuelled my interest to continue research in the field of education. I decided to pursue a Master of Arts (MA) in Education and Society, Mathematics and Science, thesis option at McGill University. In doing so, the theoretical knowledge that I would learn from the MA could supplement the practical knowledge that I gained from my teaching experiences. Although I already had some teaching experience from my time as a student in the MATL program, while pursuing my MA, I got additional experience as a substitute teacher at a secondary school.

One substitute teaching experience inspired the topic of my thesis. This experience occurred in a special education classroom where students were not integrated into the general education stream. In this classroom, all students had one or more LDs. Since the teacher knew that I taught science, she gave me the freedom to develop my own science lesson. The students in this class followed an adapted curriculum which did not include science because it centered core subjects such as English, French, and mathematics. As such, the students were very excited to have the chance to participate in a science lesson and conduct an experiment. The students created a makeshift lava lamp by adding food coloring and a seltzer tablet to a bottle filled with oil and water. During the experiment, the students were curious, asked questions, and wanted to understand the science that they were witnessing. At times, I posed questions to the students, however, many were reluctant to answer. After the lesson, I thought about why so many students did not want to answer my questions. Perhaps they were shy, did not know the answers or were not confident in their science knowledge. This experience made me curious about students with

LDs' perspectives on science and their experiences with science learning. These curiosities allowed me to develop the purpose of my study and my research questions.

Research Objectives and Questions

My past experiences as a teacher along with the previously mentioned gap in the literature, influence the purpose of my research. While I recognize that students of all ages can have LDs, my study focuses on students in K-12 education and when referring to 'students' in my thesis, I am specifically speaking of this age-range. Moreover, my research focuses on the science component of STEM and centers the perspectives of students on their science learning. Specifically, my study aims to understand the perspectives of students with LDs on their experiences with science learning and is guided by the following questions:

(1) What are students with LDs' perspectives on their science learning?

(2) What are students with LDs' perspectives on how they are supported in their science learning?

Summary of Chapters

My thesis includes five chapters. In Chapter 1: Introduction, I provide context and background information for my study. I highlight the gap in the literature and emphasize the need for my study. Additionally, in Chapter 1, I discuss my research background and motivation for conducting my study. I also describe the research objectives and questions that will be addressed. In Chapter 2: Literature Review, I present existing literature and prior research which has informed my study. Next, in Chapter 3: Methodology, I provide an overview of the methodology, research context, and study participants. Moreover, I explain the data collection methods and analysis techniques used as well as how validity was ensured in my research. In Chapter 4: Findings, I discuss the themes which emerged in the data relating to my overarching

research questions. I use participant responses as evidence to support the emergent themes. Finally, in Chapter 5: Discussion, I discuss my research questions while connecting to the existing literature. I conclude the chapter by sharing the major findings and research implications, research limitations, and areas of further research.

Chapter 2: Literature Review

In this chapter, I discuss existing research which informs my study. I begin by presenting literature on LDs in education. I then discuss the literature on various aspects of students' experiences with science learning. Finally, I describe research on how students are supported in their science learning.

Learning Disabilities in Education

LDs are one of the most common types of disabilities among students in Canada and comprise one of the largest categories of students in special education (Statistics Canada, 2015). Before conceptualizing LDs in students, it is important to provide a broad definition of disabilities since LDs are specific types of disabilities. When defining disabilities, the meaning of the terms impairments and disabilities must first be considered. While these terms are often used interchangeably, they have distinct meanings. Impairments refer to the loss of function or abnormality in intellectual or physical state. They occur on an individual level and can be caused by injuries, illnesses, or congenital conditions. Unlike impairments, disabilities refer to the limit and restriction in access to services and activities which are usually accessible to people without impairments. They occur at a societal level and are due to societal and environmental barriers (World Health Organization, 2001). Disability can be viewed through several models with the most common being the medical and social models of disability. The medical model argues that disability is due to innate deficiencies (Hogan, 2019), while the social model argues that disability is due to societal barriers (Goodley, 2001). These models of disability are used as lenses to define LDs in the context of education.

There is tension between schools' use of the medical and social models of disability to define LDs. It is difficult for schools to define LDs from a social model perspective since they

are concerned with diagnosing students with specific LDs (e.g., dyslexia, dysphasia, attention deficit disorder). Generally, schools opt to categorize students based on their specific LDs to provide them with resources and accommodations to help them succeed academically (Triano, 2000). As such, schools' definition of LDs often aligns with the medical model of disability. Indeed, through the lens of the medical model, the abilities of students with LDs veer from 'normalcy'. Thus, schools see these students as requiring interventions to 'fix' their impairments to meet the 'normal' standards in education (Heroux, 2017). From this medical model perspective, schools view the abilities of students with LDs as deficiencies in cognitive processing and learning capacity rather than differences. As such, these deficiencies lead to students with LDs having difficulty in perceiving, comprehending, remembering, and learning information (Learning Disabilities Association of Canada, 2015). In education, students with LDs are perceived to have difficulty in attaining curriculum standards due to their learning deficiencies because schools rely on the medical model to construct their definition of LDs. However, this is a flaw of the educational system because applying the medical model does not account for external factors which hinder the learning of students with LDs. Thus, in my thesis, I adopt the social model of disability to define LDs.

Within a social model of disability, LDs in education challenges educational standards such as literacy and mathematics skills that students should attain at specific ages. These standards are influenced by cultural, political, and social factors. The LDs experienced by students are socially constructed in classrooms which are exclusive and unaccommodating to their learning differences (Riddick, 2001). Such classrooms are structured in this way because, as described previously, schools tend to follow the medical model and view students' differences as deficiencies and pathologies. The definition of the social model of disability is informed by

several principles of critical disability theory (CDT). CDT describes disability as a "cultural, historical, relative, social, and political phenomenon" and is built on several key principles (Hall, 2019, p. 1). The first principle of CDT holds that students with LDs have exceptional and involved experiences which are unique compared to their peers without LDs. The next principle indicates that LDs should be viewed as variations in students rather than problems that should be corrected and are to be viewed on a spectrum as opposed to a binary. Additionally, CDT advocates for the right to self-determination for students with LDs throughout their learning journey. Finally, CDT emphasizes the high occurrence of ableism toward students with LDs where they are discriminated against and viewed as inferior to students with typical abilities (Wolbring, 2008).

The social model of disability, motivated by the principles of CDT mentioned above, provides the opportunity for change in education by challenging the learning environments that students with LDs occupy (Meekosha & Shuttleworth, 2009). These environments can be challenged by positioning students with LDs competently in their learning and ensuring that the learning environment adapts to their needs (Goodley, 2013). Applying the social model of disability in education attempts to remove damaging labels from education discourse and break down barriers to learning which can promote inclusivity and accessibility in the classroom for all students (Matthews, 2009). Given the importance of the social model of disability for change in the educational system, applying this model in my research can inform educational stakeholders on how to increase the underrepresentation of students with LDs pursing science fields. Applying this model in my research will require me to reflect on my preconceptions about disability in education. By understanding the key principles informing the social model of disability, I can ensure that I am mindful of my participants' experiences throughout my study. Framing my

study using this model will help bring awareness to the educational system on the societal barriers experienced by students with disabilities and the need to adapt learning environments. While my study uses a social model of disability lens, my target audience are individuals who interact and are involved in the educational system. Thus, my thesis discusses the practices used by schools to meet the needs of students labelled with specific LDs.

Science Learning

To incorporate students' voices in science education, it is important to gather students' perspectives on their experiences with science learning. In the sections below, I present the literature on various aspects of science learning. Such aspects include the importance of science learning and the environments in which science learning takes place.

Why Science Learning Is Important

Science learning is important for multiple reasons. In this section, I discuss four such reasons: (1) to help students understand the nature of science (NOS), (2) to develop scientifically literate students, (3) to prepare students for science careers, and (4) to help students address environmental issues.

Understanding the Nature of Science. Science learning allows students to understand the NOS. The NOS is defined by a set of key assumptions. One assumption of the NOS is that science is empirical and thus based on observations of the natural world. Another assumption of the NOS is that scientific knowledge is composed of theories and laws which are inherently different. Additionally, the NOS assumes that science is socially and culturally embedded where theories and laws are developed by humans. Finally, the NOS maintains that there is no one scientific method and that science is tentative (Abd-El-Khalick et al., 1998).

There are a number of reasons why it is important for students to understand the NOS. First, understanding the NOS allows students to get a sense of authentic science by recognizing what science is and what scientists do in the real world (Akerson & Abd-El-Khalick, 2005). Additionally, by understanding the NOS, students' content knowledge, conceptual understanding, and problem-solving skills improve (Akerson et al., 2011). Since students with LDs experience academic challenges in science education, a clear understanding of the NOS can help improve their science learning (Akerson et al., 2014). Finally, when learning about the NOS, students begin to see the value and importance of science in the real world (McComas, 2006) and are encouraged to experience life through a scientific lens (Lederman & Stefanich, 2006). Encouraging students with LDs to recognize science in the real world can motivate them to further their science learning in the future. While science learning allows students to understand the many assumptions of the NOS it can also help students develop their science literacy.

Developing Scientifically Literate Students. Science learning has implications for developing scientifically literate students. Science literacy is the ability to understand, evaluate, and formulated explanations of scientific knowledge and the natural world. This knowledge can be attained by making observations and inferences about the natural world. Furthermore, science literacy refers to the ability to apply this knowledge of scientific phenomena to various situations (National Research Council, 2007).

Developing science literacy among students is important because being able to interpret science concepts allows students to make informed decisions regarding various aspects of their lives which relate to science (Das et al., 2014). As previously mentioned, students with LDs are often seen through deficit ideologies where decisions are made for them. Thus, by increasing

their science literacy, students with LDs can make their own decisions about several matters in their lives relating to science. Moreover, being scientifically literate is important because it allows students to think critically and deeply about science in the real world (Hobson, 2001). Science can help students make sense of scientific phenomena in the real world such as the advancement in renewable energy and the development of vaccines (Holm & McIntosh, 2008; Plotkin & Plotkin, 2011). Understanding the real world and making connections to their lives, requires a level of science literacy beyond simply knowing facts about science (Sammel, 2014). In sum, science learning allows students to develop several science literacy skills such as critical and deep thinking while helping them make decisions about things pertaining to their everyday lives in the real world. In addition to developing scientifically literate students, science learning can prepare students for future science careers.

Preparing Students for Science Careers. Science learning also prepares students for the many careers relating to science (Raved & Assaraf, 2011). Careers in science fields are vast and varied. Examples of such science fields include biology, physics, astronomy, and medicine. Pursing these science fields can then lead to various careers in nursing, physiotherapy, dietetics, engineering, and more. While science learning benefits all students for their professional future, research indicates that when students with LDs are mentored by being guided and nurtured in their science learning, they are better prepared for careers in science (Coombs-Richardson, 2002).

Science learning has been shown to prepare students for careers in science by allowing them to experience how science is done and what scientists do in the real world. Students can experience this by participating in science outreach programs. These programs are designed to provide students with opportunities to interact with members of the scientific community while

learning about the process of science (McClure et al., 2020; Wright & Moskal, 2014). As seen in Markowitz (2004), when secondary students participated in science outreach programs held in university science laboratories, they gained insight into what is involved in science post-secondary education and careers. In their study, the students participated in hands-on activities and experiments in the laboratory to help them get a feel for what it means to do science.

Another way that students can experience science and the work of scientists is through inquiry-based learning (IBL). IBL is a learner-centered approach where students explore real-world phenomena. Through IBL, students participate in authentic science by mimicking what scientists do in the real world. While doing so, students gain awareness of how scientific phenomena are explored and investigated. This increased awareness through participation in IBL can prepare students for future careers in science (Kang & Keinonen, 2018). While science learning can prepare students for careers in science by allowing them to experience how science is done through outreach programs and IBL, science learning can also help students address environmental issues.

Addressing Environmental Issues. Science learning is essential in helping students address environmental issues. In the 21st century, society is facing many environmental issues which require prompt actions. Examples of these environmental issues include the decrease in biodiversity, the increase in ocean water levels, and the rising of global temperatures (Alcamo et al., 2012). Since these issues will impact the future lives of students, it is important that they are educated in addressing such issues.

Science learning can help students become aware of environmental problems which impact their lives. Through science learning, students recognize several human actions contributing to these problems and the reason for why these issues must be solved. Gaining

awareness is the first step in students learning about what they can do to help solve these problems. Students begin to recognize the role that they play in matters involving the environment. This can lead to an increase in willingness to take responsibility and accountability for their actions which negatively impact the environment (Esteban Ibanez at al., 2020). With the goal of inspiring students to become change makers by developing empathy for the environment, science learning is essential to reach such a goal (Majithia & Burman, 2015). In sum, science learning provides students with the tools needed to address environmental issues impacting our society.

In conclusion, science learning is important because it helps students gain an understanding of the NOS, develop their science literacy, prepare them for science careers, and address environmental issues. Ultimately, through science learning, students make connections between science and the real world. Through these connections, students make meaning of the world around them. Science learning also allows students to develop critical, deep-thinking, and problem-solving skills. Students can apply these skills to other situations in their everyday lives. Due to the various benefits of science learning, it is important for students to gain science experiences in different science learning environments.

Where Science Learning Takes Place

Science learning can take place in different environments. In the following sections, I present the existing literature on the following environments where science learning occurs: (1) formal science learning environments, and (2) informal science learning environments. Specifically, I describe each science learning environment and provide examples of how science learning takes place in such environments.

Formal Science Learning Environments. Science learning can occur in formal science learning environments. In these environments, this type of learning follows a science curriculum with specific standards that must be met. Science learning in formal science learning environments is compulsory, highly structured, and mandated by education ministries (Eshach, 2007). Formal science learning usually takes place within the four walls of a science class or related science space (e.g., laboratory) in a school (e.g., elementary, secondary, or post-secondary) (Stocklmayer et al., 2010). It is important to consider that while formal science learning typically takes place in a science class, this type of learning can occur wherever a compulsory science curriculum is applied. For example, even if students leave the physical space of a science class and go outdoors, or if they leave the school premise completely such as going on fieldtrips, their science learning is formal if this learning follows a science curriculum.

Students participate in a variety of activities in formal science learning environments as part of the curriculum. The choice of activity applied and the way it is applied is dependent on the school and its teachers' pedagogical approaches. First, students may gain science knowledge by memorizing science concepts or facts. In doing so, students typically gain surface level rather than deep conceptual understanding of science. Thus, this type of science learning is unfavourable (Braund & Reiss, 2006). Second, formal science learning may involve students conducting experiments or participating in laboratory activities. Often, students follow steps and procedures on how to replicate experiments or activities to produce results or products. By conducting experiments or participating in laboratory activities, students have opportunities to learn science in practical ways (Osborne & Collins, 2000). Next, formal science learning can happen through project-based learning. Science learning through project-based learning involves students developing an end product based on a science topic. Project-based learning is a

collaborative and active learning process where students learn science in meaningful ways (Kokotsaki et al., 2016). Last, formal science learning can take place through IBL. As discussed in a previous section, students learn science through IBL by exploring and investigating real-world scientific phenomena. Students take initiative on how to go about exploring and investigating such phenomena. As such, students develop an understanding and curiosity about the world around them (HarlEn, 2013).

Formal science learning emphasizes certain behaviours to be conducive to the type of learning in these environments. Science learning in formal science learning environments can take place when students behave positively toward teachers, classmates, and equipment. Positive behaviours in learning environments refer to respectful and non-disruptive behaviors which are in accordance with pre-established rules and norms. These types of behaviours ensure that students' learning is not interrupted and that they are learning in a safe and comfortable environment (Närhi et al., 2014). Since students with LDs already face numerous challenges, an environment non-conducive to learning can further heighten the challenges they experience (Algozzine et al., 2010).

There are additional aspects to consider about the formal science learning of students with LDs. Students with LDs may experience formal science learning in either specialized or inclusive science classes. Regarding specialized science classes, students with LDs are placed in separate classes where they receive specialized instruction which caters to their particular needs (Kauffman & Landrum, 2007). For inclusive science classes, students with LDs are integrated in classes in the general education stream with students who do not have LDs (Vaughn et al., 2001). There is ongoing debate about which learning environment is preferable for students with LDs (Miles & Singal, 2010). While this is beyond the scope of this thesis, it is still important to

recognize these different learning environments. In sum, formal science learning environments provide students with experiences in science learning that are deemed to be important by school curricula. In addition to these environments, science learning can take place in informal science learning environments.

Informal Science Learning Environments. Informal science learning environments are any other contexts beyond formal science learning environments where science learning can happen. As opposed to formal science learning, informal science learning does not follow a mandated science curriculum. This type of learning acts as a supplement to formal science learning and is meant to promote students' science learning by modeling real-world scientific phenomena (Dierking et al., 2003; Rennie, 2007). Participating in informal science learning is typically voluntary and based on students' interests (McGinnis et al., 2012). This type of science learning often occurs out of science classes and beyond school premises, but this is not always the case, and such environments will be further elaborated below (Braund & Reiss, 2006).

Informal science learning can take place in different environments and through various activities that supplement students' science learning. Environments where informal science learning usually takes place include science spaces such as museums, centers, zoos, and gardens. These spaces provide students with opportunities to interact and immerse themselves in real-world science (Braund & Reiss, 2006). Another way that students can learn science in informal ways is by interacting with various media. For instance, students can watch documentaries or browse the internet for information on science topics. In doing so, students are being exposed to science in formats which they typically gravitate toward (Dhingra, 2003). Additionally, informal science learning can happen when students conduct experiments and do hands-on activities relating to science. Such experiments can take place in various environments like the science

spaces mentioned above or at the students' homes. In doing so, students participate in practical science activities beyond science class giving them more practice with practical science (Easdon, 2020). Students can also experience informal science learning by having conversations about science topics with others. As such, students can talk about science topics which they find interesting, have questions about, or want to learn more about in casual ways (Callanan et al., 2011). As a final way that informal science learning can occur is through organized activities involving science such as summer camps, outreach programs, and school clubs. Participating in these organized activities increases students' experiences with science in environments which focus on complementing students' science learning (Asghar, 2012; Sahin, 2013).

While students with LDs may experience informal science learning in the ways mentioned above, they may be supported in this type of learning through approaches which cater to their specific needs. For instance, there are several studies on science outreach programs which focus on the learning needs of students with LDs. As discussed earlier in this thesis, science outreach programs provide students with opportunities to experience real-world applications of science (McClure et al., 2020). Similarly, a study by Wright & Moskal (2014) investigated a science outreach program where students with LDs participated in science activities adapted to their needs. Results from this study show that participants (students with dyslexia) were enthusiastic about their science learning while taking part in the science outreach program. While students with LDs can participate in informal science learning in various ways, they do not all attend to students with LDs' needs. Thus, it is important for educational stakeholders to consider all the ways that students with LDs can participate in informal science learning environments to improve their science learning.

In summary, science learning can take place in various ways in both formal and informal science learning environments. Although science learning in these environments mostly happens in different ways, research suggests that science learning in both environments should work in unison to improve students' science learning. Doing so can make students' science learning more meaningful to them and expose them to a variety of science experiences (Asghar, 2012). While formal and informal science learning environments have positive impacts on students' science learning, students with LDs experience challenges in these environments. Thus, it is essential to support them in their science learning and help them develop positive perspectives regarding their science learning.

Supporting Students With Learning Disabilities

Students with LDs' can be supported in their science learning by educational stakeholders such as parents, teachers, and schools. In my study, I focus on the support provided by these educational stakeholders because they are often in direct contact with students and can be influential in students' lives. These stakeholders can provide students with LDs with support for their learning more broadly which can be applied to their science learning. They can also support students in their science learning in specific ways.

Support From Parents

In this section, I present the existing literature on the various strategies that parents can use to support students with LDs' learning. In particular, I describe how parental involvement with students' homework can support students' learning more broadly and how parental encouragement in informal science can support students' learning specifically in science.

Involvement With Homework. Involvement with homework is one way that parents can support students with LDs' learning more generally. Parents can provide students with such

support by reviewing students' homework, helping students understand the homework, and engaging in students' homework tasks with them. In doing do, parents provide students with guidance, feedback, and/or explanations on various aspects of the homework (Hoover-Dempsey et al., 2001). Another way that parents can support students' learning through involvement with homework is by attending to teachers' requests about homework such as signing worksheets or assessments sent home with students. When supporting students in this way, parents should be in constant communication with teachers. Moreover, parents can participate in initiatives designed to improve students' learning at home. For instance, they can participate in workshops about how to help students with homework. Such workshops can help parents strengthen the support they provide to students with LDs for their learning (Hoover-Dempsey et al., 2001).

When parents support students with LDs through involvement with homework, there are various benefits for students' overall learning. Specifically, parental involvement with homework has been found to improve students' conceptual understanding (Cooper & Nye, 1994). This may lead to increased academic success of students as parents take an active role in helping them with their homework. Moreover, when parents apply the support strategy of involvement with homework, students may develop more positive attitudes toward their learning (Xu & Corno, 1998). These positive attitudes influence students' motivation to learn (Cooper & Nye, 1994; Xu & Corno, 1998). These benefits provide reasoning for parental involvement with homework as a strategy to support students with LDs' learning more generally.

Encouraging Informal Science Learning. Encouraging informal science learning is a strategy that parents can use to support students with LDs' learning specifically in science. Parents can support students' science learning by encouraging informal science learning in the various ways discussed in a previous section. First, parents can encourage informal science

learning by bringing students to science spaces. These spaces can include science centers or science museums (Braund & Reiss, 2006). Ensuring that students have opportunities to visit science spaces is an essential way that parents can encourage students' informal science learning. Second, parents can encourage students' informal science learning by signing them up for organized activities involving science. Such activities can include science summer camps or science extracurricular clubs (Asghar, 2012; Sahin, 2013). Third, parental encouragement in informal science learning can happen when parents watch science video media with students. Examples of such science video media include science documentaries or science videos (Dhingra, 2003). Next, encouragement from parents for students' informal science learning can occur when parents engage in science conversations with students. Such conversations can be about science topics in various disciplines (e.g., biology, physics) (Callanan et al., 2011). Last, parents can encourage students' informal science learning by providing them with opportunities to do experiments or hands-on activities at home. Even though these activities are usually simple and use household items, they can support students with LDs' science learning (Easdon, 2020).

As described in a previous section of this thesis, there are multiple ways that students with LDs can participate in informal science learning environments. Parental encouragement in these environments can lead to improvements in students with LDs' science learning. This encouragement can improve students' science learning by increasing their interest, self-efficacy, and confidence toward science. As such, students' success in their science learning increases (Dabney et al., 2013; Ferry et al., 2000). Moreover, encouragement from parents in students' informal science learning can develop students' science identity (i.e., being a science 'person'). When students develop positive science identities, their motivation to learn science increases (Dou et al., 2019). Additionally, when parents encourage students' informal science learning,

students' science capital increases (i.e., sum of all experiences, attitudes, and knowledge in science). Science capital in students increases because parents are providing students with more opportunities to participate in informal science learning through their encouragement (DeWitt & Archer, 2017). Due to these benefits, it is important for parents to encourage students with LDs' informal science learning to support them specifically in their science learning.

Support From Teachers

In the following sections, I discuss the literature on the ways that teachers can support students with LDs' learning. Particularly, I describe collaborative teaching, differentiated instruction, and scaffolding as strategies that teachers can use to support students' overall learning. I also discuss how teachers can use IBL to support students' science learning.

Collaborative Teaching. Collaborative teaching is a strategy that teachers can use to support students with LDs' learning in general. This type of teaching involves teachers working together to develop common learning goals. Teachers can collectively develop and plan lessons and learning activities. While doing so, teachers capitalized on their skills and expertise since they have opportunities to share their knowledge and experiences with each other (Laal et al., 2014). Collaborative teaching can also happen through co-teaching where teachers share responsibilities while teaching their classes. Often, teachers have control over how they share such responsibilities. Through collaborative teaching, teachers continuously reflect on and develop their teaching practices to work toward improving student with LDs' learning (Nevin et al., 2009).

Research shows that collaborative teaching has various benefits for students with LDs' learning. When more than one teacher is present in class, they can provide more targeted and individualized instruction. Learning in one-on-one or small group situations can lead to an

improvement in students' understanding and academic achievement (Vaughn et al., 2003). Furthermore, through teacher collaboration, students learn from teachers who have varying pedagogies, skills, and practices. As such, students have various types of learning experiences contributing to improved learning outcomes. Since teachers usually work toward improving students' learning, collaborative teaching can allow them to develop the most effective teaching practices by sharing opinions and advice with other teachers (Supovitz et al., 2010). With the many benefits that collaborative teaching has on students' learning, it is important that teachers use this strategy to continue to support students with LDs' overall learning.

Differentiated Instruction. Differentiated instruction is a way that teachers can support students with LDs' learning more broadly. Differentiated instruction involves adapting instructional methods and providing students with varying materials to assist them in attaining learning goals (Scruggs et al., 2012). When teachers apply this type of instruction into their teaching practice, they are not applying a 'one size fits all' approach, rather they are focusing on students' individual needs. Through differentiation, teachers pay close attention to the learning environment as a whole and what each student needs to be successful in the learning environment. As such, teachers may change pedagogies, content taught, and assessments based on students with LDs' diverse learning needs (Tomlinson & Moon, 2013).

Teachers who differentiate their instruction have been found to improve students with LDs' learning (Gray, 2008). As mentioned above, differentiated instruction centers students' individual needs, thus, this type of instruction can improve students' learning in different ways. For example, teachers can increase the academic achievement of students who have difficulty processing language (e.g., students with dyslexia) when they differentiate a written assignment by providing grammar assistance or options of drawing rather than writing (Reid, 2011). As

another example, teachers can apply differentiated instruction to improve students' learning by providing accommodations during evaluations such as a change in location, timing, or format for students who require these accommodations (Fuchs et al., 2005). While differentiated instruction is a common strategy used by teachers, it has benefits for the overall learning of students with LDs.

Scaffolding. Scaffolding is a strategy that can be used by teachers to support students with LDs' learning more generally. Scaffolding refers to instruction that is systematic and direct in early stages, and gradually becomes less structured. When teachers scaffold their teaching, they provide students with greater independence when students begin to gain mastery in their learning (Hammond, 2001). Often, scaffolding involves teachers moving from explicit teaching such as direct instruction to implicit teaching where students have more control over their learning. Moving from explicit to implicit teaching can be done when teachers bridge, link, and guide students with LDs through learning tasks and activities (Lin et al., 2012).

Scaffolding benefits students with LDs' learning. Through scaffolding, the difficulty and complexity of certain tasks is reduced and made manageable for students to excel at. Moreover, scaffolded teaching improves students' higher-order and critical thinking skills since they are constructing their own knowledge (Gonulal & Loewen, 2018). As previously mentioned, students with LDs may have difficulty with cognitive processing, thus, when scaffolding lessons for these students, it is essential that teachers structure activities which assist them with navigating around their cognitive processing difficulties (St Clair-Thompson & Gathercole, 2006). For example, when teachers evaluate students with LDs' knowledge with assessments primarily composed of word problems, it is important that they provide students with alternate representations such as symbols, diagrams, and figures to help students better interpret the

questions (Vekiri, 2002). The benefits of scaffolding mentioned above provide a rationale for the use of scaffolding by teachers to support students with LDs' overall learning.

Inquiry-Based Learning. IBL is a strategy that teachers can use to support students with LDs' learning specifically in science. As previously mentioned, IBL is a student-centered, active learning approach where teachers guide students into constructing their own knowledge rather than passively absorbing knowledge about scientific phenomena. When using IBL, teachers provide students with opportunities to develop their own questions, investigations, and models of scientific phenomena in the real world (e.g., Aydeniz et al., 2012; McGrath & Hughes, 2018). Due to IBL's constructivist nature, this approach allows students to continuously reflect on and re-evaluate learning goals which they set for themselves. Being able to adapt to changes, make judgements, and take risks, are all part of the IBL process (Sadeh & Zion, 2009).

Existing literature shows that there are benefits for students with LDs' science learning when teachers implement IBL. For example, IBL can increase students' motivation and engagement in science class. Since students make decisions about their own learning through IBL, they are more likely to be interested in and want to further develop their learning (Dunlop et al., 2015). Moreover, when teachers implement IBL, students' autonomy can increase (Wulf, 2014). Indeed, students take initiative from the beginning of their learning process and continuously develop their independent thinking while regulating their learning by working at their own pace (Wulf, 2014). Last, IBL can improve students' collaboration and communication skills. Students work together to complete tasks and come up with solutions to the problems at hand. They share their opinions and concerns with each other while learning how to voice and organize their ideas in consice ways (Wulf, 2014). Due to the various advantages of IBL, it is important that teachers implement this approach to support students with LDs' science learning.

Support From Schools

In the sections below, I discuss past research on the strategies used by schools to support students with LDs' learning. Specifically, I discuss how individualized education plans (IEPs), and the use of technology can support students with LDs' learning more broadly. I also describe how schools' implementation of science clubs can support students with LDs' learning specifically in science. It is important to note that when I use the term schools to discuss how students with LDs are supported in their learning, I am referring to personnel such as the school's administration who are the primary decisions makers about school-wide initiatives.

Individualized Education Plans. IEPs are developed by schools to support students with LDs' overall learning. IEPs outline resources, services, and accommodations that are recommended to support the needs of students with LDs and other disabilities (Fish, 2008). Schools create IEPs by involving teachers, parents, and students in the development process. They involve teachers by asking them to determine their students' needs both in and out of class and to provide recommendations for how those needs can be met (Ontario Ministry of Education, 2004). Furthermore, schools involve parents in the development of IEPs. Parents of students who require IEPs can provide their input on students' overall well-being to ensure that IEPs are tailored to students' particular needs (Burke, 2013). The students for whom IEPs are developed can also be involved in the process. Specifically, students' perspectives about how they learn best and what they need to improve their learning are taken into account when developing the IEPs. These perspectives bring authenticity and personalization to the process (Test et al., 2004).

When schools develop IEPs for students with LDs, these students' learning can improve because as the name suggests, IEPs are individualized to meet the needs of each student. Based on this individualization, schools provide students with effective strategies to help them

overcome academic, social, emotional, or behavioural challenges. IEPs can also be used to help students improve their self-efficacy and confidence, further leading to improvements in their learning (Fish, 2008). In addition to the initial creation of the IEPs, continuous adjustments and improvements are made throughout the school year. As students' learning evolves, so do their IEPs to ensure that their needs are constantly being met. While the IEPs are being implemented, schools receive feedback and thoughts from teachers, parents, and students on ways that the IEPs can be changed to better support students at different phases in their learning journeys (Ruble et al., 2010). Based on the various benefits of IEPs, schools can use these plans to support students with LDs in their learning more broadly.

Use of Technology. The use of technology can be an effective way that schools can support students with LDs' learning more generally. To provide this support, schools can use technology in various ways. For instance, schools may provide students with LDs with devices such as laptops or mobile devices with specialized software applications to help students with reading, writing, and mathematics. Depending on the needs of the students, examples of such applications include WordQ which provides word predictions, Kurzweil 3000 which provides text-to-speech, and Reflex which assists with mathematics fluency. By using these applications, students with LDs' learning is customized based on their diverse needs and they have opportunities to interact with different media (Young & MacCormack, 2014).

When schools use technology, students with LDs' overall learning may likely improve. By providing students with technology-supported tools, students can attain educational standards through adaptive and flexible learning (Cheng & Lai, 2020). Such tools are shown to improve students' engagement and understanding in their learning since these tools organize and present information in various ways. Providing students with technology-supported tools can improve

their skills and abilities to complete learning tasks (O'Connell & Dyment, 2016). In sum, the benefits of the use of technology for students with LDs' learning, provide reasoning for why schools should use technology to support these students' learning in general.

Science Clubs. The implementation of science clubs is a way that schools can support students with LDs' science learning. Science clubs can take place during school breaks (e.g., lunch and recess) or after school hours. These clubs may focus on particular science disciplines typically based on the interests of the student population (Dunn et al., 2012). For example, science clubs may focus on topics such as astronomy, environment, or robotics. In science clubs, students often participate in authentic science activities relating to their lives. Students may conduct experiments, do hands-on activities, play games, or watch videos relating to science and in collaboration with their peers. Since joining science clubs is usually voluntary, students have opportunities to pursue their interests and have a say in the type of science that they participate in (Feldman & Pirog, 2011).

Science clubs have been shown to improve students with LDs' science learning by providing them with more experiences and opportunities to participate in science activities. They act as a supplement to students' science learning in science class. When students are involved in science clubs, they may develop positive attitudes and views toward science and their science learning (Moore-Hart et al., 2004). As such, their excitement and motivation to continue with their science learning may increase (Newell et al., 2015). With the many benefits of science clubs mentioned above, it is important that schools implement these clubs to support students with LDs' learning specifically in science.

Chapter 3: Methodology

The purpose of my study was to gain insight into how students with LDs perceived their science learning and the support they receive for this learning. In the following sections, I discuss the methodology chosen, the context and participants of my study, and the data collection and analysis methods used. I also highlight the ways that validity was ensured during the progression of my study.

Overview of Research Methodology

I drew upon phenomenology to conduct this qualitative research. Phenomenology refers to the examination of a phenomenon, where a phenomenon is something that people are consciously experiencing. Phenomenology aims to understand a phenomenon through the lived experiences of people (Gill, 2020). In using the accounts of the lived experiences of the participants, the researcher can develop a consolidated description of the essential elements of the phenomenon (Dollarhide et al., 2016). Specifically, my study applied interpretive phenomenological analysis (IPA). IPA seeks to understand how participants make meaning of their experiences. By applying IPA, the researcher develops themes in the form of a narrative based on their interpretations of the participants' explanations of their lived experiences. Rather than providing a theoretical explanation, IPA produces an interpretative description while highlighting the differences in participants' experiences (Smith & Osborn, 2003). Using IPA in my study was relevant because I was interested in exploring the phenomena of how students with LDs develop their own perspectives on their lived experiences with science learning.

Research Context

My study took place in an independent school in Montreal, Quebec called The Sunshine School[1]. The Sunshine School is a special education school which offers services and resources to students with severe LDs. The school has an elementary and secondary school program with English and French sectors. The Sunshine School aims to improve their students' day-to-day academic, social, and emotional success as well as their integration into society. The Sunshine School follows the Quebec Education Program mandated by the Quebec Ministry of Education. The school strives to provide students with an individualized and specialized education that enables them to meet the standards of the Quebec curriculum. Students are also offered additional tutoring and remediation sessions. The Sunshine School's mission is to implement a pedagogy which focuses on student-centered learning where students can take control of their learning. Moreover, the school aims to foster an environment where students take an active role in their learning and work at their own pace to become independent learners.

The Sunshine School's multidisciplinary staff is trained in special education and includes teachers, administrators, educational technicians, speech-language therapists, and psychologists. The staff regularly participates in professional development and specialized training sessions to develop evidence-based teaching practices. For example, sessions may concentrate on reading strategies for students with LDs or on the development of IEPs. The schools' staff creates IEPs for students which recommend accommodations and resources to help meet the students' learning needs. The IEPs are created in collaboration with the students and their parents. The school also holds various workshops for parents to participate in. Topics of these workshops include helping students with LDs with reading comprehension or with homework.

[1] All names (e.g., schools, teachers, students, other establishments) are pseudonyms.

In addition to academic initiatives, The Sunshine School organizes extracurricular activities for their students. Examples of activities included theatrical plays, outings to art museums, visits to science centers, and attendance to sporting events. Furthermore, The Sunshine School organizes various clubs which students can participate in such as Workout, Chess, Robotics, and Eco clubs. The school also provides students with opportunities to participate in workshops and talks about bullying, sexuality, indigenous rights, social media, and more.

Participants

Participants in my study were students from The Sunshine School. Purposeful sampling was used to recruit participants with similar experiences (Palinkas et al., 2015). Barry, a science teacher at The Sunshine School whom I had already known prior to the start of my study, assisted with recruiting participants. Barry invited all of his grade eight students to participate in my study. Seven students, whose ages ranged from 13 to 15 years old, agreed to participate. While not all of the LDs that participants had were disclosed, examples of some of the LDs that they had included dyslexia, attention deficit hyperactivity disorder, dysphasia, and executive function disorder. Most participants did not attend The Sunshine School during their elementary schooling years and began attending the school in grade 7. Since my study applied IPA, having a small number of participants supported my ability to obtain detailed and meaningful data from the viewpoints of my participants (Gill, 2020). Additionally, incorporating students' voices in my study provided unique and valuable insights about various aspects of education (Cook-Sather, 2007).

Data Collection

Data were collected through interviews. Interviews provide insight into a person's beliefs, perspectives, and values. Through interviewing, the researcher can understand how the

participants interpret and make meaning of their lived experiences (Warren, 2002). For my study, I used semi-structured interviews, a commonly used data collection method in IPA (Creswell et al., 2007). Due to the flexibility of semi-structured interviews, I was able to ask follow-up questions which allowed me to acquire a deep understanding of how my participants made sense of their experiences with science learning.

Participants were individually interviewed once between September and October 2021. The interviews were audio recorded and lasted about 20 minutes. The interviews were divided into four sections: (1) introductory information, (2) experiences with science, (3) science learning, and (4) support from others.

The purpose of the first section of the interview was to become acquainted with my participants. Examples of questions in this section included:

- What do you like to do with your friends and family members?
- What do you like to talk about with your friends and family members?

The second section of the interview explored students' science experiences in various contexts. Interview questions from this section included:

- Describe your most recent science class. What did you like about this class? What did you dislike about this class?
- Do you participate in science activities out of class? If so, what do you do?

The third section of the interview included questions about students' science learning. Examples of questions included:

- Do you think that you are a good science student? Why or why not?
- Do you think you participate in science class? Why or why not?

Finally, in the fourth section of the interview, questions focused on the support that students with LDs receive from others. Example questions included:

- Do you talk about science with your friends or family members?
- Do your parents encourage you to participate in science activities in or out of school?

During the interviews with the first few participants, my biases were more evident, and I had expectations of emergent themes. Thus, these interviews were less open-ended, and I asked less follow-up questions. After the first few interviews, I noticed common themes among my participants' responses and with the semi-structured nature of my interviews, I was able to ask questions related to these emerging themes to my participants interviewed later in my research process. In doing so, I was able to gather a greater depth of information during those interviews. My biases and assumptions will be further elaborated on in the section below where I discuss how researcher reflexivity was applied throughout the research process.

Data Analysis

Once all the data was collected, all interviews were transcribed verbatim. The transcripts were then read twice to gain a general overview of the information. Next, the data was organized into a table by interview question. All participant answers were included for each interview question. To develop themes from the data, thematic analysis was used since it is a systematic and flexible data analysis method (Braun & Clarke, 2012). Through thematic analysis, I coded the data using short phrases to interpret participant responses (Braun et al., 2016). Inductive coding was applied where the data was analyzed for emergent codes (Linneberg & Korsgaard, 2019). An initial round of inductive coding revealed many emergent codes. Two additional rounds of coding were done to refine the codebook by deleting irrelevant codes and combining similar codes to produce the final codebook. Subsequently, I grouped codes together to form

major themes (Braun & Clarke, 2012). Multiple subthemes emerged and each was given a concise title. While thematic analysis through inductive coding allowed me to develop relevant themes, I applied several strategies to ensure that my research was valid.

Validity of the Research

To ensure validity of my research, I used the following three strategies: (1) rich and thick descriptions, (2) peer reviewing, and (3) researcher reflexivity. These three strategies demonstrate the credibility of the research and the accuracy of the data findings (Noble & Smith, 2015).

Rich and Thick Descriptions

I provided rich and thick descriptions by explaining the purpose of the study, context of the study, data collection methods, and data analysis approaches in detail. In doing so, the reader is presented with a clear idea of the progression and different aspects of the study. These detailed descriptions help develop a "valid, truthful, and believable account" (Brink, 1993, p.38) of the research. This enables the reader to have a vivid understanding of the research and feel as though they experienced parts of the study. Readers can then make judgements about the quality and applicability of the research (Creswell & Miller, 2000). The rich and thick descriptions that I provided help validate my study.

Peer Reviewing

Throughout my study, notably during the data analysis portion, I consulted with an external peer reviewer, who is a graduate student in the Department of Integrated Studies in Education (DISE) at McGill University. The reviewer is familiar with science education at the secondary level and was thus a valuable reviewer. They acted as a second coder by reviewing the inductive codes developed during the data analysis phase. They also provided me with support

and feedback on my methodology and data analysis approaches. Through peer reviewing, my assumptions and strategies were questioned and challenged which increased the credibility of my study (Creswell & Miller, 2000). Peer-reviewing supported the process of validating my study.

Researcher Reflexivity

Researcher reflexivity is an important validation method as it allows the reader to understand the position and interpretations of the researcher (Long & Johnson, 2000). In this section, I reflect on my role as a researcher and clarify my research assumptions and biases based on my past experiences. I also discuss my motivation and beliefs which have shaped my research.

As mentioned earlier in this thesis, I am a certified science teacher. It is important that I recognize the assumptions and biases that I bring to my research based on my experiences as a science teacher. As a science teacher, I value science and believe that it is important for all students to receive adequate science education. I believe that science learning is an essential part of a student's academic journey where all students should be supported throughout. I place significance on the benefits of incorporating students' voices in education discourse to inform various aspects of the educational system. My bias toward the importance of science education has shaped my view on research in this domain where I believe further studies which uplift students' voices about science education are needed.

During my experiences as a science teacher, I have taught various students with LDs. Based on informal conversations with and observations of students with LDs, I found that they were not being given the same opportunities and encouragement to engage in science experiences compared to students without LDs. For example, a special education class in a school where I taught, did not have science as part of its curriculum. Thus, I assumed that

students with LDs' perspectives on science differed from the perspectives of students without LDs. Due to these assumptions, I was expecting certain responses when interviewing my participants.

Although I had biases and assumptions when conducting my research, I was mindful when developing my interview and follow-up questions. I was cautious on how I framed the questions to not direct participants toward a particular answer. I was also conscious of my tone, body language and reactions during the interviews. As a researcher, refraining from imposing preconceptions while designing and conducting interviews is an essential element of IPA. This allows the participants to share their thoughts without hesitation (Smith & Shinebourne, 2012). In sum, researcher reflexivity, along with rich and thick descriptions, and peer reviewing were essential processes to establish validity of my study.

Ethical Considerations

Prior to the start of my study, I received conditional approval from the Director General of The Sunshine School to conduct my research. Since my interviews took place at The Sunshine School and with their students, it was essential that I received permission from the Director General of the school. With this conditional approval, I received ethical approval from McGill's Research Ethics Board. My participants were minors; thus, they signed an assent form, and their parent/legal guardian signed a consent form. Along with the consent form, students' parent/legal guardians were sent an information letter to further explain my study (Appendix A). In the assent and consent forms, I was transparent about the purpose, benefits, and risks of my research. This would ensure that my participants felt safe and comfortable in sharing their thoughts during the interviews. Moreover, before beginning the interviews, each participant was told that they may skip any question or stop the interview at any time. Although it was stated in the assent and

consent forms, participants were asked for permission to record the interview session prior to the start of the interview. All data was kept on a password protected computer. Furthermore, all names, including names of schools, teachers, students, and other establishments were anonymized.

Chapter 4: Findings

My study explored students with LDs' experiences with science learning. In this chapter, I present the themes which emerged from the data collected through participant interviews. In the sections which follow, I discuss the findings regarding first, students with LDs' perspectives on science learning, and second, students with LDs' perspectives on how they are supported in this science learning.

Students With Learning Disabilities' Perspectives on Science Learning

Participants provided various perspectives on science learning. In the sections below, I present students with LDs' perspectives on several aspects of their science learning. Such aspects include why science learning is important, and how science learning takes place.

Why Science Learning Is Important

Participants mentioned that science learning is important because science is involved their everyday lives. For example, Kelly said, "Science is a very important part in life." Students who feel that science is part of their everyday lives indicated that it is important to have a broad understanding of science. As described by Milly, "I think everyone should know [science] to a certain extent. Like, if you want to go further, then that's your choice, but you should know generally science." Students believe that science learning is important because it allows for the development of common knowledge about phenomena that they experience in their everyday lives. For instance, Robby said, "I think it's important for everyone to know at least a little bit [of science] to become common knowledge." Similarly, Aly mentioned, "It's important to know the basics of science for other reasons. Like you need…it's also basic knowledge. Like, how do fish breathe under water? Or it's important to know how your body works." Students find science

learning to be important because it helps them understand phenomena in their day-to-day lives and to develop common knowledge about such phenomena, as evident here in Aly's response. Students with LDs also shared that science learning is important because it prepares them for future engagement with science. The students mentioned that science learning is particularly beneficial for those who plan to participate in science activities in the future. For instance, Andy said, "I think it could be important for people who want to do more science." Specifically, students explained that science learning is necessary for science careers. Joey shared, "It is important if you want to be a scientist or join the army for certain types of stuff." Although Joey specifically spoke about the importance of science learning for career purposes, students generally believe that science learning is important for any future experiences with science.

Moreover, students with LDs discussed that science learning is important because it allows them to understand how things in the world work. For example, Milly said, "Science, it helps me find out like how things work." Students feel that understanding how things work in the world is done by gaining theoretical and practical knowledge. As Kelly explained, "Science is often about learning mentally and physically to know how things work." Students indicated that science learning helps them understand how things work in their everyday lives. As further discussed by Kelly, "Part of science and learning is knowing how things work. Like let's say paint mixing…so you need to know how much of this colour you need to get this colour." Robby shared a similar thought saying,

> Science helps me understand many things for example questions like where do the clouds come from, how does rain work and other things like how does the solar system work? It just gives me a greater understanding on just certain perspectives of the world and how it works.

Here, Robby explained how science learning helps him understand world phenomena such as weather and space. As another example, when speaking about common household items, Jessy said, “Without science we wouldn’t know what we know today because nowadays, more machines contain more and more technological items like the freezer.” While Jessy explained that science learning is important to understand how common household items work, students generally feel that science learning helps them understand how things work in the world more broadly.

Finally, participants expressed that science learning is important because it could help society address pressing environmental issues. For example, Aly said, “For our world, it’s the time now to act and I feel like now it’s the time to act and learn how to make more environmentally right decisions.” Similarly, Jessy said, “[We learned] abiotic and biotic with the biomes and also what effects them and what we can do about them to help the environment.” Kelly provided another example where she described how science learning can be useful for helping people directly affected by environmental issues. She said,

> Science has to do with weather and natural disasters and if you can spot a natural disaster right before it happens, something happens to the water before a tsunami, then you can spot that and tell everyone to get out.

Although all three students feel that science learning could help them make decisions that would impact the environment, generally, students believe that science learning could help them address environmental problems. In sum, students with LDs explained that science learning is important because it allows them to connect science to their everyday lives, prepares them for future experiences with science, helps them understand how things work in the world, and could assist society in addressing environmental problems.

How Science Learning Takes Place

When students were asked to share their perspectives on science learning, they also discussed their perspectives on how science learning takes place. Specifically, students discussed how science learning takes place in different science learning environments such as in and out of science class.

Science Learning in Science Class. Students with LDs discussed various ways that science learning takes place in science class. First, students shared that science learning in science class means going to the science lab in their school. For example, Joey said, "[In science class] we go more to the labs." Similarly, Jessy mentioned, "We are coming in here in the lab to mess around with some of this stuff." Next, students shared that science learning in science class involves conducting experiments. For instance, Andy said, "We were doing this one [experiment] in science class where we had to take DNA from strawberries." He shared another example of an experiment he did in science class by saying, "We put chemicals together and stuff like we put liquids or some things together." Third, students described science learning in science class as participating in hands-on activities. For example, Joey shared, "In science, there's more hands-on [activities] and everything." As another example, Kelly spoke about a hands-on activity in science class where the students investigated nature around their school. She recounted, "We went outside to observe things like the grass and how the grass actually feels." While science learning typically occurs within indoor spaces, students shared examples of activities that take place in outdoor contexts, including the example described here by Kelly. Finally, students explained that science learning in science class involves doing projects. As shared by Joey, "We had to do a project about our ecosystems." Similarly, Milly expressed, "We're working on a project. It's like the Paris

agreement and the school. Like, what can The Sunshine School do for the environment?" Robby also spoke about the same project by saying,

> We looked at the Paris agreement and that was to reduce the carbon emissions from the countries. And then we were told, we were tasked to do a presentation that was the Paris agreement but instead of for Paris for The Sunshine School and what we could do to reduce the emissions for The Sunshine School.

Students shared that science learning in science class takes place by doing projects on topics which relate to their lives, as described by Milly and Robby.

Participants mentioned that they enjoy participating in the above-mentioned activities which allow them to learn science in science class. When speaking about conducting experiments in science class, Aly said, "I'm excited to do more science-y stuff with more like, experiments." Similarly, Robby shared, "I really like doing the experiments and stuff." When discussing a hands-on activity on a unit about ecosystems covered in science class, Jessy said, "We are going to make a greenhouse which I am excited for." Likewise, Andy said, "I find [science class] more enjoyable because I find it's like a hands-on class." Regarding the projects that students do in science class, Robby said, "I do like projects because we get to learn about certain things." Generally, students shared that they enjoy participating in the activities which are part of their science class.

Participants discussed multiple ways that they are involved in their science learning in science class. One way that students shared that they are involved in their science learning is by participating in science class. Students described that they participate in science class by thoroughly considering their responses to their science teacher's questions. For example, when speaking about how he participates in science class, Andy mentioned, "If [my science teacher] is asking questions like, 'How could we do this?', I would try and figure it out and I would try to

describe how that happened." Similarly, Milly said, "I think [I participate by] trying to answer questions by thinking about them. When [my science teacher] normally asks questions, I try to give him an answer." In speaking about the importance of participating in science class by answering questions, students emphasized the process of thinking deeply about the questions to develop meaningful answers, as evident here in Andy and Milly's response. Students also discussed how they participate in science class by talking with their science teacher. For instance, when discussing his participation in science class, Joey said, "[I] talk to the [science] teacher." Likewise, Robby expressed, "[Participating in science] is to just like talk to [the science teacher] and also to like say or propose a certain idea or give a comment to him." Students discussed how they share their ideas with their science teacher as a way of participating in their science learning in science class, as seen here in Robby's explanation.

Students with LDs provided reasons for why they think participation in science class is important in their science learning. One reason is that participating in science class allows them to be successful in their science learning. For example, Jessy said, "You have to get grades, and if you don't participate you won't get grades for [science] and you won't pass." Jessy continued, "I think [participating] is important because it's helping us pass our grades which is helping us get better jobs and better things that we want to do." While Jessy believed that participation is important for his success in the future, in general, students viewed participation to be an important factor in their success in their science learning. Another reason for why students believed that participating in science class is important, is because it helps them improve their understanding in science. As expressed by Milly, "I find if you participate, you tend to learn more or retain the information better." Similarly, Joey explained, "You definitely learn better and if you don't participate, then you don't know how to do stuff." As another example of why students' find

participation in science class to be important for their understanding in science, Kelly said, "You need to kind of participate in science to know how things work. Go back to history, so in order for people to understand human anatomy, they had to first cut open a dead person." Although Kelly specifically speaks to historical discoveries as a means to understand science, students generally feel that participation in science class allows them to improve their understanding in science. Students with LDs described another way that they are involved in their science learning which is by having good behaviour in science class. Specifically, students shared that good behavior involves paying attention. For example, in speaking about his behaviour in science class, Andy said,

> I try and pay attention especially when we're doing stuff like the strawberry DNA, so I don't mess something up. Let's say you're doing something and you're mixing, and it goes out or something and if you're not paying attention, you could do it wrong.

Here, Andy speaks of the importance of paying attention in science class and directly attributes this to good behaviour. For Aly, good behaviour in science class means acting respectfully toward others and her surroundings. In speaking about how she has good behaviour in science class, Aly said, "I wouldn't goof around, I don't run around the science room, I tie my hair, I'm not like throwing the concoctions in the hair, like putting it in people's hair." As evident in Aly's response, she associates being respectful in science class with having good behaviour. When speaking about how they are involved in their science learning, both Andy and Aly tend to place importance on having good behaviour in science class. Together, good behaviour and participation in science class are mentioned by students as ways to be involved in their science learning.

Science Learning out of Science Class. Students with LDs described multiple ways that science learning takes place out of science class. First, participants shared that science learning out

of science class involves visiting science centers and museums. For example, when speaking about what he does out of science class which relates to science, Andy said, “I go to places like science centers a lot.” Similarly, Robby expressed, “I’ve definitely gone to science museums.” Students discussed examples of science centres and museums that they have visited. For example, Robby said, “I went to the Space Dome and there I did many activities.”

Second, students mentioned that science learning out of science class means watching science documentaries and videos. For instance, Milly mentioned, “I have watched a science documentary outside of school.” Similarly, when discussing science activities which he does out of science class, Joey expressed, “I watch science documentaries. I watch science videos on YouTube or watch movies.” Multiple students mentioned examples of science documentaries and videos that they watch out of science class. For example, Joey discussed videos which spoke about the history of scientific phenomena. He said, “Sometimes [the videos] talk about dinosaurs, and what happened to them and everything.” Similarly, Andy mentioned that he watches videos which provide a procedure on how to conduct science experiments. He shared, “I’ve seen like a YouTube video about, I think it’s how to make something called elephant toothpaste.” Here, Andy learned how to make elephant toothpaste, which is a colorful foam, by watching a step-by-step video on how to conduct a science experiment.

Last, students shared that science learning out of science class occurs by conducting at-home science experiments. As shared by Aly, “I used to do a lot of science experiments at home when I was younger.” Similarly, Jessy said, “I do some [science experiments] at home.” Participants provided examples of at-home experiments that they did in the past. For instance, Jessy said, “There was one science thing where you have to put two bottles together empty, and one has to be full with water. Like, a bit to the top and when you twirl it, it would make a

tornado." Jessy shared another example of an at-home experiment that he did by saying, "I took a balloon and I had like 14 nails in a carboard sticking through it. Then I put another piece of carboard and pressed down. The balloon didn't pop but it turned into a heart shape." While Jessy described at-home science experiments that he already did, students shared various examples of activities which they participate in out of science class.

Although some participants mentioned at-home experiments as contributing factors to science learning out of science class, most participants did not make the same association. For some students, they did not have the experience of doing experiments at home. For example, Milly mentioned, "I don't think I've done any science experiments [at home]. I never thought about doing that stuff outside of school." Other participants believed that at-home experiments should not be conducted out of science class because of negative consequences that may arise. For instance, when speaking about science learning out of science class, Kelly shared, "I don't know about doing experiments because often experiments can get messy and we don't have enough things." Andy described the type of at-home science experiments that he believes should not occur out of science class by saying, "I wouldn't try chemical, like, dangerous experiments because I don't want to explode something." Andy's example showed that the unpredictable nature of some science experiments is a reason for why students do not consider at-home experiments to be part of science learning out of science class. Although students had contradicting views on at-home science experiments as being part of their science learning out of science class, students unanimously viewed visiting science centers and museums, and watching science documentaries and videos to be ways that science learning takes place out of science class.

Participants discussed that they enjoy the above-mentioned activities which contribute to their learning out of science class. For example, in speaking about science centers and museums,

Robby said, “I really like space and all those kinds of things. I really like astronomy and also, I really like engineering like machines, so I like going to museums about that.” Here, Robby indicated that he enjoys visiting science museums out of science class because they allow him to pursue his interests in space, astronomy, and engineering. As another example, when speaking about the science centers and museums that he has visited, Andy said, “I found it was fun and it was also fun to do it with [my cousins]. I got to socialize with people or like with who I know…so I’d say I enjoy going to places like that.” For Andy, he enjoys visiting science centers and museums out of science class because they provide him with opportunities to socialize with others. Students also spoke fondly of the science documentaries and videos that they watch as part of their learning out of science class. For example, when speaking about how he chose the videos that he wanted to watch, Joey said, “I go to my ‘for you page’ to choose [the video]. Sometimes, I’m like, ‘Oh that’s interesting’.” Similarly, when discussing the types of science documentaries that she is interested in watching, Aly said, “I’m really interested in nature documentaries about global warming.” Finally, students also described their enjoyment in conducting at-home science experiments. For example, Jessy said, “I wanted to try [the experiment] at home because it looked fun.” Similarly, Aly said, “I’d like to do more [at-home experiments], because science is really cool and fun.” Generally, students enjoy visiting science centers and museums, watching science documentaries and videos, and conducting at-home science experiments because these activities allow them to pursue their interests.

Students’ With Learning Disabilities’ Perspectives on How They Are Supported in Science Learning

Students with LDs shared their perspectives on the ways in which they are supported in their science learning. In the following sections, I discuss students with LDs’ perspectives on the

support they receive from various educational stakeholders. Below, I present my participants' perspectives on the following: (1) support from parents, (2) support from teachers, and (3) support from schools.

Support From Parents

Students with LDs discussed two ways in which they are supported by their parents. When describing how they feel supported by their parents in their science learning, students mentioned one way that they feel supported in their learning more broadly and one way that they feel supported in their learning specifically in science. The first way that students spoke of in terms of how their parents support their overall learning is by encouraging them to pursue their interests. For instance, Milly said, "[My parents] are like do what you…if you want to try something new, they're often like, ya, you should try that." Similarly, Kelly said, "If I say that I really wanted to do something, but then I was preventing myself from doing it because of something that was happening, then they would probably push me to do it because it makes me happy." As seen in Kelly's response, her parents also support her learning by encouraging her to follow her interests and she sees this as her parents having her best interest in mind. As another example of how parents support students' learning, Robby said,

> My parents say if there's something you like to do, just tell us and we'll see what we can do. My dad was principal in my school, and he asked me, "What do you want in extracurricular activities?" And I told him I want two things: chess and robotics. Then I started from there, like learning how to code a little bit.

While Robby specifically spoke about how his parents' encouragement to pursue his interests helps him learn more about his interests, generally, my participants feel supported in their learning by their parents' encouragement.

One way that students with LDs feel supported by their parents specifically in their science learning is by having conversations about science with them. For instance, when describing how Kelly's parents support her science learning, she said, "I used to talk about science a lot with my parents." Jessy provided an example of a conversation that he has had with his parents. He said, "The satellite that was made, I'm not sure if it was launched yet, but that's something I've talked to them about and then we learned about it in class, so I knew it." While Jessy shared that having conversations about science with his parents supports his learning specifically in science class, in general, students feel that through conversations with their parents about science, they are supported in their science learning. In addition to discussing the support they receive by their parents, students also described the support they receive from their teachers in their science learning.

Support From Teachers

Students with LDs shared that they feel supported by their teachers in various ways. While discussing the support they receive from their teachers in their science learning, they only spoke about how they feel supported as learners more generally and not specifically as science learners. One way that teachers support students' learning is by being trained to teach students with LDs. For instance, in speaking about the teachers at The Sunshine School, Milly shared, "The teachers are actually trained [to teach students with LDs] not like the teachers [at other schools] who are trying to adapt and not really knowing how to do it." Similarly, when discussing how the teachers at The Sunshine School support his learning, Andy said, "They know what [LDs] you have and know how to help you." Students shared that their teachers' training on how to help students with LDs supports their learning, as evident here in Milly and Andy's responses.

Another way that teachers support students with LDs' learning is by providing them with help during their learning. For example, when speaking about how Andy's teachers support his learning, he said, "Sometimes teachers take kids out of class if they need more help." Similarly, Joey explained, "The teachers are help[ful], they show us how to do stuff so we can learn better." The help that students receive during their learning is a reason for why students feel supported by their teachers in their learning, as seen here in Joey's response. While students feel supported by their teachers in many ways, they also receive support in their science learning from their school.

Support From Schools

Finally, in speaking about how they are supported in their science learning, students with LDs spoke about the role that schools play. When speaking about the support that they receive from their school in their science learning, similar to the support that they receive from their teachers, students only discussed how they are supported in their learning more broadly. First, students shared that their school supports their learning by assisting them in overcoming challenges brought on by their LDs. For example, Milly said, "I personally found that [The Sunshine School] helps me a lot with my, like disabilities, or differences or whatever you want to call them. I found that it helped me a lot." Similarly, Andy said, "The Sunshine School is a school that helps kids with disabilities and stuff like dyslexia which is what I have." As another example of how the students' school helps them overcome challenges due to their LDs, Joey shared,

> The Sunshine School is a type of school that helps people who have disabilities for talk[ing] like me. My disabilities are that I can't talk that good, I can't write, I can't read. I basically… it effects all my types of learning, almost.

While Andy and Joey indicated how The Sunshine School supports their learning by helping them overcome specific challenges that they experience, generally, the students' school supports their learning by ensuring that the challenges they experience due to their LDs are considered.

Second, participants explained that their school supports their learning by having small class sizes. For instance, when comparing The Sunshine School to other schools, Andy said, "We have, I would say different classroom sizes and stuff. [Classes are] a lot smaller compared to other schools. My other school there were like 24 kids in the class, so it was bigger." Kelly had a similar acknowledgement on class sizes at The Sunshine School saying, "Classes are a lot smaller, so [the teachers] do have a lot more time for us." While Kelly mentioned that small class sizes provide teachers with more time during lessons, students commonly feel that small class sizes support their learning.

Next, students with LDs shared that they feel supported by their school in their learning because it provides them with a sense of inclusion. Students explained that by attending The Sunshine School, they feel included because they are able to relate to other students. For example, Milly said, "I know that everyone [at The Sunshine School] has something like a disability and that I'm not just like, 'Oh I'm the only one in this class that has it'." Similarly, while discussing why she feels included by attending The Sunshine School, Kelly shared, "It was honestly just a matter of like kids being on my level actually really helped me feel good about myself." Although here Kelly expressed that feeling included in The Sunshine School helps build her confidence, students usually feel supported by their school because of its inclusive nature.

Chapter 5: Discussion

The focus of my study was to integrate students with LDs' voices in science education discourse by gathering insight into their perspectives on their science learning. Additionally, I explored students with LDs' perspectives on how they are supported in their science learning by various educational stakeholders. In this chapter, I answer my research questions based on my findings while making connections to existing literature. I also discuss the major findings and implications of my research. I conclude the chapter by explaining the limitations of my study and areas for further research.

Discussion of the Research Questions

I collected data to help answer my two research questions. First, I sought to understand students with LDs' experiences in their science learning. Next, I aimed to learn about students with LDs' experiences with strategies used to support their science learning. Based on the findings from my study, below, I discuss my two research questions in more detail. Throughout this section, I make connections between my findings and the existing literature. Furthermore, I discuss the inconsistencies from my findings in relation to prior research, while also providing potential reasons for such inconsistencies.

Research Question 1: What Are Students With Learning Disabilities' Perspectives on Their Science Learning?

In my study, students with LDs were asked to share their perspectives on various aspects of their science learning. By having such a focus, students with LDs were given opportunities to elaborate on their experiences with, and feelings toward their science learning. My participants spoke about the following main aspects of this type of learning: (1) why science learning is

important and (2) how science learning takes place. In the sections which follow, I discuss students with LDs' perspective on these two aspects of their science learning.

Students With Learning Disabilities' Perspectives on Why Science Learning Is Important. Students with LDs revealed several reasons for why they thought science learning to be important. One reason was that the students believed science is involved in their everyday lives and in the world around them. Thus, the students placed importance on understanding scientific phenomena which relates to their lives in the real world. Specifically, they felt that it is important to have common knowledge about scientific phenomena that they encounter in their everyday lives. Since the understanding of science in people's everyday lives is an attribution of science literacy (National Research Council, 2007), it seems as though my participants emphasized the importance of being scientifically literate. Students in my study were vocal about the importance of having a broad understanding of matters relating to science which are common to most people. Their views on the importance of science literacy are consistent with prior research stating that science literacy is essential for people to be aware of and responsive to science issues affecting their personal lives (National Academies of Sciences, Engineering, and Medicine, 2016). My findings suggest that students with LDs considered science learning to contribute to their science literacy even if they did not specifically use the term science literacy. While my participants were sharing their perspectives on the importance of science, their constant references to everyday life and the real world further emphasized their beliefs about the importance of being scientifically literate students.

Another reason why students with LDs thought that science learning is important, was because it prepares them for future engagement with science. Particularly, students in my study thought that science learning is essential to be successful in future science activities more

generally and science careers more specifically. These findings are not surprising as prior research has shown that science learning in various forms and contexts is helpful in preparing students for future science activities such as educational programs and careers (Kang & Keinonen, 2018). In my study, while sharing their perspectives on why they thought science learning is important for future science activities, students simultaneously mentioned who they thought should learn science, an unexpected finding. Evidently, my participants felt that it was necessary to discuss *for whom* science is important to learn at the same time as discussing *why* science is important to learn. Students with LDs had two distinct thoughts: (1) most students shared that they thought that it is important for everyone to learn science, and (2) some students thought that it is most important for people who want to pursue a science career to learn science. Although the minority response, the latter perspective is interesting and could be due to the way the educational system is structured. Most often in secondary schools, subjects follow their own curriculum with certain standards that students should attain. In these cases, subjects are taught separately, and interdisciplinary teaching rarely occurs (Jones, 2010; Tsui, 2020). Perhaps my participants viewed science as an isolated subject taught in school with no relevance to their personal lives. Regardless of their intended future careers, it is important that students with LDs recognize the importance that science learning has in their lives.

Furthermore, my participants shared that science learning is important because it helps them understand how things work in the world. This finding suggests that students with LDs believed that science learning could provide them with a deep understanding of things relating to science in the real world. Gaining a deep understanding of science in the real world can be achieved through IBL, as mentioned previously in this thesis (Marshall & Horton, 2011). Through conversations with my participants' science teacher, I confirmed that the teacher uses

IBL as a teaching and learning approach in his science class. Although my participants did not use the term IBL, while sharing their perspectives on the importance of science learning, students described learning outcomes of IBL. It is interesting to think about why the students in my study did not use the term IBL while discussing their perspectives on their science learning even though they experienced this learning approach in science class. It could be the case that these students were unaware of the term, or they did not recognize that they were ever experiencing IBL. However, I do believe that there is value in students with LDs recognizing the learning outcomes of IBL even though they do not specifically name the process. While my participants did not use the term IBL to come to their belief that science learning is important to know how the world works, this finding sheds a light on a potential connection between IBL and students with LDs' experiences with science learning.

Last, students with LDs expressed that science learning is important because it can be useful in addressing environmental issues which require immediate action. Specifically, my participants shared that having science content knowledge can help address these environmental issues which affect individual people or society as a whole. These views are consistent with Potter (2009) who emphasized that being educated on scientific matters which impact the environment is important to battle current environmental issues such as climate change and global warming. Furthermore, recent research emphasized the importance of science education in educating younger generations on how to solve present and how to prevent future environmental problems (Monte & Reis, 2021). My study further emphasizes the need for a focus on the environment and environmental issues in science education by demonstrating that students place importance on science learning to understand environmental issues. Generally, my participants felt that gaining knowledge on science matters could help them in their role of addressing

environmental issues which impact their personal lives and the lives of others. In addition to sharing their perspectives on the importance of science learning, students with LDs shared their perspectives on how science learning takes place in different contexts.

Students With Learning Disabilities' Perspectives on How Science Learning Takes Place. Students with LDs discussed how they believed science learning occurred in various contexts. Specifically, my participants spoke of two contexts: (1) in science class and (2) out of science class. My participants described what science learning consisted of and how they engaged in this learning in these two contexts.

Science Learning in Science Class. My participants shared different ways that science learning occurred in science class. Specifically, they described science learning in science class to involve going to the science lab, conducting experiments, participating in hands-on activities, and doing projects. As mentioned previously in this thesis, these learning activities are commonly present in formal science learning environments as part of the science curriculum. Indeed, students in my study did not describe any activities which were different than the activities found in formal science learning environments as mentioned in the existing literature (e.g., Eshach, 2007; Stocklmayer et al., 2010). Thus, students with LDs seemed to associate science learning in science class to formal science learning.

Moreover, my participants mentioned that they enjoyed the activities that occurred as part of science class (i.e., experiments, hands-on activities, and projects). This finding is consistent with prior research which stated that students favoured hands-on activities and projects over textbook activities in science class (Foley & McPhee, 2008; Johnson & Delawsky, 2013). Since experiments, hands-on activities, and projects have been shown to increase student engagement (Holstermann et al., 2010; Johnson & Delawsky, 2013), this could be reasoning for why students

in my study expressed enjoyment for such activities. It is important that schools and science teachers consider the types of activities that students with LDs enjoy doing in science class as there is evidence that enjoyment in learning can lead to improvements in learning (Hernick & Jaworska, 2018).

Students with LDs also shared their perspectives on how they were involved in their science learning in science class. One way that the students in my study were involved in their science learning was by participating in science class. Specifically, they explained that they participated by carefully considering their answers to their science teachers' questions and by speaking with their science teacher. Similar to what has already been described in the literature (e.g., Jones, 2008; Natvig, 2003), students with LDs believed that participating in science class is important for them to be successful in their science learning and to improve their understanding in science. Another way that my participants were involved in their science learning was by having good behaviour in science class. In particular, students shared that they had good behaviour by paying attention and acting respectfully in science class. Generally, the behaviours mentioned by the students in my study referred to socially acceptable behaviours of good students and specified how they are expected to behave in most schools (Sprick, 2013). It is interesting to think about why students with LDs associated behaviours such as paying attention and acting respectfully with improving their science learning in science class. Perhaps, they were accustomed to behaving in these ways during their years in school and have made connections between these behaviours and successful learning in science class or in class in general. While my participants discussed participating and having good behaviour as ways that they were involved in their science learning in science class, they also shared their perspectives on how science learning took place out of science class.

Science Learning out of Science Class. Students with LDs discussed multiple ways that science learning took place out of science class. All of my participants shared that science learning out of science class meant visiting science centers and museums and watching science documentaries and videos, whereas only some participants included at-home experiments as part of science learning out of science class. The ways that my participants described how science learning took place out of science class was similar to the ways that the existing literature describes science learning to take place in informal science learning environments (Braund & Reiss, 2006; McGinnis et al., 2012). This finding suggests that the students in my study correlated science learning which took place out of science class to informal science learning. As mentioned above, not all students with LDs described at-home experiments to be part of science learning out of science class. This is an interesting finding and may be explained by the types of experiments that my participants conducted in science class. Perhaps, in science class, they were used to working with materials and equipment not commonly found in households (e.g., Erlenmeyer flasks, microscopes). Students in my study may also not have realized that at-home experiments do not only include stereotypical science experiments such as mixing solutions and causing explosions. They may not have considered common scientific processes such as baking a cake or making ice as science experiments which can be done at home. As such, students with LDs' reluctancy to conduct at-home experiments could have stemmed from their traditional views of science experiments.

My participants also expressed that they enjoyed the activities that they did out of science class. As has already been described in the literature, students may have enjoyed participating in these activities out of science class because they often have more liberty with their learning while doing so (Dhingra, 2003; Griffin, 2004). Essentially, considering the activities which

students with LDs enjoyed doing out of science class can inform educational stakeholders such as schools, teachers, and parents on which activities they should encourage students to participate in during informal science learning. This is important because encouraging students with LDs to be active participants in their learning, has potential to improve their learning (Yoder & Hochevar, 2005).

Despite my effort to understand *how* students with LDs were involved in their science learning in different contexts, my participants did not speak to how they were involved in their science learning out of science class. This is interesting considering that students with LDs specifically spoke about *what* types of activities took place out of science class. Since the interviews for my study took place in my participants' science class, perhaps they were influenced by the context and felt that it was irrelevant to speak about how they engaged in their science learning out of science class. These findings emphasize the need for further investigations on students with LDs' perspectives on how they are involved in their science learning beyond typical and commonly known learning environments (e.g., science classes, science labs).

Although there is some overlap between the ways that students in my study described their learning in and out of science class, their descriptions are considerably distinct. As mentioned earlier in this thesis, there are plenty of benefits for students with LDs' science learning when they engage in both learning environments (Asghar, 2012). Thus, it is important that students with LDs experience science in different ways in formal and informal science learning environments to further improve their science learning. In addition to providing their perspectives on their experiences with science learning, my participants were also asked to share their perspectives on how they are supported throughout this learning.

Research Question 2: What Are Students With Learning Disabilities' Perspectives on How They Are Supported in Their Science Learning?

A focus of my study was on students with LDs' perspectives on how they are supported in their science learning. My participants received support from educational stakeholders which included: (1) their parents, (2) their teachers, and (3) their school. In the sections below, I discuss how these educational stakeholders supported students with LDs in their overall learning and science learning.

Support From Parents. Students with LDs described one way that their parents supported them in their overall learning. Specifically, students in my study shared that their parents supported their overall learning by encouraging them to pursue their interests. Indeed, extensive research showed that parents have an impact on students' motivation to learn, decisions to learn, and reasons to learn (Kaplan et al., 2001; Vedder-Weiss & Fortus, 2013). Due to the impact that parents have, when encouraging students to pursue their interests, no matter the types of interests, parents can have an impact on students' learning. By acknowledging that my participants' parents supported their overall learning by encouraging them to pursue their interests, my participants placed importance on this type of support. This finding contributes to the existing literature on the influential role that parents play in students' learning (Thomas et al., 2020; Topor et al., 2010). While students with LDs shared that their parents supported their learning more broadly through encouragement, there was no mention of whether parents were involved with students with LDs' homework, a common support strategy described in the literature (Hoover-Dempsey et al., 2001). This inconsistency emphasizes the need for parents to reflect on their role in supporting students with LDs' overall learning in various ways.

Students with LDs shared one way that they felt supported by their parents in their science learning. This way included having conversations with their parents about science topics. Conversations about science between parents and students are described in the literature as a way that parents can encourage informal science learning among students (Maier et al., 2014). Thus, my participants recognized that their parents supported their science learning by encouraging their informal science learning. While having conversations about science is a start, there are more ways that parents can encourage students' informal science learning, as discussed in a previous section (e.g., bringing them to science museums, enrolling them in science outreach programs), to ultimately support their science learning (Braund & Reiss, 2006; Noel-Storr, 2004; Zimmerman, 2012). Perhaps the parents of the participants in my study did encourage the students with LDs' informal science learning in other ways, however, my findings did not indicate this. It could be the case that my participants solely identified encouragement from their parents in the form of verbal encouragement through conversations. Or, perhaps students did not associate their parents bringing them to science places as forms of encouragement. Since the students in my study only spoke about one way that their parents encouraged their science learning, it is important that parents continue to think about the variety of ways that they can support students with LDs' learning of typical 'school subjects' such as science, beyond the confinement of a school. In addition to support from their parents, students with LDs received support from their teachers.

Support From Teachers. When speaking about how students with LDs have been supported by their teachers in their science learning, my participants only described support strategies for their learning in general. In particular, my participants mentioned that they felt supported by their teachers because their teachers were trained to teach students with LDs, a

finding similar to past research on the training of teachers in specialized schools (Feng & Sass, 2013). Students in my study also shared that they felt supported by their teachers because of their teachers' continuous help during their learning. This finding is consistent with existing literature stating that when teachers possess qualities such as helpfulness, students' learning improves (Pollock & Tolone, 2020). These findings suggest that students with LDs place importance on learning from teachers with various skills and qualities. It is important that teachers continue to develop these skills and qualities due to the great impact that they have on students with LDs' learning. Teachers can strengthen these skills and qualities through teacher education such as pre-service and in-service teacher education. Specifically, teacher education should prioritize the development of teaching skills that support the learning of students with varying needs, namely students with LDs (Savolainen et al., 2012). As seen in my study, my participants felt supported when their teachers implemented strategies which catered to their individual needs. Thus, it is important that teachers are provided with opportunities to participate in teacher education which helps them develop their skills in fostering a learning environment which improves the learning of students with LDs.

While students with LDs acknowledged several strategies used by teachers to support their overall learning, these strategies do not align with specific strategies mentioned in the existing literature. In fact, my participants do not mention the use of collaborative teaching, differentiated instruction, or scaffolding as strategies that their teachers used to support their overall learning. It is reasonable that students would not use these specific terms, but they did not even describe experiences that resemble these strategies. For instance, if students were describing collaborative teaching, I would have expected them to say something like, "There were two teachers in class at the same time". Or, if students were describing differentiated

instruction, they may have said something like, “My teacher allowed me to use drawings instead of words to answer the question”. Perhaps my participants did not recognize that they were being supported in their learning by their teachers in the ways described in the existing literature. Or perhaps students did not feel as though such strategies had an impact on their learning. Regardless of whether it is recognized the students, it is important for teachers to draw on the vast array of strategies which exist to ensure that all students with LDs can improve their overall learning.

In my study, students with LDs made no indication that they were supported by their teachers for their learning specifically in science, even though I am aware that their science teacher implemented IBL, as previously mentioned in this thesis. Although students mentioned learning outcomes from an IBL approach, which is a pre-established science specific support (e.g., Aydeniz et al., 2012; McGrath & Hughes, 2018), they did not indicate that their science learning was supported by teachers through this approach. As described earlier in this thesis, my participants may not have been aware that their science teacher was implementing IBL which could rationalize why they did not mention IBL as a way that they felt supported in their science learning. Another reason could be that the students with LDs’ science teacher did not use IBL consistently or effectively in science class. While speaking with my participants’ science teacher, he mentioned that he does not receive professional development on IBL. This lack of professional development could have impacted how the students’ science teacher used IBL in his science class. Professional development can help teachers with implementing IBL, which has been found to be challenging for teachers to use in their classes (Kazempour & Amirshokoohi, 2014). Prior research further indicated that science teachers may encounter challenges with developing IBL lessons which follow the science curriculum (Chichekian & Shore, 2016).

Science teachers have also been found to experience challenges with time management when implementing IBL (Barron & Darling-Hammond, 2010). Due to these challenges, it is important that teachers are supported by professional development in implementing IBL so that they can then support students with LDs' science learning by using this approach.

Support From Schools. Students with LDs discussed the different ways that they were supported by their school in their science learning. Similar to the support provided by their teachers, my participants only mentioned how their school supported their learning more broadly. Specifically, my findings showed that students with LDs felt supported by The Sunshine School in their overall learning because their school assisted them in overcoming challenges stemming from their LDs. While my participants experienced specific challenges depending on their LDs, generally, they felt that their school was able to support them in overcoming these challenges. For instance, students shared that The Sunshine Schools' focus on the learning of students with LDs helped them in overcoming challenges with their reading, writing, and speaking. These findings are consistent with prior research stating that specialized schools improve students with LDs' learning by catering to their particular needs (Kauffman et al., 2018). Specifically, these specialized schools cater to students with LDs' needs by developing programs and strategies that best support their learning (Kauffman et al., 2018). My participants also mentioned that they felt supported by The Sunshine School in their overall learning because of its small class sizes. While the students in my study felt as though small class sizes had a positive impact on their learning, opinions on the benefits of reduced class sizes vary greatly in the existing literature. Some scholars argue that reduced class sizes benefit students' learning since teachers have more individual contact with students (Blatchford et al., 2003). Contrarily, other scholars maintain that students' achievement is a result of effective teaching and not class

size (Ehrenberg et al., 2001). This ongoing debate among scholars calls for further research on the relationship between class size and students' learning. Finally, my participants felt supported by The Sunshine School because they felt a sense of inclusion while attending this school. Prior research has also highlighted that when students with LDs have positive feelings of inclusion, their achievement may increase (Hawkins, 2011). When students with LDs feel included in their learning environment, they feel as though their learning abilities are equal to their peers without LDs which can increase their confidence in their learning (Stiefel et al., 2018).

While the students in my study felt supported by The Sunshine School in their overall learning, many strategies described in the existing literature to support students with LDs were not identified by my participants. For instance, the students did not mention whether The Sunshine School provided them with IEPs to follow. Although IEPs are described in the literature as a way that schools can improve the overall success of students with LDs (Fish, 2008), perhaps my participants did not acknowledge that their school was using IEPs to support their learning. Additionally, students in my study made no reference of the use of technology by The Sunshine School which is established by the existing literature as a way to support students with LDs in their learning more broadly (Cheng & Lai, 2020). When visiting The Sunshine School to conduct interviews, I noticed technology (e.g., laptops and projectors) present in the school. Although students in my study encountered technology while being at school, perhaps they did not feel as though this technology was meant to specifically help them improve their overall learning. Moreover, students with LDs did not describe science clubs implemented by their school as a strategy to support their learning specifically in science. Prior research reported that science clubs can be useful in supplementing students' science learning (Feldman & Pirog, 2011). As mentioned in a previous section of this thesis, The Sunshine School provided their

students with many options of clubs to join, including science clubs. Accordingly, it was striking that my participants did not mention science clubs as a way to supplement their science learning. There is a possibility that the students in my study were unaware of the science clubs at their school. Or given the timing of my study, perhaps some clubs had been removed due to the COVID-19 pandemic. Given the importance of the strategies mentioned by my participants on how their school supported their learning, it is important that schools continue to use these strategies while considering other ways that they can support their students' learning.

The ways that my participants' parents, teachers, and school supported their overall and science learning are important to recognize since my study viewed LDs through a CDT lens. As previously mentioned, CDT focuses on the environmental and societal barriers experienced by students which cause their LDs (Hall, 2019). By applying CDT in an educational context, it is the responsibility of the educational stakeholders to ensure that the learning environment is accessible to students with LDs and that there are no barriers which may hinder their learning. Educational stakeholders can ensure that they are promoting students with LDs' learning by using the above-mentioned strategies to support these students in their learning. While such strategies can help students with LDs in improving their learning, it is essential that educational stakeholders continue to develop these strategies alongside the evolving needs of students with LDs.

Major Findings and Research Implications

Findings from my study highlight the importance of listening to students with LDs' perspectives on their science learning and about the support they receive for this learning. As seen in the sections above, students with LDs shared and elaborated on their thoughts about their experiences in science learning. The major findings from my study are:

- There are many reasons for why students with LDs believe that science learning is important. These include: (1) science is part of students' everyday lives, (2) science prepares students for future engagement in science, (3) science helps students understand how things work in the world, and (4) science helps students address environmental problems.
- There are various ways that students with LDs describe science learning in science class. These include: (1) going to the science lab, (2) conducting experiments, (3) participating in hands-on activities, and (4) doing projects. Overwhelmingly, students share that they enjoy science learning in such ways. Furthermore, students describe ways that they are involved in their science learning in science class such as: (1) participating in science class by thourouly considering their answers to their science teachers' questions and by talking with their science teachers, and (2) having good behaviour in science class by paying attention and acting respectfully.
- There are multiple ways that students with LDs explain science learning out of science class. These consist of: (1) visiting science centers and museums, (2) watching science documentaries and videos, and for some students (3) conducting at-home experiments. Students express enjoyment and interest in participating in the above-mentioned activities.
- There are different strategies that students with LDs' parents, teachers, and school use to support students' overall and science learning.
    - The approaches that parents use include: (1) encouraging students to pursue their interests to support their overall learning, and (2) having conversations with students about science to support their science learning.

- The approaches that teachers use include: (1) having training on how to teach students with LDs, and (2) helping students during their learning. Both approaches support students with LDs' learning more broadly.
- The approaches that the school uses include: (1) assisting students in overcoming challenges due to their LDs, (2) having small class sizes, and (3) providing students with a sense of inclusion. All of these approaches support students with LDs' overall learning.

These findings give insight into the perspectives of students with LDs' experiences in their science learning. They also give students with LDs a voice and agency to share how they have been feeling about various aspects of their science learning in different contexts. These major findings give rise to implications for educational stakeholders.

First, my study has several implications for parents. While speaking about the importance of science learning, students with LDs often make connections between science and their daily lives. Since parents are typically with students on a day-to-day basis, it is important that they continue to encourage students to make these connections and in turn, reinforce beliefs about the importance of science. Moreover, parents should be responsive to the types of activities that students with LDs associate with science learning out of science class (e.g., science centers and museums, science documentaries and videos, at-home experiments). In doing so, parents can plan time to do these activities with students with LDs to support their science learning. Since the students in my study acknowledge that their parents support their science learning, parents should consider their roles as supporters in students' learning of 'school subjects', in addition to their overall learning. While my study has implications for parents of students with LDs, it also has implications for students in general regarding their learning in science. Students without LDs

can also benefit from their parents' encouragement in participating in activities which contribute to their learning out of science class (Joy et al., 2021). Generally, findings from my study can inform parents on how to better support the science learning of students with and without LDs.

Second, findings from my study have implications for science teachers. Since students with LDs perceive science to be important in their everyday lives, science teachers can ensure that their lessons are relatable and relevant to students' lives. Additionally, by considering students with LDs' perspectives on the activities that they enjoy doing in science class (e.g., experiments, hands-on activities, projects), science teachers can structure their lessons to include learning through such activities. Science teachers can develop learning goals which students with LDs can attain by participating in activities that they enjoy. Since my findings reveal that students with LDs may not acknowledge how they have been supported by their science teachers specifically in their science learning, it is important that science teachers consider how they can better support students in their science learning or how they can make their support more explicit. Moreover, by considering students with LDs' perspectives on how they are involved in their science learning in science class (e.g., through participation and good behaviour), science teachers can think about their class norms and how they expect their students to learn in science class. If science teachers' norms and expectations of students' involvement in science class match those of students, science teachers can promote students' involvement by encouraging participation and modeling good behaviour in science class. Although my study has implications for science teachers, it can also inform the practices of all teachers in general. Due to the benefits of relating subject matter content to students' personal lives, it is important for all teachers, regardless of the subject that they teach, to connect their lessons to students' lives (Gainsburg, 2008). Also, since all teachers apply some form of norms and expectations in their classes

(Rubie-Davies, 2007), my study emphasizes the need for teachers to consider how students feel about such norms to be able to effectively implement them in their class.

Finally, my study has implications for special education schools. My findings suggest that students with LDs' overall learning is supported by their school in various ways. For example, students in my study felt that The Sunshine School helped them overcome challenges due to their LDs because the school focuses on the learning of students with LDs. This finding highlights that the programs put in place by special education schools, such as The Sunshine School, are beneficial for the learning of students with LDs. Thus, it is important that special education schools continue to build on these programs to ensure that the learning needs of students with LDs are always met. The students in my study also felt a sense of inclusion while attending The Sunshine School. Since special education schools can make changes on a large scale and for the entire student population, they can ensure that their school culture is inclusive and welcoming to all students. Special education schools can develop mission statements and goals which strive for a school culture where all students feel comfortable in their learning environment. In addition to the implications that my study has on special education schools, it can also have implications for schools which are part of the general education system. All students, regardless of whether they have LDs, benefit from learning strategies which focus on their needs (Leung, 2008). It is important that all schools acknowledge that their students have varying abilities in order to implement strategies to help improve their learning. Additionally, fostering an inclusive school culture should be a priority of every school. When all students feel included in school, their confidence and engagement in their learning increases (Padak & Rasinski, 2010). While the context of my study is a special education school for students with

LDs, my findings could inform all schools on the benefits of individualization and inclusivity for students' learning.

Research Limitations

Encouraging students with LDs to pursue science in post-secondary education is essential to increase representation of people with disabilities in STEM fields. One such way to do so is by incorporating students with LDs' voices in science education discourse. My study does this by providing students with LDs with an opportunity to discuss their perspectives on their experiences with their science learning. My participants also shared their perspectives of how they are supported in their science learning. As discussed in the section above, gaining insight into the perspectives of students with LDs on their science learning can inform educational stakeholders on how to encourage students with LDs in pursuing science disciplines in the future. While the findings of my study have valuable implications for educational stakeholders, several limitations exist.

One limitation of my study is the time of year of the data collection. The interviews were conducted in the fall which is the beginning of the school year. Thus, students were returning from summer break and did not yet participate in many science classes for the current school year. The students in my study may not have participated in science activities during the summer break or may not have had many experiences with science up to this point in their school year. The summer break and limited number of science classes at the beginning of the school year may have influenced students' perspectives about their science learning. To allow students to gain more science experiences and to provide them with enough time to remember past science experiences, I could have conducted a second interview a few months into the school year. In

doing so, students would have opportunities to participate in more science activities and further develop their perspectives on their science learning.

Another limitation of my study is the use of only one data collection method (i.e., interviews). Using only one data collection method limited the scope of my study and I was not able to gain a whole picture of the situation. Future studies could adopt observations as a data collection method to gain more information on student' science learning experiences. Depending on the aim of the study, observations of students could be made in both formal and informal science learning environments. Indeed, researchers can gain insight into students' lived experiences in various science learning environments. Gathering insight into students' lived experiences in environments where they participate in science activities is important to gain an overall image of students' science and science learning experiences. To promote validity, the researcher can follow up with the participants to make sure that the observational data collected is accurate.

A third limitation refers to the depth of information I gained per participant. Although a relatively small sample size is favourable for IPA methodology, having conducted only one short interview for each participant limited the amount of detailed information gained. Conducting a second interview per participant, similar to how I would address the first limitation, would allow me to follow up on ideas discussed in the previous interview. As such, participants can clarify and elaborate on ideas which will provide detailed and thorough information.

Areas for Further Research

My study contributes to the existing literature on students with LDs and in particular, their voices in science education discourse. Findings from my study contribute to such literature by providing students with LDs with opportunities to share their perspectives on various aspects

of their science learning. While my study focused on what students with LDs *experienced*, *did*, and *enjoyed* regarding their science learning, future studies could focus on what students with LDs *want*, and *need* in their science learning. Specifically, future studies could ask students with LDs to share their perspectives on the types of activities that they want and need to support their learning in and out of science class. These studies could also investigate the type of support that students with LDs want and need from parents, teachers, schools, and other educational stakeholders for their science learning. As described earlier in this thesis, students with LDs' opinions are often neglected in education discourse (Byrnes & Rickards, 2011). As such, considering the needs and wants of students with LDs is important for educational stakeholders to develop strategies that best support students with LDs' science learning. Through this consideration, the educational system could evolve to be more student-centered and reflective of students with LDs true learning experiences in science.

Furthermore, future research could center students with LDs' perspectives on other aspects of their science learning. For example, such research could aim to understand students with LDs' perspectives on science concepts, scientists, and science careers. This research could shed light on whether students with LDs hold positive views of their experiences with science. As previously mentioned in this thesis, the underrepresentation of people with disabilities in STEM fields is a problem that needs to be addressed (Thurston et al., 2017). As such, it is important to learn more about students with LDs' perspectives on various aspects of their science learning in order for educational stakeholders to develop strategies to increase students with LDs' positive perspectives of science. By increasing students with LDs' positive perspectives of science, educational stakeholders can further encourage and motivate students with LDs in pursing science disciplines in their future.

In order to encourage students with LDs in pursing science fields as their future education and career paths, I advocate for further uplifting of students with LDs' voices in science education discourse by being attentive to their perspectives on their science learning. Students with LDs are the ones with lived experiences about their science learning and the barriers they face during their science learning. Ensuring that these students overcome barriers along their learning path is the responsibility of various educational stakeholders such as parents, teachers, and schools. To break down these barriers to science learning, these educational stakeholders must work together to better listen to and consider students with LDs' perspectives on their science learning and while doing so, give them opportunities to make decisions about their learning. My study provides an initial understanding of students with LDs' perspectives on their science learning and highlights the benefits of listening to such perspectives to further incorporate students with LDs' voices in science education discourse. While my study is a first step, I assert the need for future research to further explore the perspectives of students with LDs on their science learning. Doing so can inform educational stakeholders on how to better incorporate the voices of students with LDs in science education discourse to ultimately reach the goal of increasing the representation of people with disabilities in STEM.

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Appendix A: Parent/Legal Guardian Information Letter

My name is Cinzia Di Placido, and I am a master's student in the Department of Integrated Studies in Education at McGill University. For my master's research, I am interested in exploring students with learning disabilities' experiences in science in and out of school. Additionally, my study aims to understand how students with learning disabilities are supported in their science learning. The findings of this study could help to better understand the perspectives of students with learning disabilities on their science learning and lead to improved pedagogical practices.

I am inviting your child to participate in my study. I hope this study will provide your child with the opportunity to share their experiences and their voice.

Attached is a consent form to be signed if you allow your child to participate in this study. If you consent, I will ask for assent from your child to ensure that they are willing to participate. The consent form provides details on the study and on your child's participation in the study. If you allow your child to participate in this study, please sign the attached consent form and return it to your child's science teacher. If you have any questions or concerns about your child's participation in this study, please feel free to contact me by email at cinzia.diplacido@gmail.com.

Thank you,
Cinzia Di Placido