Effect of Science Anxiety (SA) and Modern Strategies to Combat SA in Grade 4 to 8 Teachers as well as Students

By

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Abstract

Science anxiety (SA) affects both students and teachers and results in anxiety towards the subject of science. There have been many studies exploring SA, yet there is little research exploring strategies to reduce SA in teachers. To this end this study was completed, two junior/intermediate teachers were interviewed to discover the causes of SA and strategies to combat SA. The primary purpose of this study was to further explore the causes of science anxiety in students and to discover methods and strategies for grade 4 to 8 teachers in Toronto in order to help support students and reduce science anxiety. The findings were consistent with the literature in terms of strategies for reducing SA, co-operative learning and utilizing a constructivist approach worked best. Gender differences were not found and educational background of the participants was found to affect the way they teach. The findings were analyzed and common themes were explored. The themes include teachers understanding of SA, effect of educational background, anxiety, strategies and limitations and finally enthusiasm and gender.

Key Words: Science Anxiety, Strategies, co-operative learning, gender differences
Effect of Science Anxiety (SA) and Modern Strategies to Combat SA in Grade 4 to 8 Teachers as Well as Students

Chapter One: Introduction

Introduction to the Research Study

Science anxiety is a fear of science that afflicts many students currently in science classrooms (Mallow, 1988). Dr. Jeffery Mallow first coined the term, and the subsequent research on the matter is quite extensive. Individuals may carry science anxiety with them for many years, and it can negatively affect their attitudes towards the sciences. Science anxiety (SA) is nothing new in education and has been a topic of discussion for some time now. According to Jones and Wheatley (1990), science anxiety in girls is especially prevalent in schools. Many students consider math and science to be their most challenging subjects in school (Mallow, 1988). The causes of science anxiety are numerous and include, lack of positive role models, a past negative experience in a classroom, being taught by a SA afflicted teacher and the stereotyping of scientists in popular media (Mallow, 1988).

Purpose of the Study

The purpose of this study is to further explore the causes of science anxiety in students and to discover methods and strategies for grade 4 to 8 teachers in Toronto in order to help support students and reduce science anxiety. These strategies broadly include cooperative learning tools, assessment tools and increased inquiry based experiments in classrooms. Experiment is defined as a test done to see what the effects of something is (Merriam-Webster online dictionary, n.d.). These tasks could involve
experiments where students are exploring a scientific question or perhaps activities, which apply more to the student’s real-word experiences.

**Research Questions**

The goal of this research is to explore the causes of science anxiety in students and to discover methods and strategies to reduce science anxiety for grade 4 to 8 teachers in Toronto. Therefore, it is important to question the experiences that teachers have with science prior to teaching. This will be done by questioning their experience with science, was it negative or positive? One of the common themes that came up in Mallow (1988), Jones and Carter (2007) and Bryant et al. (2013) is that the beliefs and attitudes held by teachers about science can influence their own student’s perceptions of the subject. The following are the research questions that this study will aim to answer:

1. What are some strategies used by teachers in grade 4 to 8 classrooms when teachers feel they are suffering from science anxiety?

2. What are the perspectives and beliefs of grade 4 to 8 teachers on the topic of science anxiety? What are some preferred instructional strategies utilized by teachers in grade 4 to 8 classrooms to help reduce SA?

3. What are the perspectives of grade 4 to 8 teachers on the gender difference that exist among those who suffer from SA?

4. What role does constructivism, education through real life experiences have on science anxiety?
Background of the Researcher

I have always loved science; I was that child that always asked “why” about everything and was constantly asking my parents about the world around me. I would even be running my own investigations at home, such as mixing ketchup and mayonnaise to save time while making a sandwich. As I grew older I noticed that not everyone shared my exuberance for science. In fact for most of my life all I have heard is how “hard” science is and how you need to be really “smart” to do well in it. Even my guidance counselors at school would attempt to guide me more towards the humanities and arts, telling me I didn’t need to take so many math and science classes and that I already had the minimum required for university. What they didn’t understand is that I wasn’t just taking those courses for my grades, but because I genuinely loved science and always enjoyed learning more. As I continued on in my education and decided to major in biology, I noticed an alarmingly low number of female students, especially those from a minority background, in the sciences. During my four years of undergraduate studies at Ryerson University, I continued to foster my love of science and also began to gain a passion for teaching. I want to do to science education what Mark Zuckerberg did to social media: to revitalize it and get people talking more about the sciences. I want to ignite my students’ passion and curiosity to help them see that scientists are not all boring, glasses-toting middle aged men, as portrayed by popular media. In fact scientists have many faces and come from many different backgrounds. Science is not strictly about blindly memorizing facts; it is more concerned with making sense of the world that we live in. It is this idea of science as an exploration, which has kept me in the field and continues to fuel my passion. Utilizing my own positive experiences in science
classrooms, I want to encourage more students to go into the sciences, and reduce the anxiety that some students experience when studying science.

Overview

Chapter 1 includes the introduction and purpose of the study, the research questions, as well as how I came to be involved in this topic and study. Chapter 2 contains a review of the literature. Chapter 3 provides the methodology and procedure used in this study including information about the sample participants and data collection instruments. Chapter 4 identifies the participants in the study and describes the data as it addresses the research questions. Chapter 5 includes limitations of the study, conclusions, recommendations for practice, and further reading and study. References and a list of appendixes follow at the end.
Chapter Two: Literature Review

In this chapter I begin with a definition of SA in order to provide a framework to understand the themes. The literature review follows this definition of SA and includes four themes related to the causes of science anxiety followed by strategies to reduce SA. The four themes related to the causes of SA are as followed; lack of role models, beliefs and attitudes about science, constructivism and science anxiety and gender differences. The first theme draws on the works from Mallow (1988) as well as Hango (2013) and shall explore the lack of role models in the field. The second theme, which outlines the attitudes and beliefs about science, was drawn from the works of Pajares (1992), Jones and Carter (2007), Mayer (2001) and Handelsman et al (2004). The third theme of the affect of constructivism on SA was drawn from the work done by Bryant et al (2013). The fourth theme explores the effects that gender differences have on SA by drawing on the works of Jones et al (2000). The chapter shall end with current strategies to reducing SA and draws on the works of Mallow (1988), Oludipe and Awokoy (2010) and Griggs et al (2013).

Definition of Science Anxiety

Science anxiety is the fear of science that is held by many students and adults today; this fear has led them to avoid and view the subject negatively (Mallow, 1988). Research has shown that girls tend to be affected more by science anxiety than boys (Mallow, 1988). Science anxiety is distinct from general test or performance anxiety; this is because students suffering from science anxiety are often calm and productive in their non-science courses (Mallow, 1988). Science anxiety begins as a seed planted at a very young age in students (Mallow, 1988); throughout school, students receive little or no
training to think independently and are not exposed to an inquiry-based approach (Mallow, 1988). Students are mainly exposed to more “interesting” demonstrations of science, so when they are finally confronted with the reality of science, students become anxious (Mallow, 1988).

**Lack of Role Models**

Another factor that affects science anxiety involves a lack of role models in the field. For example there are very few women in STEM (science, technology, engineering and mathematics) fields. According to Statistics Canada 39% of STEM graduates aged 25-34 are female, compared to 66% non-STEM related female graduates (Hango, 2013). Furthermore the female STEM graduates were concentrated in science and technology fields, with only 23% in engineering and 30% in mathematics (Hango, 2013). This lack of female role models reduces the amount of students that can see themselves in the field. When students see someone of the same ethnic background and gender as themselves in a certain field they are able to envision the possibility of working in that field (Mallow, 1988).

**Beliefs and Attitudes about Science**

Past negative experiences in science classrooms has been noted as a cause of science anxiety in students. This is because the attitudes and beliefs held by teachers about science can affect the way they teach and can ultimately color their own students perception of science (Jones & Carter, 2007). Pajares (1992) says that “beliefs teachers hold influence their perceptions and judgments, which in turn affects their behaviors in classrooms” (p. 307). Why would a science teacher have anxiety about their subject?
Well if we look to who is teaching science subjects in grade 4 to 8, 10% of grade 4 students in Ontario are taught by a teacher who majored in science, compared to 66% who majored in another subject (Martin et al., 2012). 18% of grade 8 students in Ontario were taught by a teacher who majored in science while 56% were taught by a teacher who majored in another subject (Martin et al., 2012). So why are they teaching science? Science teachers are in demand, due the unpopularity of this subject area in schools (Bryant et al., 2013). There is an abundance of English and history majors to teach those subjects, but not enough in the sciences. As a result, there are teachers who don’t have much experience in the subject and so are learning the curriculum as they are teaching it (Mallow, 1988). As these teachers are not used to teaching science they treat it like any other subjects and rely heavily on memorization and textbook work (Mallow, 1988). Relying on textbooks and memorization leads to rote learning, which does not promote true learning and understanding for students. Students end up being able to recall information and are not able to truly apply their knowledge (Mayer, 2001). Science education should be reflective of the true nature of the field of science itself, by capturing the inquiry process in the classroom (Handelsman et al., 2004)

**Constructivism and Science Anxiety**

The paper by Bryant et al (2013) explored the possible connection between constructivism and science anxiety. The study involved looking at students in America as well as Denmark and comparing differences among genders as well as the two countries. Constructivism is a philosophy of education that promotes education through real life experiences to construct knowledge (Bryant et al., 2013). There are two subsets of constructivism, philosophical and pedagogical (Bryant et al., 2013). Philosophical
constructivism gives facts less weight than empiricism, viewing them as only one part of validating a theory. In fact philosophical constructivism questions the existence of facts altogether (Bryant et al., 2013). Pedagogical constructivism on the other hand recognizes learning as an active process. Relying on this particular view, students are taught to develop their own understanding rather than the teacher providing the understanding and essentially force-feeding the knowledge to them (Bryant et al., 2013). Science teachers who have had success usually employ a mixture of pedagogical and philosophical views; they believe in facts but also allow students the freedom to develop their own understandings and knowledge (Bryant et al., 2013). Recent research has revealed that having a constructivist attitude toward science results in three conceptual belief categories (Bryant et al., 2013). The first category states that there seems to be a belief that science is negative towards people and that the scientist is anti-human. The second portrays all scientific knowledge as subjective. And the last belief centers on science as male-centered, possessing an anti-female bias (Bryant et al., 2013). The study found a correlation among constructivist attitudes and science anxiety (Bryant et al., 2013). The study found that SA was highest in students who were in the last two belief categories. By understanding the constructivist beliefs that students hold, we can determine their likelihood to have science anxiety.

**Gender Differences**

Research has shown that students’ perceptions about science differ based on gender (Jones et al., 2000). Males tended to experience more extracurricular activities involving a variety of tools such as electric toys, microscopes and pulleys (Jones et al., 2000). In contrast females reported more experiences with bread-making and planting
seeds (Jones et al., 2000). Males tended to indicate that they were interested in atomic bombs, atoms and x-rays. While more girls reported an interest in healthy eating, weather, and diseases (Jones et al., 2000). Also, more males than females say they could see themselves in positions of power, while females indicated more that they wished to help others (Jones et al., 2000). More females reported that science was difficult to understand while more males said that science was dangerous and meant for boys (Jones et al., 2000). According to Jones et al (2000) students’ attitudes about science being gendered and difficult are what fuel SA in girls especially (Jones et al., 2000).

**Strategies for Reducing Science Anxiety**

The benefits of cooperative learning has long been discussed, a recent study in Turkey applied the strategy to reducing SA in students enrolled in chemistry (Oludipe & Awokoy, 2010). The study compared the effects of cooperative learning to traditional chalk and talk lessons (Oludipe & Awokoy, 2010). They discovered that after utilizing the cooperative method, students had drastically reduced anxiety towards chemistry compared to the chalk and talk group (Oludipe & Awokoy, 2010). Cooperative learning allows students to have control over their learning and this leads to a greater understanding of the information (Oludipe & Awokoy, 2010). In cooperative learning the focus is on the group and this reduces the student’s anxiety (Oludipe & Awokoy, 2010). Students with lower abilities in chemistry are able to gain from their group and results in students being more confident (Oludipe & Awokoy, 2010).

Research from Griggs et al (2013) has shown a correlation between self-efficacy and science anxiety. Griggs et al (2013) explores how utilizing the responsive classroom
approach increases self-efficacy and thus reduces SA in the classroom. The responsive classroom targets four areas: Engaging Academics, Positive community, Effective management and Developmental awareness (Griggs et al., 2013). Engaging academics involves building interactive and purposeful tasks in the classroom. Effective management involves producing an environment that allows students to retain autonomy and learn effectively. Positive community is building a sense of community and safety in the classroom. Finally, Developmental awareness is keeping in mind child development and ensuring the learning environment is developmentally appropriate (Griggs et al., 2013). Both co-operative learning and the responsive classroom approach reduce SA, they share certain characteristics such as being student centered.
Chapter 3: Methodology

Procedure

This nature of this qualitative research study is to explore the causes of science anxiety in students and discover methods and strategies to help reduce Science Anxiety among students. This will be done through a series of interviews with junior/intermediate teachers to determine their current knowledge about Science Anxiety and the effects it can have on their students. This study will also investigate the types of strategies, if any, that Grade 4 to 8 teachers utilize in order to combat Science Anxiety in their students. The interview questions that will be used for data collection can be found in Appendix I.

Participants

Participants were recruited from the schools I had done placements at, the only requirement I looked for was experience and that my participants be teachers. I emailed and phoned participants to gauge their willingness to be involved in the study, a follow-up was then done to determine appropriate times that worked for the participants. Due to the time restraints that this study had as well as my own limited contacts, both the participants are from the same school and have similar years of experience. The participants shall be referred to using pseudonyms and are as followed; Sam and Julia.

The first participant Sam has been a teacher for 21 years and has an educational background in sociology and anthropology. She currently teaches Grade 5 in a suburban school and teaches all subjects except Physical Education, French and Music. She used to teach in the Etobicoke board before it amalgamated into the Toronto district school board (TDSB) and has taught in the TDSB since.
Julia has been teaching for 24 years and has a science educational background, she currently teaches grade 4. She teaches all subjects except for French, Physical Education and Music. She also taught in the city of Toronto board before it amalgamated into the TDSB.

**Data Collection and Analysis**

Data shall be collected solely through interview questions, each response shall be transcribed and re-read several times to allow themes to be drawn from each interview. The responses given shall be analyzed to gauge the participant’s current knowledge and understanding of Science Anxiety. Each participant shall have an individual folder in order to organize all responses and observations made by the researcher. Common responses shall be highlighted in order to easily recognize any correlations.

**Ethical Review Procedures**

The ethical review process as outlined by the Masters of Teaching Program at the Ontario Institute of Studies in Education (OISE) shall be followed. Prior to the interviews, all research participants will be given a letter of informed consent to read and sign before the interview may take place (see Appendix II for consent form). A copy of the consent form will be given to the participant and the researcher shall keep another to put into the records for the study. All participants will also be thoroughly informed that data collected is solely for the purpose of this research study and that their anonymity will be ensured through the use of pseudonyms for both participants as well as institutions.
Limitations

Possible limitations that may have affected this study involve the lack of experience of the researcher, which could result in mistakes in terms of data collection and research scope. Finally there is the possibility that the research questions asked during the interview processes will be too limited to draw reliable conclusions.
Chapter 4: FINDINGS

This chapter displays the findings from the two interviews conducted, there was much gained from the information and the data collected. After analyzing the data, several themes emerged about the causes of science anxiety and strategies to combat it. The themes are as followed a) understanding of SA, b) anxiety, c) strategies and limitations, d) education and e) enthusiasm and Gender. The themes shall be presented individually to properly display the main ideas and findings from the interviews.

Understanding of SA

One theme that came up in both interviews was the understanding that participants have of SA and how they saw it in their classes. Both participants were from the same suburban school, but Julia had a background in science while Sam did not. Sam described SA as “Children being scared to participate and enjoy the subject of science” while Julia described it as “Someone, who the thought of doing science, either teaching or as a student, would say automatically ‘I’m not good at science’ and already sets himself up sort of not to be successful”.

Sam believes to have seen a reduction of SA thanks to the new focus of the science curriculum. Sam says it is “more hands on, more learning through experimentation, inquiry based kind of research…it’s kind of taken the anxiety off children”. While Julia has noticed increased anxiety depending on content, in her rocks and minerals unit there is more terminology and less hands-on activities compared to her pulleys and gears unit where the kids actually build a pulley. She compares it to math anxiety and notes that its a lot of “making sure they are familiar with all that vocabulary
while we are learning it. Having the buzzwords as anchor charts”. Julia makes this very important distinction between the different units in Science that she teaches and the anxiety level of her students. She is very aware that the units with more vocabulary and reduced hands-on activities where the students are able to apply their knowledge leads to more anxiety.

Anxiety

Both participants saw the difference between anxiety of the content and anxiety of test taking. Sam agrees that students have anxiety of content over test-taking itself and that this anxiety can manifest itself as “being able to read all the material, being able to answer the questions that the test is asking I would definitely see a correlation of that”. While Julia describes it as “when you go blank and they forget or they look at the terminology and the question and they know the answer but may have forgotten what the one word is in the question”. This distinction between anxiety of test taking itself and anxiety of the content is important in determining whether the student is suffering from SA. Science anxiety is towards the subject matter not of taking test in general, so its important to determine whether students are suffering from the usual test taking anxiety or is it content specific.

Strategies and limitations

Throughout both interviews Sam and Julia mention multiple methods to reduce anxiety in science. Julia describes bringing her students interest into the unit, for examples “with light if I talk about cameras an how their eye works, if they are interested in photography or even film. Those kind of things, trying to bring in content that there
interested in”. Julia describes how people view science as being about formulas and memorization and made up of paper and pen tasks. What made her fall in love with science in the first place is “its hands-on and its getting to mix stuff up and stick things together”. Sam says “hands-on activities tend to help children understand science and not be fearful of it. I think a lot of group work, where their all engaged and not just answering questions but engaged in the activity together”. Sam also mentioned that the board had science kits which can be ordered and which contain many hands-on resources.

Sam did not mention any limitations to implementing the strategies she described, but Julia did. She highlights time, money ad space as the main limitations to implementing the strategies she mentioned. “Any flat surface in my room ends up having pulleys system balancing on it, so that’s a space issue”. Time is an issue because some activities may take all afternoon and you are “juggling your schedule to fit you know everything in”. Julia says that reorganizing your timetable is easier when you’re a homeroom teacher; you are able to take over some periods and give more time in others to catch up. Money is an issue in terms of buying material, though over time you do accumulate resources.

Education

Sam and Julia differ in their scientific background and both discuss how their educational background has influenced their teaching. Sam believes that her sociology and anthropology background have given her a “better understanding of the way groups work”. Also “as a teacher you need a balance so instead of me going to you know wanting to do the social studies aspect, taking on the science role between my grade 5
colleague and myself is kind of outside my comfort zone”. The research states how the beliefs held by the teacher influence how they teach, Sam recognizes her shortcomings and rather than allowing them to have a negative impact on her teaching she utilizes her colleagues to help account for her shortcomings. This air of collegial support is very strong at the school where both Julia and Sam teach. They often plan units together and are friends outside of work as well.

Julia finds that her background in science has helped her to think like a scientist so “WHY was the big question, so why is this happening and then figuring out how your going to figure out why and answer that question. So I think that I’ve always thought that way and so when I approach science I think as a scientist”. Julia finds that she utilizes questioning in her classes more, “I think how are these kids going to learn, instead of me telling them all the answers” and “why is rainbows you know seven colors, well instead they can get prisms, the lights they can split the white light and they can say hey those are the colors of the rainbow and then you know why is that happening up in the sky after it rains”. This idea of bringing scientific authenticity into the classroom has been that basis to scientific teaching (Handelsman et al., 2004). This process that Julia utilizes is in line with the literature as she captures the inquiry process in the classroom. Application questions usually require students to think like scientist and yet students are not taught to think like scientist.

Enthusiasm and Gender

Another theme that can be seen in both interviews is student enthusiasm for science; Sam believes that there has been an actual increase in enthusiasm for the subject
and she also has not noted any differences among genders. This is not really in line with the literature; according to Martin et al (2012) there is a noticeable discrepancy between girls and boys who have chosen to pursue STEM subjects in university. Sam says she noticed more anxiety in her math classes than science and when asked if there was more girls than boys affected she says “I’m seeing more of an even split now, it’s probably still a percentage of girls over boys but it’s kind of balancing out a bit”.

Julia, using her kids as examples, says it depends on the teacher. Julia says “I found middle schools are probably the time when my kids lost interest in science until two of my kids had an amazing science teacher math science guy in grade 8 and they loved it. They built cars and raced them and did a lot of experimentations, hands-on work and they love science again”. This is in line with the literature; one of the strategies to decrease science anxiety involves utilizing more inquiry-based projects. When students are able to apply their knowledge, they retain the knowledge longer.
Chapter 5: DISCUSSION

Introduction

Science anxiety is the fear of science and is manifest in students as well as teachers in science classrooms. What are some strategies used by teachers in grade 4 to 8 classrooms to deal with SA? What are the perspectives and beliefs of grade 4 to 8 teachers on SA? What are some preferred instructional strategies utilized by teachers in grade 4 to 8 classrooms to help reduce SA? What are the perspectives of grade 4 to 8 teachers on the gender difference that exist among those who suffer from SA? What role does constructivism, education through real life experiences have on SA? These are the questions that this study attempted to answer. This chapter shall consist of a comparison of the themes raised in the previous chapter with the literature. Also the implications, further study and limitations of this study shall be outlined.

Connection between literature and findings

Some of the themes that came up in the findings can also be found in the literature, the recurrence of these themes solidifies their validity and supports further study into this topic. The themes that were consistent with the literature include, strategies for SA. The literature mentions co-operative learning as a method for reducing science anxiety. Sam mentions her use of groups as a strategy to reduce SA, this is line with the literature from Oludipe and Awokoy (2010). Oludipe and Awokoy’s (2010) study, which found reduced anxiety in chemistry after comparing chalk-and-talk lessons with co-operative learning lessons. The literature says that when students are able to work in groups they feel reduced pressure to perform and are able to lean on their classmates for support. Utilizing a collaborative approach for students in science classrooms would
reduce anxiety around the subject and allow students to learn from each other as well as the teacher. This may seem like common sense and we do see group work being used during experiments but what about during instructional time? Why not utilize collaborative process during that time as well especially when the research says that this leads to greater academic success over chalk-and-talk lessons. Some units in Science tend to be heavy with terminology and direct instruction can sometimes be the most effective way to get the terminology across. Perhaps the solution lies in balancing this direct instructional times with something hands-on, to allow the students to apply their knowledge. Bryant et al. (2013) states how constructivism, education through real life experiences, affects SA. Julia with her scientific background utilizes this approach almost unconsciously. She attempts to bring in things that the kids have experience with or have seen in their own lives to enhance their learning. Education that is relevant to students’ lives makes them more invested in the subject matter and allows them to connect to it as well.

Both participants agree that their educational background has affected the way that they teach. Sam does not have a scientific background, but she is aware of her weaknesses and often collaborates with the science teacher to plan lessons and get support. While Julia has a scientific background and realizes that she brings a more scientific way of thinking to her classroom and in turn promotes her students to think like a scientist. Pajares states teacher’s beliefs influence their perception and in turn can color their students perceptions of the subject. Julia’s approach to teaching science is reflective of the research around scientific teaching and how it should be reflective of the field of science itself (Handelsman et al., 2004). The literature states that teachers without a
scientific background tend to treat the subject like any other and rely more heavily on rote learning. This is not consistent with Sam, who recognized the danger of this and collaborates with her colleague. This suggests that increased collaboration among colleagues with science education backgrounds could reduce SA in teachers themselves.

The literature is very consistent in there being a gender difference between boys and girls suffering from SA. According to Jones et al (2000) students attitudes and beliefs about science being gendered and difficult fuels SA in girls. Yet neither teacher noted differences between genders in Science class. This is surprising as the research shows that there is a very real difference between genders for students that pursue STEM fields in university. This could suggest that perhaps there is a leveling out occurring between genders regarding science. Perhaps it could be do to the age group, the participants taught grade 4 and 5, or the sample size of this study. Exploring whether this is true in older grades would require further research.

**Implications**

This study has implications for all stakeholders in science education (teachers, parents, school boards and administrators etc.). Science anxiety affects teachers as well as students, and utilizing a collaborative and constructivist approach seems to reduce SA. This has implications for teachers, as the strategies mentioned seem to reduce SA in the classroom. These strategies involve trips, hands-on projects and group work to reduce SA in the class. The findings suggest that there is no gender difference between students affected by SA. This is quite different from what the research says, both Jones at al. (2000) and Bryant at al. (2013) state that there is a noticeable difference of SA affliction
between genders. Though this is probably due to the small sample size of this study, it would be beneficial to repeat the study with a larger sample size and see if this is still true.

This study has implications to school boards administrators as well. As mentioned in the findings, lack of time, money and space are limitations for applying the strategies listed. Administrators need to lobby for resources to allow teachers to purchase the supplies they need. This may require a reworking of the funds set aside for science supplies every year. The school schedule may need to be reworked as well and more time should be allocated to science classes or perhaps the class periods may need to be moved around to allow for double science periods. This should give educators enough time when needed to do more experiments. Also developing a sense of collaboration among staff, such as partnering teachers with science backgrounds with those without one.

School boards may also need to change the way that they provide funding to schools as well as the professional development provided. More funding will allow schools to provide more trips and allocate more funds to science classes. Both participants noted a lack of education on the subject matter of SA. By providing more education on the subject matter, more teachers will become aware of SA and be able to change the way they teach science to reduce SA in their classrooms.

Limitations and Further study

As stated earlier, limitations that may affect this study involve the lack of experience of the researcher, the limited scope of the research questions and finally the number of participants interviewed.
This is only the first in what I hope to be series of studies that I shall conduct on SA. Future research would involve increasing the participant pool to produce more applicable data. I would interview teachers, students, parents and administrators. By increasing my research pool, I would be able to further explore the gender differences of students affected by SA. I would also like to look at whether there is a difference between schools located in different socioeconomic areas. Schools in lower socioeconomic areas tend to have fewer resources than those in higher socioeconomic areas. It would be interesting to see if there is more pronounced SA in schools located in lower socioeconomic areas.

Gender differences is also prevalent in the literature, it may be beneficial to compare a same sex classroom with a mixed gender classroom and see if there is a differences in SA cases. Perhaps same sex classrooms may have fewer cases of SA and it may be beneficial to have single-sex science classrooms as a strategy to reduce SA.

In future research changing the data collection method and utilizing a more mixed method approach could be interesting. I would like to incorporate surveys to increase my data collection pool. This study did not reveal much for students in older grades, future research could include comparing different grade levels and noting if there is a point where SA becomes more prevalent in students. Also whether this gender gap occurs in older grades, as the literature does say that there is a low number of girls going into STEM related fields.
Finally I would like to look at the actual effectiveness of the strategies mentioned in reducing SA. Which strategies worked best? Also why did they work? This could be done by following up with students suffering from SA after being exposed to the strategies mentioned in this study.
References


Appendices

Appendix I: Interview Questions

General Questions
1. What grade(s) do you currently teach?
2. How long have you been teaching for?
3. What subject(s) do you currently teach?
4. What subject(s) have you taught?
5. What grade(s) have you taught?
6. Have you taught in different Boards? If yes, where?

Science Anxiety Questions
1. Can you define the term Science Anxiety?
2. Have you ever heard about Science Anxiety?
   a. If Yes
      i. Where did you hear about it?
      ii. Did you learn about it while you were getting your teaching certificate?
      iii. Did you learn any particular teaching strategies for it? If yes, what were they and do you currently use any of them in the classroom?
   b. If No
      i. What do you think it may mean?
3. Are you familiar with test anxiety?
   i. Have you noticed any of your students suffering from test anxiety?
   ii. Have they been in any particular subject(s)?
4. Are there any strategies that you have found useful to combat test anxiety?
   a. If Yes
      i. What is it?
      ii. How do you implement it in your classroom?
      iii. Do you find that the students are benefiting from this?
5. Have you gone to any workshops or presentations about Science Anxiety since when you were a faculty of education student?
6. Do you have Science Background?
   a. If Yes
      i. Do you utilize many hands on experiments?
      ii. How many field trips related to science do you take your class on per year?
      iii. Do you think your Science background has helped you to make your science classes more engaging?
      iv. Have you noticed your students doing better on assessments after a trip or a hands-on activity?
   b. If No
      i. What did you specialize in during your undergraduate degree?
      ii. Do you find yourself spending a lot time learning the content?
iii. How many Science related field trips do you take your class on per year?
iv. Do you do many hands on experiments in the classroom?
v. Have you noticed your students doing better on assessments after a trip or a hands-on activity?

7. Have you recognized any students in your classroom affected by Science anxiety?
   a. If Yes
      i. How many?
      ii. How are they doing academically in science?
      iii. Are they doing better in other classes?
      iv. What strategies do you utilize to support those students?
      v. Are there any limitations to implementing those strategies?
   b. If No
      i. In your opinion why do you think that is?

8. In your opinion do you think teaching science through a more inquiry-based approach could help reduce Science Anxiety in students?

9. In your opinion do you think that there is a correlation with low academics in science and Science Anxiety?

10. In your opinion would more teachers benefit from more professional development to deal with SA in schools.
Appendix II: Letter of Participation and Consent

Dear: __________________________

My name is Muna Ali and I am currently enrolled in the Master of Teaching program at the Ontario Institute for Studies in Education (OISE). I shall be exploring the effects as well as some of the factors attributed to Science Anxiety in our classrooms, and determine whether inquiry-based strategies and teacher development may help. The purpose of this letter is to invite you to participate in an interview for this research study.

Your involvement in this study would require approximately 40 -60 minutes of your time, the interview shall also be tape recorded at a time and place that is most convenient to you. Your identity as well as the identity of your institution will be kept confidential through the use of pseudonyms. Your participation in this study is completely voluntary; you may refuse to answer any questions, omit any responses and choose to leave the study at anytime for any reason. A copy of this study when completed can be provided to you upon request.

If you agree to participate in this study, please sign below. Your participation is greatly appreciated.

Sincerely,

Muna Ali
Candidate, Masters of Teaching, OISE
mu.ali@mail.utoronto.ca
Tel: 647-864-6181

I acknowledge that the content as well a purpose of this research study has been fully explained to me and that any questions have been answered to my satisfaction. I understand that I can withdraw at any time from this interview.

Participant’s Name (Printed): __________________________

Participant’s Signature: __________________________

Date: __________________________