

Student Engagement in the Mathematics Classroom
Through Inquiry-Based Learning

by

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Abstract

The purpose of this research project is to explore an effective and engaging mathematics instructional method for teachers of Punjab that could foster a growth mindset, grit, problem solving skills, and critical thinking in the students. These qualities cannot be achieved by using traditional methods of teaching mathematics, which I have experienced during my studies in India, where the teacher is considered the only source of knowledge and children are seen as empty boxes to fill with abstract facts. However, now all the developed countries are giving more emphasis on student-centric approach of learning. The new BC curriculum integrates mathematics as a part of everyday life and sees students as active participants in the learning process. By learning mathematics, students learn to analyze a problem and then consider the solution and evaluate its effectiveness. The inquiry-based learning method provides a personalized and flexible learning environment for students of the 21st century. I prepared a series of workshops for teachers. The intent of these workshops is to introduce teachers of my home country to inquiry-based learning. The inquiry-based learning model engages students effectively in the mathematics classroom.

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Table of Contents

Chapter One: Introduction.....	6
My Research Question to Inquire.....	6
Justification.....	6
Definition of Terms.....	8
Overview of Project.....	9
Chapter Two: Literature Review.....	10
Student-Teacher Relationship that develops Student engagement.....	10
Problem-Solving Method in Mathematics.....	15
Problem-Solving builds Thinking in the Classroom.....	16
Scaffolding in Problem-Solving.....	18
Assessment.....	19
Growth Mindset.....	20
Grit.....	23
Conclusion.....	24
Chapter Three: The Bridge.....	26
Methodology.....	26
Rationale.....	27
Model for My Plan.....	28
Inquiry-Based Learning.....	28
Why Inquiry-Based Learning in Mathematics.....	29
Role of Teacher and Student-Teacher Relationship.....	29
Importance of Growth Mindset and Grit in Inquiry.....	30

Implementation of the Project.....	30
Chapter four: The Plan.....	31
Overview.....	31
Workshop one.....	31
Workshop Two.....	34
Workshop Three.....	36
Workshop Four.....	39
Workshop Five.....	42
Chapter five: The Conclusion.....	44
Summary.....	44
Discussion and Conclusion.....	44
Limitations.....	46
Looking Forward.....	46
References.....	48
Appendix A.....	54
Appendix B.....	55
Appendix C.....	58

Chapter 1: Introduction

As a mathematics and physics teacher of high school students in my home country of India, I observed in my classes that most of the students found physics and mathematics challenging. When I asked them why, I got some interesting answers. Some of them replied that they became confused in the formulas and it is hard to retain so many formulas at the same time, and some answered it was because they were not clear with basic concepts. Some found the language difficult and some had low self efficacy and found it challenging and confusing; they lacked the skills and confidence to persist. So, I concluded that it was time to change my students' perspective on mathematics. Mathematics provides a foundation for many science, technology, and engineering programs (Cross, Woods, Schweingruber, & National Research Council, 2009). However, this is not the work of one day; it will take a longer time to change it. I realized during my studies that many teachers use traditional lecture methods to teach math, which in turn often makes students passive in the classroom. The teacher plays an important part in inculcating interest among the students.

Research Questions

My research question is how can we make mathematics classrooms more engaging? I will also explore the following connecting questions: Why is studying math important for children at an early age? What kind of classroom environment can facilitate effective learning of concepts for the students? This research will help me gain a deeper understanding of how to engage students more fully in this subject area, particularly for those children who find math challenging.

Justification

Mathematics is used in everyday life. For instance 1, 1, 2, 3, 5.... is the Fibonacci

sequence, which can be seen in pineapples, sunflowers, pine cones, and so on. It is used to understand the cycles of nature and to develop calendars. We use mathematics during grocery shopping when we measure weights and interpret the cost of food. Architects use geometry and measurement skills to create blueprints of buildings. In short, it is woven into our daily lives. We use it intentionally and unintentionally. This is why it is important to engage students more in this subject area.

Studies show that inquiring and problem solving in math help students become more creative, as they are using their imagination (Quinnell, 2010). As Cross et al. (2009) assert, “Mathematics provides a powerful means for analyzing and describing the world. Mathematical ways of describing and representing quantities, shapes, space, and patterns help to organize people’s insights and ideas about the world in systematic ways.”(p. 21).

The first concept that a child learns in mathematics is numbers. Children learn from number quantity and relative quantity and gain the ability to do some simple calculation (Cross et al., 2009). The number system explains the answers of “how many” and “how much.” It can provide detailed information of things or the qualities of objects. Children can learn many other concepts from the number system that they can use in the future. Numbers do not exist in isolation; they have in themselves other concepts such as addition, subtraction, multiplication, and division (Cross et al., 2009). Children can learn many things from geometry and measurement, such as the shapes and sizes of different 2D and 3D objects. Shapes are found in every object in nature, so it is important for every child to study it (Cross et al., 2009). “Through their study of geometry and measurement, children can begin to develop ways to mentally structure the spaces and objects around them. In addition, these provide a context for children to further develop their ability to reason mathematically” (Cross et al., 2009, p. 35).

Mathematics is investigatory in nature (Quinnell, 2010). Students learn collecting, organizing, and analyzing data collected and then planning further steps to solve a problem. The investigatory nature of mathematics fosters an informal environment in the classroom to debate and communicate, which in the past was not possible because of our old teaching methods (Quinnell, 2010). It helps teachers to know what students think of the problem and provides an opportunity for students to know each other's point of view and help each other. Investigation can inculcate debate and communication among children, which nourishes children's needs. In this approach, students develop their own ways to solve problem; this inculcates a problem-solving nature and critical thinking in the students (Quinnell, 2010).

Definition of Terms

Clapham & Nicholson (2009) define *mathematics* as “the branch of human enquiry involving the study of numbers, quantities, data, shape and space and their relationships, especially their generalizations and abstractions and their application to situations in the real world” (p.505).

A *mindset* is an attitude towards the challenges in life (Dweck 2006; Mandel, 2017). A *growth mindset* is a positive attitude towards the challenges in life. People with a growth mindset believe in learning. They know they will learn something new even if they fail (Dweck, 2006). A *fixed mindset* is a negative attitude towards the challenges in life. People with a fixed mindset are afraid of challenges because they do not want to fail. They always feel intelligence is something people are born with (Dweck, 2006).

Scaffolding is a method, a device, a technique, or a guide in the hands of teachers that can support students to learn complex things that are otherwise beyond their reach (Simons & Klein, 2007, p.44).

Grit is the passion and perseverance for long-term goals. Grit entails working strenuously towards challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress. “The gritty individual approaches achievement as a marathon; his or her advantage is stamina” (Duckworth, Peterson, Matthews, & Kelly, 2007, p. 1088).

Inquiry-based learning is a process in which students are actively engaged in constructing, evaluating, and reflecting on the knowledge that they have developed and which they can successfully use in the complex world.

Overview of Project

In my literature review I will discuss the following topics: The effect of a positive student-teacher relationship on the student, the value of having a growth mindset and grit in learning and teaching mathematics, problem solving, and scaffolding in problem solving. In the third chapter I will describe my rationale and methodology for the workshops that I designed for school teachers of Punjab, India. My workshops are on inquiry-based learning, which I think is necessary for a 21st-century education system.

The fourth chapter is the heart of my project, which is the plan. In this chapter, I have explained all my workshops with an overview. Chapter five is the conclusion.

Chapter2: Literature Review

I spent most of my time researching my literature review. This chapter gave me a deep understanding of student engagement in mathematics. I found teacher-student relationship, problem-solving skill, scaffolding, growth mindset, grit, and thinking classroom are the key factors to develop student interest and success in mathematics. In this chapter I will discuss these factors in more depth.

Student-Teacher Relationships that Develop Student Engagement

Relationship building plays a crucial role in every aspect of our lives. As both an educator and a student in educational studies, I was always curious about how the relationship between teacher and student impacts the classroom environment. A strong relationship has the potential to make the learning both engaging and more positive for a student. On the other hand, a lack of rapport can diminish the interest of a learner in the subject. According to Starkman (2006, p.29), “engaging teachers” are those who make classroom learning interesting. Making classroom learning engaging includes giving students an opportunity to enjoy learning and to know the purpose of what they have learned. Students will know how to transfer their knowledge to other subjects and have a desire to learn more. Students of engaging teachers enjoy learning and understand the content properly to utilize it in their life (Starkman, 2006, p. 30). Some teachers use technology as a tool to engage students. “When you have the ability to transmit information in a way that is proactive, relevant and entertaining, you are an engaging teacher”(Starkman, 2006, p. 31). “Students learn the topic and apply the topic to their lives they enjoy doing it. That is the essence of engagement” (Starkman, 2006, p.35).

According to Partin (2009), students are engaged more if teachers provide them with a meaningful lesson that they can relate to their lives. A teacher can still set the expectations of

acceptable behavior, classroom conduct, and scholarly standards, but do this with the involvement of students. Setting rules based on teacher and student needs builds an engaged learning environment (Partin, 2009). Displaying the standards agreed upon prominently in the classroom is a technique that fosters dignity and respect. Relationship building takes time and a realization that it is the care of teachers that matters for students, not just the acquiring of knowledge in the form of abstract facts (Partin, 2009).

Teachers can use various strategies in the classroom to engage their students such as information technology, group work, project-based learning, and group discussion methods (Parsons, & Taylor, 2011, p. 5). Interesting activities help to engage students better in the classroom.

As Starkman (2006) mentioned, a safe and comfortable environment of the classroom can foster engagement, and build a relationship. According to Starkman (2006), respect for each other's feelings is helpful in making a classroom more safe and comfortable, a place where learners can enjoy their tasks. By showing care to the students and by giving them respect, listening to them, being helping and supportive, a teacher can nurture students. All teachers work hard to do their jobs by giving time to students in order to understand their needs, building connections with topics being studied, as well as goals about further schooling and careers (Starkman, 2006).

Students reveal that some teachers consciously maintain a distance from their students and do not acknowledge students' anxiety, which can make their teaching less effective (Bernstein-Yamashiro & Noam, 2013, p.30). Creating a "personalized classroom" environment can help the teacher to learn more about the student as an individual, which can facilitate classroom discussion (Bernstein-Yamashiro & Noam, 2013, p.30). The teacher can spend more

time with the students to know them on a deeper level, which can lower the classroom anxiety (Bernstein-Yamashiro & Noam, 2013). “The relationship can be built based on the curriculum and class interaction, after school activities and counseling” (Bernstein-Yamashiro & Noam, 2013, p. 46).

The research of Starkman (2006) shows that caring for student matters greatly for a good learning environment. Starkman mentioned an example of a caring teacher, Peggy Allen, an amazing first-grade teacher in South Lebanon who used to invite four students at a time to join her after school for an afternoon of swimming and dinner, and often pizza (Starkman, 2006, p.85). In this way, she used to spend two to three hours daily with her students to build healthy relationships. She kept on doing this practice until she created positive relationships with her previous students as well. Peggy was caring about her students, not only in the classroom but outside the school as well (Starkman, 2006, p.85). She catered to the varying styles of her students, and this was visible in an incident where the author described how Peggy let some of her students do “word searches” that showed them how to learn while playing. If students were interested in watching butterflies during math class, she helped them to resolve mathematics problems related to butterflies; this exhibited the caring and understanding nature of the teacher. Because of her caring nature, Peggy resolved the issue of another student, who was upset because of being teased about her middle name. Peggy very respectfully kneeled down to make the student comfortable. She hugged the child and consoled her with her own example. Peggy is a model teacher who goes beyond the formal relationship to make her students feel cared for (Starkman, 2006).

The importance of relationship building was described to us by one of our guest speakers, Shelly Green, who visited our class at Vancouver Island University (VIU). She stated that the

power behind her success is “relationship building” (S. Green, personal communication, November 4, 2016). She explained how she and her team worked with the students who were arriving late to the classroom. As a credible leader, she shared a good relationship with her team members and expected her teachers to share the same rapport with the students (S. Green, personal communication, November 4, 2016).

How do you measure the student-teacher relationship? Jaspel, Desrosiers, and Singh (2012) used a self-administered questionnaire to test the student-teacher relationship. When the child was near the end of kindergarten, the teacher was asked seven questions to describe her positive relationships with the children surveyed in her class. The teacher was asked to answer questions such as: Do you share a close and warm relationship with this student? Does this child share his or her information spontaneously? Were you in tune with the child’s feelings? Does your interaction with this child make you, the teacher, more confident or not? These questions gave teachers an opportunity to evaluate their relationships with their students. A similar type of questionnaire was prepared for the children to measure their positive relationships with their teachers (Jaspel, Desrosiers, Singh, 2012, p.3). The analysis of the responses depicted that teacher-student bonding got weaker with the passage of time from kindergarten to higher grades. Teachers were feeling more effective and confident while interacting with six-year-old children, but only part of that effectiveness and confidence remained when the children became seven, eight, and nine years of age. Researchers have proposed reasons for this difference in relationships, and one could be that the student’s emotional growth and the teacher’s roles change in classrooms from kindergarten to fourth grade. “Girls shared the closest relationship with the teachers as they are more socially and emotionally sensitive as compared to boys” (Jaspel, Desrosiers, & Singh, 2012, p.16). The above-mentioned case studies prove that the best

time to develop a strong student-teacher relationship is in the initial starting school years of children.

The research of Skipper and Douglas (2015) provides evidence that feedback can be an important aspect of the healthy teacher-student relationship, especially in the case where children fail at tasks; this highlights the importance of experiences of success in helping children develop and maintain good relationships with their teachers.

William & Leahy (2015) argued that motivation plays a big role in learning. To build a good relationship between teachers and students, motivational skills are very useful. A good motivation brings new and positive thoughts into the student's mind. We often see that a teacher who appreciates and motivates the students becomes a role model for the students, rather than the teachers who always criticize the students. Both intrinsic and extrinsic motivation is necessary for the enhancement of student performance (William & Leahy, 2015, p. 187). Usually people prefer intrinsic motivation, but the extrinsic motivation has its own importance for the learner. Extrinsic motivation gives more space for teacher-student rapport building (William & Leahy, 2015).

Teaching is a challenging job, as it requires much hard work to deal with different students with different needs (Bernstein-Yamashiro & Noam, 2013). By listening and caring for the students, teachers can develop basic trust between teacher and student, which is essential for student achievement (Ayalon, 2011). As mentors, teachers keep students on track academically. To engage the student in the classroom, teachers can use different methods other than traditional methods of instructing. The teacher can use brainstorming, question-answer methods, or group discussions to explore the students' knowledge. In this way, students recognize that their teacher values the knowledge and experience that students bring to their learning. From my own

experience, I recognize that a positive student-teacher relationship is the basis for a student's bright future because, after the influence of parents, teachers are the people with whom a child spends most of his or her time with, during the process of learning.

Problem-Solving Methods in Mathematics

According to Bruner (1973), a child is a problem solver from birth whenever they encounter their environment. They solve problems and acquire skills with a minimal instructional approach. The problem is not something that we can solve effortlessly. We need a creative method to solve it (Liljedahl, 2005). If the problem challenges our curiosity, if it brings tension, then we feel the pleasure in solving it (Polya, 2004). Polya (2004) explained that mathematics teachers have a greater opportunity to turn a student into a problem solver. They can help the student solve problems, but the help should be not too much or too little; with too much help, the student would not be challenged, and with insufficient help they could lose interest and make no progress (Polya, 2004). They should always be left with their share of work that could inculcate their interest in mathematics (Polya, 2004).

Polya(2004) gave more emphasis to posing questions and suggestions that could stimulate the student's mind to start thinking about the problem in the right direction. Stimulating questions can arouse the students' curiosity and motivate them to solve the problem. Polya provides four phases/stages/steps of the problem-solving process:

Understanding the problem. We all need to understand the problem first. If we start solving it without understanding, it may lead to a loss of interest. If the student is able to answer the questions like "What is the unknown? What are the data? What is the condition?"(Polya, 2004, p. 7), then he/she probably understands the problem.

Devising a plan. To devise a plan, we need an idea (Polya, 2004). Questions and suggestions from the teacher like “Do you know a related problem? Look at the unknown! And try to think of a familiar problem having a same or a similar unknown” (Polya, 2004, p.9) can help the student to provoke the idea. We need to gather our previous knowledge to devise a plan. We need to investigate whether we have used all the data and conditions. This stage needs concentration, our time, devotion, and a sense of purpose (Polya, 2004).

Carrying out the plan. This stage is much easier than the previous stage. If we are able to check the steps we used to solve the problem, we are on the right track (Polya, 2004).

Looking back. This is the stage of verification. If we stop our work after solving the problem, then in the future we would not be able to utilize the method that we have devised to solve the given problem to solve other related problems (Polya, 2004). “Can you check the result? Can you drive the result differently?”(p.15) If we are able to answer these questions, then we have utilized this method properly (Polya, 2004).

The problem-solving method is not only used in mathematics to inculcate interest in students, but it also used in other subjects and real life to solve your problems (Polya, 2004). It helps student engagement in classroom and strengthens the bond between student and teacher, whereas in the traditional method of teaching there is only a one-way interaction with the teacher and students play a passive role. This method makes the classroom more alive and ensures two-way interactions in the classroom.

Problem Solving Builds Thinking in the Classroom

Liljedahl (2015) observed students solving math problems. Students gave up easily when they became stuck on the problems. Students would try hard in front of teachers, but in their

absence they stopped their efforts. Liljedahl did not observe “AHA! experiences” (Liljedahl, 2005, p. 219) during his observations, which led him to design thinking classrooms.

A thinking classroom is a classroom that is not only conducive to thinking but also occasions thinking, a space that is inhabited by thinking individuals as well as individuals thinking collectively, learning together, and constructing knowledge and understanding through activity and discussion. (Liljedahl, 2015, p.4).

For the thinking classroom, Liljedahl started with problem solving in which students became engaged in conversations and tried to solve problems through discussions. According to the researcher, the nine elements in mathematics teaching by problem solving are: Types of tasks given to the student, how these are presented to the students, formation of groups, student workspaces, classroom design, how hints or prompting questions are given to the students, and how teachers give students effective feedback during the task and after it (Liljedahl, 2015). All these aspects affect student engagement. Liljedahl observed that by changing work spaces by making students work more on whiteboards around the classroom instead of sitting in rows in desks and solving problems with paper and pen, students participated more effectively in the task (Liljedahl, 2015). In this way, they discuss more about the problems with their groups or with other group members. This structure fosters thinking. When students sit in rows, they always try to hide themselves behind other students (Liljedahl, 2015). Now, as they work on white boards around the classroom, if they do not participate and stay behind, they get exposed more to the teacher who is at the centre of the classroom (Liljedahl, 2015). Using white boards instead of pen and paper makes students more willing to take risks, as they can erase if they make mistakes. This makes them confident to try different strategies in order to solve the problems. Making random groups for the task slowly breaks social barriers in the classroom, as people agree to

work with different students, so the amount of knowledge increases (Liljedahl, 2015). Tasks should be scaffolded in such a way that they keep a perfect balance between the difficulty of the task and the ability of the students to solve it. If the task is too simple, they can get bored, and if it is too hard, students can get frustrated. So, it is the duty of the teacher to control the frustration level of the students during problem solving (Liljedahl, 2015).

Scaffolding in Problem Solving

Scaffolding plays an important role in problem solving. Scaffolding is a method, device, technique, or guide in the hands of a teacher that can support students to learn complex things that are otherwise beyond their reach (Simons & Klein, 2007). Wood, Bruner, and Ross (1976) explain that “scaffolding consists essentially of the adult ‘controlling’ those elements of the task that are initially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence” (p. 90). Vygotsky (1978) discussed the effect of scaffolding on student learning as a zone of proximal development. He defined the zone of proximal development as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1978, p.86). In scaffolding, first the teacher provides students with the required information about the problem, and then during the process, the teacher monitors the learners, giving them ongoing support by maintaining the direction of the problem, controlling frustration, maintaining a degree of freedom, and asking them open-ended questions as prompts; in this process, teachers gradually release the responsibility to the learner (Puntambekar & Hübcher, 2005; Wood et al., 1976). In this environment, the teacher acts as a catalyst that can initiate and increase the rate of learning. According to Simons and Klein (2006), scaffolding is a

powerful guidance tool in the hand of the instructor that can improve student performance. Their study shows that when students experience scaffolding, they perform better in science, math, and technology. Scaffolding provides support for students to perform the tasks that they can do by themselves, while at the same time encouraging them to move toward the tasks they will be able to do in the future. In this way, students both extend and take ownership of their learning (Wood et al., 1976, Simons & Klein, 2006).

Assessment

Assessment for learning in problem solving is an ongoing and continuous process (OECD, 2013). Assessment can be done with feedback that is constructively utilized by the student to achieve his/her goal. In schools, students are given progress in learning, sometimes in the form of comparison with their peers, and sometimes they are told how much more effort they need to reach their goals (William & Leahy, 2015). Feedback should be an act of reinforcement rather than criticism because with criticism learners invest less effort, which leads to more criticism (William & Leahy, 2015). By reinforcing that the learners are on the right track, they can direct their work to reach their goals.

“Four things can happen after giving the feedback: 1) change in behaviour 2) change in goal 3) abandon the goal 4) rejection on feedback” (William & Leahy, 2015, p. 107). To give feedback to a student, teachers should know what motivates each student. Secondly, trust must be built with the student. Feedback should be descriptive rather than ranking work as good, excellent or bad, describing the weaknesses and strengths in the work. Suggestions need to be included in the feedback so that students know their areas for improvement (William & Leahy, 2015). Some students believe that intelligence is something that is fixed and inherent (William & Leahy, 2015). This is a kind of fixed mindset among students. It is the responsibility of teachers

and parents to develop a growth mindset among the students so they can believe in themselves and can polish their knowledge. Parents who praise their child's efforts rather than their achievement are likely to enhance knowledge and experience more development in learning (William & Leahy, 2015).

Praise has no direct link with student performance (William & Leahy, 2015). It is sometimes harmful for students. Feedback is given in the form of a grade in traditional teaching. Students are assessed on the basis of their academic achievement. Due to grading, two problems arise: 1) asymmetry of situation, and 2) strong correlation between the grades and efforts, as we assume that students with good grades invest more effort and students with low grades exert less effort, which is not always true (William & Leahy, 2015, p. 117). So, it can be good to assess students in terms of progress rather than achievement. In giving feedback, we should be clear that we are giving feedback to improve a particular piece of work or to improve the capability of the students. It should be supportive (William & Leahy, 2015).

Growth Mindset

Generally in the classroom setting, the teacher's energy goes towards teaching particular subject matter, rather than negotiating the task (Mandel, 2017). According to Mandel, there are a variety of students in the classroom. Some are those who are participating in the classroom activities and performing beyond the expectation of the teachers. Others wait for the teacher to approach them for guidance to initiate the task, and some even do not want to start the activity (Mandel, 2017). Studies shows that there are many factors that influence students to do certain tasks that they find difficult to do or initially they do not want to do (Mandel, 2017). These factors are the beliefs of students about themselves. Students sometime run away from difficult things they think they will fail at when they try new methods. Fear and a lack of confidence

come from within us. This is called our mindset. Basically, our mindset is our attitude that we think our ability is in hard and challenging situations of life (Mandel, 2017; Dweck, 2006).

The first person to suggest the idea of a mindset was Dweck (2006). According to Dweck, two kinds of mindsets exist; one is a fixed mindset and the other one is a growth mindset. People with a fixed mindset are afraid of challenges because they do not want to fail. They feel that if they fail, it will prove them dumb and not smart. They thrive for easy things that they can do flawlessly and effortlessly. They always feel intelligence is something people are born with, that if someone is good at a subject it is because they've had that skill from birth (Dweck, 2006; Bostwick, Collie, Martin, & Durksen, 2017).

On the other hand, people with a growth mindset love challenges. They believe in learning. They know they will learn something even if they fail. They put their effort into resolving the problem. If they fail, they try another method, but they do not give up. It is not about trying and trying something new, it is about learning something new from each trial (Dweck, 2006; Mandel, 2017; Bostwick et al., 2017).

According to Mandel (2017), if a student faces a problem, first he/she tries to solve it. One possibility is that he/she could be successful in solving it in the first attempt; another possibility is he/she would make mistakes and fail to solve it. In this scenario, three things could happen, and all these things lead to three kinds of mindset. The first is that he/she would stop trying and assume that he/she is not able to solve that problem. The student believes that it is not meant for him/her to be successful and stops trying. These kinds of people are fixed-mindset people. The second kind of people may try to solve the problem again and again by the same method without actually learning from their mistakes. Those people think they are trying, so they have growth mindset, but they have a virtual growth mindset because they are not learning from

their mistakes; they just keep trying, which also leads to failure. The third kind of people, learn from their mistakes and try not to repeat them. They do not hesitate to try a different method. By trying and learning at each step, they get success. These kinds of people have a real growth mindset.

Talking about teachers with fixed and growth mindsets, for professional development, a growth mindset is necessary so that teachers are ready to take risks in their teaching to use new resources and methods to improve their teaching (Dweck, 2014). They take the initiative to develop their abilities. New teachers need to experiment with new teaching methods to know what works best for students by reading professional literature to discover new ideas and teaching techniques (Dweck, 2014). They can observe other teachers to see how they approach and work with students, or they can ask colleagues for feedback about their teaching (Dweck, 2014). Teaching is collaborative work. People with a fixed mindset fear negative judgment from others, thinking that if they have talent, no one can judge them, but this is a time of technology, so to thrive in this era, adopting new methods and techniques to polish personal talent is critical. Teachers with a growth mindset are always ready for new changes; they learn from their mistakes, making them better for the future (Dweck, 2014).

People with fixed mindsets always hide their deficiencies and mistakes (Dweck, 2014). Growth-mindset people discuss their classroom problems with coworkers in order to learn from them, sometimes gaining new ideas and solutions from the discussion. New teachers, instead of setting big goals, should first start with short-term goals. With the passage of time and patience, big goals will be attained with the attainment of short-term goals (Dweck, 2014). We can learn something from each student. A teacher with a fixed mindset considers disruptive students a threat, while a teacher with a growth mindset considers it a challenge and an opportunity to

polish his/her skills and ability to become a better teacher (Dweck, 2014). A teacher with a growth mindset is more courageous to adopt new environments and welcome new changes in the education field.

Grit

What makes a person successful? It is hard work, resilience, determination, and having a goal to accomplish. If we combine all these things, we have a common word: Grit (Duckworth, 2016). Duckworth (2007) commented,

Grit is the passion and perseverance for long term goals. Grit entails working strenuously towards challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress. The gritty individual approaches achievement as a marathon; his or her advantage is stamina. (p. 1088)

Duckworth (2016) did great research on grit. She is a professor of psychology at the University of Pennsylvania. Prior to her career in research, she was a math and science teacher. In her teaching career as a math teacher, she observed that some of her students grasped math very quickly and some struggled to understand it (Duckworth, 2016). However, during exam time, a few of her most talented students did not perform well. On the other hand, she was surprised to see the performance of students who struggled in the classroom. What made a difference are the efforts that they expended to get good scores in the final exams (Duckworth, 2016).

Duckworth also suggested that aptitude is not the only thing that can guarantee success (Duckworth, 2016). It is aptitude with effective efforts that leads to achievement (Duckworth, 2016). To justify this, she shares one of her experience at Lowell High school at San Francisco. This school admits students on the basis of academic achievement (Duckworth, 2016). There

were two types of algebra classes: One was an accelerated track and other was a regular track; she was teaching a regular class. David was one of her students who initially did not participate much in the classroom activity. However, with the passage of time, he enjoyed doing assignments and asked Duckworth for harder assignments. Upon Duckworth's recommendation, he got into the accelerated track class, where he struggled initially but due to his efforts and hard work he graduated with good grades and earned a PhD in mechanical engineering. Now he is a rocket scientist. Talent combined with effort makes us acquire skills. Skill and effort together results in achievement (Duckworth, 2016).

Duckworth started her research on grit at the United States Military academy at West Point. Most of the cadets drop out before graduation despite their outstanding academic and physical standards. Duckworth came with a test called a "grit scale" (Duckworth, 2016, p. 9), which was a reliable predictor of who would stay and who would not at the military academy. Grit plays an important role in predicting who is determined and passionate enough to acquire their long-term goals (Duckworth, 2016).

According to Duckworth, grit is not a fixed type of physiological trait that once we acquire it remains same. It grows with experience and age (Duckworth, 2016). We get grittier as we get older. According to Duckworth, grit and mindset are interconnected. Duckworth and Dweck (2014) found that the student with a growth mindset is significantly grittier than the other students. These students put more effort into acquiring their goals (Duckworth, 2016).

Conclusion

What I have realized from my readings is that to be successful in math or any of the subject areas, grit and a growth mindset plays a very important role. Grit makes you work hard to achieve your aim, and with a growth mindset, students do not have set backs in when they fail,

they learn new things from their errors and never give up. Problem-solving skills and scaffolding can build a thinking classroom in which students inquire about their problem and try to solve it through collaboration with other students and with the help of the teacher. My literature review has led me to a method of teaching inquiry-based learning, which supports critical thinking and collaboration, key skills for the 21st-century education system. In this method, students build their questions to explore and conduct inquiries with the help of their team. In this method, the teacher acts as a facilitator who guides the students. By using this method, students build critical thinking and social skills (Partin, 2009). This method will act as my model for my research paper. It is explained in the next chapter.

Chapter Three: The Bridge

This chapter will provide a link between my literature review, the rationale, and the design of my workshops that I have developed for this project. During my research on effective student engagement in the mathematics classroom, I discovered that inquiry-based learning acts as a model that provides answers to my questions about student engagement. Inquiry-based learning is highlighted in many papers and policy documents as a method to support the 21st-century education system. The new BC mathematics curriculum gives more emphasis on “experiential” learning. Mathematics is viewed as an interdisciplinary skill that a child can use in everyday life (Government of B.C., n. d.).

Methodology

During my research I read many different scholars in the field of mathematics teaching and learning pedagogy. Most of them used a mixed method. According to McLaughlin, Bush & Zeeman (2016), mixed method is a combination of qualitative and quantitative research method to address a research question. Hayward, Kogan, and Laursen (2015) used a mixed method to observe the impact of their workshops on the teaching pedagogy of the participants. They conducted three workshops on inquiry-based learning (IBL) with both pre-workshop and post-workshop surveys. The results of their surveys showed that most of the teachers adopted the IBL method in their teaching after attending their workshops.

I have designed a series of workshops to be led by a facilitator for a targeted group of learners. The target audience consists of public school teachers in Punjab, India. “A workshop is defined as a brief and intensive educational program for a relatively small group of teachers that focuses especially on developing techniques and skills in a particular field” (Workshop, n. d.). I reviewed text books, online articles, and journals, presentations on the internet, and YouTube

videos in order to gather ideas and information about both the content and design of the workshops.

I am using qualitative methods to gather feedback on the impact of the workshops. “A researcher that selects a qualitative research method collects open-ended, emerging data that is then used to develop themes. This method allows for a study of an exploratory nature” (Campbell, 2014, p. 3).

Rationale

Through these workshops participants will become familiar with IBL as a method to engage students. When I was in India, I did not have a thorough understanding of IBL and the concept of a growth mindset. It has been through my master’s program at Vancouver Island University, Nanaimo, BC that I got an opportunity to study and understand these concepts in more depth. My research has led me to the conclusion that if teachers in India implement IBL instead of the traditional teaching methods, more engaging learning environments will be created for students. As cited in Makar & Fielding-Wells(2018),Mills and Goos have determined that “students are losing interest in mathematics largely due to a prevalence of tasks, pedagogies and learning environments that disengage students” (pp.53-63). If “inquiry-based learning creates personalized learning pathways for all the learners” (Mackenzie,2016, p. 9), then through this method, students will be more engaged in the classroom. In IBL, the control of learning gradually shifts from the teacher to the learner (Mackenzie, 2016), which further leads to the learner taking more ownership of their work. Inquiry-based learning develops both critical thinking and creative thinking, which are the key qualities of the 21st-century learner. For example, critical and creative thinking are part of the core competencies in the new BC curriculum.

Model for My Plan

During my literature review I read the work of Polya (2004) who demonstrated that the problem-solving method inculcates mathematics curiosity in the student. Polya divided the method into four parts, which I found similar to IBL. The problem-solving skill can be developed through inquiry-based learning, as these skills are central to IBL. As there is no wrong or right answer to a question, this method also removes the fear of failure, thus leading to increased confidence and a growth mindset in the students.

I decided to frame my workshops around introducing IBL to the teachers. The workshops also include the other three major parts of my literature review, i.e. the student-teacher relationship's effect on student engagement, the growth mindset, and grit.

My workshop design is the following:

- 1) Inquiry-based learning
- 2) Why inquiry-based learning?
- 3) Inquiry-based learning and student-teacher relationship, role of teacher
- 4) Importance of the growth mindset and grit in learners

Inquiry-Based Learning

In my first workshop I will introduce participants to what IBL is. It is a process in which students are actively engaged in creating, evaluating, and reflecting on the knowledge that they have developed and which they can successfully use in their future problems and in real life. According to Mackenzie (2016), there are four levels of IBL. First, the teacher can start with a structured inquiry, in which teacher has complete control. The teacher is the one who decides the

essential question, resources, learning evidence, and performance task for the students. In the next level, the teacher shifts to the controlled and guided inquiry in which questions are chosen by the teacher, and students choose their design product or solution. In all these three levels, teachers deliver the most known content from the curriculum and factual knowledge to the student (Mackenzie, 2016). The process gradually shifts to open or free inquiry, in which students construct their own question to inquire about, and make and implement their plan. In this way, students take ownership of their learning.

Why Inquiry-Based Learning in Mathematics?

BC's new mathematics curriculum gives more emphasis on hands-on experiential learning. Mathematics is viewed as an interdisciplinary skill that a child can use in everyday life (Government of B.C., n. d.). The three core competences of the BC curriculum are communication, thinking, and personal and social skills (Government of B.C., n. d.). These competences can be acquired through IBL. According to Dai, Gerbino, and Daley (2011),

Inquiry-based learning engages learners' minds in puzzling out things, examining assumptions, carrying out mental experiments or real ones, developing well-reasoned arguments by gathering and evaluating evidences, fashioning solutions to problems which are meaningful to the learners, and envisioning alternative possibilities, and so on and so forth. (p.140)

Role of Teacher and Student-Teacher Relationship

My third workshop is on the role of the teacher as a facilitator in IBL. According to Mackenzie (2016), "Inquiry provides the structure and pedagogical framework to be the teacher our students need" (p.20). The teacher plays the role of a guide, a coach, a mentor, and a facilitator at different levels of inquiry. It is important to scaffold students' learning in an

effective way. Creating a safe environment for the student in the classroom is essential so that students can ask questions and participate in the class activities without any fear of judgment or failure (Mackenzie, 2016).

Importance of Growth Mindset and Grit in Inquiry-Based Learning

In my studies, I frequently came across the concepts of the growth mindset and grit. To me these can be considered the two pillars in IBL. Growth mindset and grit can motivate students and teachers to persevere in periods of failure or setbacks. In IBL, the possibility of diversion from the learning path is high and sometimes demands more time to reach the intended results. So, it is very important for the learner to develop grit and a growth mindset. My 4th workshop is on the growth mindset and grit.

Implementation of the Project

The project can be implemented in May when schools in India have summer vacation for the students. The workshop would be held in the school over a period of five days. During April, the facilitator can meet the principal and teacher to find which week is best suited for teachers to meet in the school for the workshops. The following chapter will explain the workshops in more depth.

Chapter Four: The Plan

This chapter will describe the detailed plan of the workshops that I have designed for teachers on the basis of my literature review. These workshops are my first small steps to bring a big change to the education system of Punjab.

Overview

The workshops are based on the inquiry-based learning model. These workshops will be held in the first week of May during summer vacation. The first workshop will give detailed information about IBL to teachers. The second day will make teachers realize why we need to change our method of instruction in the classroom. They will get to know the importance of IBL. The third workshop will be on the role of teachers in IBL. The fourth day will explain the attributes that will be developed in the students and teachers by using this method of teaching. The fifth workshop will be the paying gratitude towards each other.

For assessment, on the first day, the facilitator will distribute blank reflective journals to the participants. In this journal, participants will reflect on what they feel about the workshops, what they have learned that is new, and what they want to explore more from the workshops. In short, they will write reflections in these journals. In every workshop they will submit it to the facilitator and take it back at the end of each day. In the last workshop, participants will give a small presentation on what they have learned from these workshops.

Workshop One: Inquiry-Based Learning

Aim: Participants will understand the meaning of learning, how they take place, and the concept of IBL.

Required materials: Chart papers, colourful markers, papers, white board, markers, library excess, *Are You Ready to Disrupt Learning?*(video-16min 38secs), and the article, “What is Inquiry?”

Activity 1

Duration: 30 minutes

Objective: Know your group

Procedure: In this activity the facilitator will introduce him/herself. He/she will make the sitting arrangement circular so that each member of the group can see everyone in the room. The facilitator will pass the paper and markers to the group and tell them to fold it in half and write their name on it and place it on the table, so it will be helpful for other group members to see each other’s name.

The facilitator will ask the participant to think about their recent learning happens in a couple of weeks. The facilitator will share his/her learning experience and then will ask the participants who is born in the month of January to start with their introduction and share their recent learning to the group. And it is his/her choice which way he/she would want to proceed in the group.

Activity 2

Duration: 20 minutes

Objective: Participants will able to understand the concept of learning. Which kind of learning is effective for them?

Procedure: The facilitator will make three groups and tell them to design their dream classroom where maximum learning could happen and discuss what things are essential for the learning to happen. Is it only the content that teachers deliver in the classroom, or is the way they

deliver the content in the classroom important? Then the facilitator asks their points of view and writes those points on the white board regarding what they think about learning.

Activity 2.1: The facilitator will show the video *Are You Ready to Disrupt Learning?*

Objective: Participants will be able to understand the concept of learning and what kinds of strategies are effective to inculcate learning.

Procedure: The facilitator shows the video to the participants. After this, the facilitator tells them to discuss with the person by their side: What are the features of the two classrooms described in the video, and what classroom their designed dream classroom resembles the most. Do we always need a teacher in order to have learning, or does learning happen on its own? What extra points were left out that they want to add to the white board?

Activity 3

Duration: 40 minutes

Aim: Participants will understand the meaning of Inquiry-based learning.

Procedure: In this activity the facilitator will make four groups with four participants in each group alphabetically. Ask them to think about what they know about inquiry and IBL. Give them 25 minutes to search about the topic and come up with definitions and some of the features of IBL, and they need to present their findings in front of everyone as a presentation of two to three minutes. They can use the internet on their mobile phones or laptop if they have them and also use the library for help. After 25 minutes, they will gather in the room for presentations. Charts and colourful markers are distributed to them.

By doing this practice, they will know how IBL works. After the presentations, if anyone has questions, they can ask that question in the group and try to figure it out.

Activity 4

Duration: 1 hour

Aim: Participants will know the types of inquiry model they can use in their classroom.

Procedure: The facilitator will distribute the article from Galileo.org website, “What is inquiry? After reading the article, participants will be divided into groups of three members each. They will discuss which approach would be best for their classroom setting and why. After this, they will share their understanding about the topic with the other group members.

Workshop Two: Importance of Inquiry-Based Learning

Duration: 3 hours

Aim: Participants will realize the importance of IBL.

Material required: “Twenty-first Century Students: Engaged, Ethical and Entrepreneurial” (article), *Transforming the Education System in India* (video, 10min 19secs), *Education in India: are the Students Failing or the System?* (video, 11min 22secs), *Creativity in Mathematics: Inquiry-Based Learning and the Moore Method* (video, 20min 43secs).

Activity 1

Duration: 15- 20 minutes.

Objective: Participants will be able to know each other more closely.

Procedure: In this activity the facilitator will make random groups each with two participants. They both need to interview each other and share about their likes, dislikes, hobbies, or anything that is important to them. They will be given five minutes for this. After that, they need to introduce their partner to the group. In this way, everyone is introducing their partner in their own words and they will get to know each other better. It will help them to make a connection with each other.

Activity 2

Duration: 30 minutes

Aim: Participants will be able to identify the qualities of 21st- century students.

Procedure: In this activity, the participants read the article “Twenty First Century Students: Engaged, Ethical and Entrepreneurial.” After this, the facilitator will form groups of two members. They need to discuss the key points of the article and have to answer the following questions: Do our school system and methodology of instruction create the citizens of future? If yes, then how? And if no, then how can we as teachers contribute to create 21st-century learners? After this, participants will share their thoughts with other group members.

Activity 3

Duration: 20 minutes.

Aim: Participants will understand why we need to bring the changes in our education system.

Procedure: In this activity participants will watch the video *Transforming the education system in India*. And after this, participants will present their thoughts about the education system of India. How much has it changed from past to present when they were students and now when they are teachers? Is it beneficial to use old teaching methods in the era of technology?

Activity 4

Duration: 20 minutes.

Aim: This video will show them an example of the school in India where the inquiry-based learning approach is used and they are getting good results.

Procedure: In this activity participants will watch the video *Education in India: Are the Students Failing or the System?* After watching the video, participants will discuss the key themes they got from the video. Why do the results of schools shown in the video get better by time; what are the reasons behind this?

Activity 5

Duration: 30 minutes.

Aim: Participants will understand the significance of using IBL in their classroom.

Procedure: Participants will watch the video *Creativity in Mathematics: Inquiry-Based Learning and the Moore Method*. They will discuss what they feel, how students are learning math in that kind of classroom setting and what they observe in the behavioral changes among the students. Do they feel it is beneficial for students or not? Participants will share their opinion with the group members.

Activity 6

Duration: 20 minutes.

Aim: Participants will understand why we need inquiry.

Procedure: In this activity the facilitator will distribute an article “Why inquiry?” After reading the article, participants will discuss with the other group members what they find interesting in the article, and one by one they will write those points on the chart and display the chart in the room.

Workshop Three: The Role of Teachers

Aim: Participants will understand their role as a teacher in IBL and realize the importance of the relationship between the teacher and student.

Duration: 2 hours 30 minutes.

Required material: Markers, chart papers, pen and papers, videos *How To Get Into Inquiry-Based Learning: Part 1 – First Steps to Inquiry*(video, 3min 44sec) and *How To Get Into Inquiry-Based Learning: Part 2 – Working Towards Open Inquiry* (video, 6min 35 sec).

Activity 1

Duration: 15-20 minutes.

Objective: This is a check-in activity to break the monotony of the classroom.

Procedure: In this activity participants will place their name tags on the table. The facilitator will give them two minutes to think about their favorite teacher during their school or college and think about the quality in that teacher that they liked most. What qualities did they take from their favourite teacher and use in their teaching career. The person who entered last in the room has to start and share his/her experience with the whole group. It is on that person which way he/she wants to proceed in the group, either left or right.

Activity 2

Duration: 20 minutes.

Objective: They can self-realize how they prepare for their lesson and how others do it.

Procedure: The facilitator will distribute papers with three columns to the group. Column 1 has the heading “Before”, column two has the heading “During”, and column three has the heading “After “ (Appendix A). They are asked to write what they mostly do before they enter the classroom, during their instruction in the classroom, and after they are done with their classroom instruction. The facilitator will ask them to share what they have written to their group. In this way they will get a chance to hear others, and they can add their points to their charts as well.

Activity 3

Duration: 20 minutes.

Objective: Deeper understanding of the role of the teacher and the value and importance of the student-teacher relationship in IBL.

Procedure: The facilitator will show them the video *How To Get into Inquiry-Based Learning: Part 1 – First Steps to Inquiry* and *How to Get into Inquiry-Based Learning: Part 2 – Working towards Open Inquiry*. In this video, two types of relationships between students and teachers are shown in IBL. After watching the video, participants of each group will discuss, what difference they noticed between the two teachers? which teacher they liked and why from the video? They will think about the importance of a positive student-teacher relationship in IBL. Now the facilitator will show them the second video, *How to Get into Inquiry-Based Learning: Part 2 – Working towards Open Inquiry*. After watching the video, they will discuss in their group what the important things to keep in their mind are to use IBL in their classroom.

Activity 4

Duration: 1 hour.

Objective: Participants will get some more understanding about IBL.

Procedure: In this activity the facilitator will make slips out of which number one is written on four slips, two is written on four other slips, and three and four written on the remaining eight slips respectively. Participants are asked to select one slip from the box. Four participants with the number one slip make Group A, participants with slip number two make Group B, and participants with slip numbers three and four will make groups C and D respectively. They are given charts and colourful markers and they write points that are important for them before, during, and after the classroom if they are inculcating IBL in their

classroom. At the end they will be given 30 minutes to discuss and record what they want to present and given three minutes to present their opinion to the group.

At the end of the workshop participants will present their thoughts on the role of the teacher in IBL to the whole group. Do they realize how important this is to them? Before exiting they will display their charts on the walls of the workshop.

Workshop Four: Attributes Developed

Aim: Participants will learn about mindsets, skills, and attributes that will be developed in students by using IBL.

Material required: Charts, markers, and video *Teaching a Growth Mindset, Teaching Problem-Solving Skills*(video- 14min 30sec), and the video#*EIE16: General Session - Grit: The Power of Passion & Perseverance with Angela Duckworth*(video,51min 48 sec).

Duration: 3 hours.

Activity 1

Objective: Check-in activity to make them familiar with what they are going to learn in the workshop.

Duration: 10-15 minutes.

Procedure: In this activity the facilitator will ask the group members to think about a skill they already have or they want to learn in the future and also give their thoughts on whether they think skills can be developed with time or those are things with which a person is born with. The facilitator will give two minutes to think, and then he/she will ask the person who is born in the same month as the workshop to share their thoughts with the group.

Activity 2

Objective: Participants will know and understand the terms *growth mindset* and *fixed mindset*.

Duration: 25 minutes.

Procedure: This activity starts with a video *Teaching a Growth Mindset* and participants will learn about *Dweck (2006)*, who bring the concept of term *growth mindset*. Through this video participants will be familiarized with the terms growth and fixed mindset and why this is important for them as well as for their students. At the end of the video they will be asked to share their thoughts regarding the terms to the person who is sitting by them.

Activity 3

Objective: Participants will try to understand more deeply the concept of mindset by solving dilemmas.

Duration: 45 minutes.

Procedure: In this activity the facilitator will ask the participants to make eight groups with two participants in each group and make sure they make a team with a person whom they never made a group with before. Then facilitator will give them instructions and give eight slips with eight different dilemmas or scenarios from Dweck's (2006) book (Appendix B). With these slips they need to put themselves in that scenario and discuss what they would think about that as a fixed-minded person and as a growth-minded person. They will be given three minutes for each scenario, and then they will pass their slip to the next group. In this way everyone will need to discuss all eight scenarios. This activity will be like a brainstorming activity. At the end, the facilitator will display each dilemma and every group has to present their thoughts regarding that scenario and whatever they discussed.

Activity 4

Objective: Participants will understand the importance of grit in learning.

Duration: 40 minutes.

Procedure: In this activity the facilitator will ask the participants to write their goal or aim that they want to achieve in their life on their name slip placed on their table. The facilitator will start the video#EIE16: *General Session - Grit: The Power of Passion & Perseverance with Angela Duckworth*. As this is a long video, the facilitator will play the video until 29 minutes and 45 seconds. At the end, participants will be given some time to think, and they can come up with questions about grit and try to find the answer within the group.

Activity 5

Objective: Participants will get to know how problem-solving skills could help them and their students to solve problems.

Duration: 45 minutes.

Activity: In this activity the facilitator will ask the participants to make four groups with four persons in each group by themselves. They will help change the classroom arrangement with four tables with four chairs at each corner of the room. They are given charts and colourful markers for this activity. Now the facilitator will introduce them to the task they will perform. They need to come up with a model of how they make their students solve a problem by themselves. They will be given 30 minutes to discuss and record and two minutes to present. After this, participants will watch the video *Teaching Problem-Solving Skills* and discuss what is problem solving and how to solve a problem. At the end of the workshop the facilitator will take a group picture of the participants that the facilitator will distribute at the last workshop.

Assessment: The facilitator will tell them they need to reflect in their reflective journal why a growth mindset, grit, and problem solving are important for them to learn and for their students, and whether they will utilize these skills in their subject area that they teach.

Workshop Five: Reflective General Presentation and Paying Gratitude

Aim: In this workshop, participants will reflect on and share their experience and will pay gratitude to each other.

Duration: 3 hours.

Activity 1

Objectives: Reflect on their learning through presentations.

Procedure: Participants will give their reflective journal to the facilitator and share their learning experience and how they will merge their teaching with IBL. They will be given 10-15 minutes to present and five minutes for the question and answer section.

Activity 2

Objectives: facilitator will assess the learning of their participants from this activity.

Procedure: The facilitator will divide the white board into two parts, one with the heading Pros and the other with the heading Cons. Participants will discuss the advantages and disadvantages they think are connected to IBL and have a debate on it by dividing the group into two teams; one who will list the pros and the other will make their points on the cons of this method.

Activity 3

Objective: Goodbye and paying gratitude to the group members.

Procedure: In this activity the facilitator will distribute self-made greeting cards with the group photograph in it to the group. Each card will have a written quote for the card holder. The facilitator will tell everyone to write something about the card holder in the card holders' card to pay gratitude. The facilitator will also share his/her experience with the group. After this, the facilitator will distribute feedback forms (Appendix C). They need to fill them out and submit them before going.

Chapter Five: Conclusion

Summary

The aim of this research project was to explore how problem solving, scaffolding, teacher-student relationships, a growth mindset, and grit affect the teaching of mathematics. It has inspired me to design a series of workshops on IBL for public school teachers in Punjab, India, so that they can have a clear picture about this effective teaching method and try to implement it in their classrooms.

As I stated in chapter one, mathematics has an investigatory nature in that students collect, organize, and investigate the data that they have collected in order to obtain a deeper understanding of the concept. This type of deep learning is not possible if we present them with solutions to their problems or directly solve it in front of them and they just copy it into their notebooks. A change is required in teaching mathematics. I have found that IBL can bring about these changes. Based on my research, IBL is a method of guiding students to investigate their own essential questions and build their new knowledge. In this method, teachers play different roles during the process of learning: They become a facilitator, a coach, an adviser, and a critical friend (Mackenzie, 2016). The role of the teacher changes according to the requirements of the students (Mackenzie, 2016).

Discussion and Conclusion

When I started my project, I had clear questions about why children find math difficult and which effective teaching method could develop their interest in mathematics. What factors affect students' learning? I learned that the relationship between a student and a teacher is significant. It is the responsibility of the teacher to create a safe environment for a student to participate, inquire, and learn. Spending time with students helps teachers get to know their

students better and can build a mutually respectful relationship among them (Bernstein-Yamashiro & Noam, 2013; Starkman, 2006). In a safe environment, students fearlessly ask questions, share their thoughts with their classmates and the teacher, and take risks to solve problems (Starkman, 2006).

In addition, I have explored the problem-solving method and scaffolding. Polya(2004) was an excellent resource. The author gave a series of steps in the problem-solving method and also illustrated it with examples. I have also read Liljedahl (2015, n. p.), who emphasized the benefits of “thinking classrooms.” A thinking classroom is a classroom where students actively engage in problem solving, share their findings, and work in collaboration with their peers instead of sitting passively at their desks. The teacher acts as a facilitator who scaffolds student activity by asking open-ended questions and providing hints, so that students can get closer to their goal. The growth mindset and grit also play important roles. Grit is the “passion and perseverance” for long-term goals (Duckworth, 2016). The grittier the student is, the more effort he/she will put towards the solution (Duckworth, 2016). Students with a growth mindset consider mistakes part of their learning (Dweck, 2006). Growth-minded people do not fear challenges and taking risks (Dweck, 2006).

The literature review enhanced my understanding of creating an engaging mathematics classroom. However, I was searching for a comprehensive model for my workshops. After meeting with my professor, Susan Montabello in the education department of Simon Fraser University, I have found an answer to my question. IBL became my model, and I designed workshops for Indian teachers. Mackenzie (2016) was a good resource for me to understand more about this method. Mackenzie shared his story of how he started IBL in his classroom. He took small steps by co-designing a curriculum with his students to know what they wanted from

their course. This activity helped him to build classroom community. Inquiry is all about exploring your own essential questions. He also said the inquiry student is “curious, creative, shows initiative and multi-disciplinary thinking, is empathetic, and exhibits a growth mindset, grit, and character”(Mackenzie, 2016, p.34).

Limitations

The project that I have designed is only for teachers. However, teachers need support from students, parents, and school administration to implement this type of course in their classes, and I do not include them in my topic.

To develop IBL in the classroom, sometimes teachers need materials and resources; obtaining these materials is the responsibility of the school management. My project did not cover this aspect of the method. My project was not able to provide lesson plans for each topic of mathematics using IBL, as in India the syllabus of mathematics is lengthy. I have used a qualitative method for my research project, as it is based on my findings from the literature review. I did not implement it. I did not do any surveys or interviews.

The inquiry-based learning method is successfully implemented in Canadian schools. I experienced it during my visit to the Pacific School of Innovation and Inquiry in Victoria, BC (School visit, March 1, 2017). If the study is conducted in the schools of Punjab, the results might be different.

LookingForward

It would be excellent if IBL is initiated through these workshops in the schools of Punjab. In this way, we can get a clear picture of the strengths and challenges of this model in practice. There is a need for open discussion and feedback from teachers who will implement this

teaching method in their classrooms. What kind of changes will they observe in their students?

Researchers can develop a curriculum for Indian students embedded with IBL.

On the website of the central board of secondary education (CBSE) in India, the emphasis is on a child-centered, stress-free, and holistic approach for education. They also give prime focus on innovations in learning and teaching methodology like new BC curriculum, which also focuses on inquiry. These things are missing in the Punjab school of education board website. The inquiry-based learning method is central to 21st-century education as we prepare our students for the future.

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Appendix A

BEFORE	DURING	AFTER

Appendix B

You will be given 5 minutes to read and think about for each scenario. What will you do in each situation given below?

1. One day, you go to class that is really important to you and that you like a lot. The professor returns the midterm papers to the class. You got C+. You're very disappointed. That evening on the way back to your home, you find that you've gotten a parking ticket. Being really frustrated, you call your best friend to share your experience but are sort of brushed off.

2. Imagine you've applied to graduate school. You applied to just one place because it was the school you had your heart set on. And you were confident you'd be accepted since many people considered your work in your field to be original and exciting. But you were rejected.

3. "Here I am," you think, "in the low level job. It's demeaning. With my talent I shouldn't have to work like this. I should be up there with the big boys, enjoying the good life." Your boss thinks you have a bad attitude. When she needs someone to take on more responsibilities, she doesn't turn to you. When it's time to give out promotions, she doesn't include you.

4. Imagine your young son comes home from school one day and says to you, "Some kids are smart and some kids are dumb. They have a worse brain." You're appalled. "Who told you that?" you ask him, gearing up to complain to the school. "I figured it out myself," he says proudly. He saw that some children could read and write their letters and add a lot of numbers, and others couldn't. He drew his conclusion. And he held fast to it. Your son is precocious in all aspects of the fixed mindset, and soon the mindset is in full flower. What will you do to change his thinking?

5. Imagine you're a nice, caring person-as you probably are usually. You love your spouse and feel lucky to have them as your partner. But when they violate one of your rules, like letting the garbage overflow before taking it out, you feel personally betrayed and start criticizing. It begins with "I've told you a thousand times," then move on to "You never do anything right." When they still don't seem properly ashamed, you flare, insulting their intelligence ("Maybe you aren't smart enough to remember garbage") and their character ("If you weren't so irresponsible, you wouldn't...." "If you cared about anyone but yourself, you'd..."). Seething with rage, you then bring in everything you can think of to support your case: "My father never trusted you, either," or "Your boss was right when he said you were limited." Your spouse has to leave the premises to get out of range of your mounting fury.

6. You seem to have everything. You have a fulfilling career, a loving marriage, wonderful children, and devoted friends. But one of those things isn't true. Unbeknownst to you, your marriage is ending. It's not that there haven't been signs, but you chose to misinterpret them. You were fulfilling your idea of the "man's role" or the "woman's role," and couldn't hear your partner's desire for more communication and more sharing of your lives. By the time you wake up and take notice, it's too late. Your spouse has disengaged emotionally from the relationship.

7. Read each statement and decide whether you mostly agree with it or disagree with it:

1. Your intelligence is something very basic about you that you can't change very much.
2. You can learn new things, but you can't really change how intelligent you are.
3. No matter how much intelligence you have, you can always change it quite a bit.

4. You can always substantially change how intelligent you are.

8. Look at these statements about personality and character and decide whether you mostly agree or mostly disagree with each one.

1. You are a certain kind of person and there is not much that can be done to really change that.

2. No matter what kind of person you are, you can always change substantially.

3. You can do things differently, but the important parts of who you are can't really changed.

4. You can always change basic things about the kind of person you are.

Appendix C

Workshops feedback form

Date:

Name:

Contact number:

Please rate the following statement on the scale of 1-5 where:

5- great, 4-good, 3-average, 2-fair, 1-poor

STATEMENTS	1	2	3	4	5
How valuable these workshops were?					
How effective was the facilitator?					
How clearly was goals and objective stated?					
Does content matches workshop objectives?					
What is the level of challenges?					
Would you recommend to others?					

Please answer the following questions:

1) Write at least one thing you have learned from these workshops

2) Write at least one topic you would like to explore more

3) Question you still have

4) Suggestions for the improvement of workshops and for the facilitator

5) remarks