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Creating First Grade Math Learning Materials in the Chinese Immersion Learning Environment

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Creating First Grade Math Learning Materials in the Chinese Immersion Learning Environment

By

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A capstone project submitted in partial fulfillment of the requirements for the degree of Master
of Arts in Education.

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CHAPTER ONE

Introduction

Introduction

Mathematics is a subject that people have mixed feelings about. It is boring because all people do is play around with numbers; it is challenging because people need to have clear logical problem-solving skills to solve complex problems; it is frustrating because of the painful process of not getting the right answer. However, this horrifying subject is the most basic and essential foundation of many other subjects.

I am an expert in mathematics. Growing up, I did not like it because of my experiences of frustration and failure. This personal experience of math learning encourages me to want to be a teacher who can help my students feel more confident and be equipped with more solid skills in mathematics.

I am a first-grade classroom teacher at a Chinese Immersion school in Northeast Minneapolis. There, I teach my students multiple subjects all in the Chinese language: Chinese Language Arts, Social Studies, Science, and Mathematics. All my students are Chinese Language Learners, so it sounds like it would be more challenging for a group of 6-year-old and 7-year-old students to learn math in a language they are unfamiliar with. Therefore, this Capstone project is going to investigate the essential question: *How does a teacher effectively teach mathematical concepts to first-grade students in Chinese?*

Chapter one will mainly focus on my rationale behind this capstone project based on my experience as a student who studied abroad in a different country and as a first-grade classroom teacher who witnessed her students' math problem-solving process. The chapter ends with a

quick summary and the connections that this chapter has moved forward into the rest of the chapters.

Background

In this section, I will be introducing a little bit about my background, and how my background relates to the topic of math education.

I was born and raised in China, attending an elementary school in a small town in Southern China, and then moving on to middle school and high school in Beijing. I also had one year of studying in Houston, Texas when I was in 10th grade. Therefore, I grew up learning my core subjects (language arts, math, social studies, and science) all mainly in Mandarin Chinese.

I wanted to be a teacher ever since I was in first grade. Back then, the main reason why was that being a teacher in China meant you were the authority in the classroom. The teacher can tell the students whatever they want, and they can yell or shout at the kids if they want to. In China, the teacher's instruction must be obeyed.

Later, I noticed that many teachers in China would expect only one specific answer or solution for any question or problem, including open-ended questions. Therefore, there was not much room for creativity and a growth mindset.

In China, most students learn new things by memorizing facts. Many teachers care less about how you remember or know the knowledge facts (whether is through experiments, exploring new things online, self-observation, etc.), and more about if students know the facts so that they will be able to perform better on the unit tests. Additionally, the students who have better behavior and test scores will get labeled as "good students", but students who have behavior problems and low test scores will be labeled as "bad students". That was my learning journey throughout elementary school and middle school.

After a year of studying in Houston Texas, I noticed that American teachers were more relaxed about students' learning. Unlike the Chinese educational system, American teachers were more about respecting students' learning growth. They respect each student as an individual being no matter how good their test scores can be.

When I was in America, the last thing I wanted to do was speak English to people around me, because back then I was new to the country and the language environment. I was so scared that other high school students would judge me if my English did not make sense to them. I was mainly quiet and confused that year studying in Houston Texas. Math class was the only class I did an awesome job at compared to the rest of my classmates (American students)! I cannot say it was my favorite class, but it was the easiest class compared to the other classes I took in high school. One reason was that I already learned the Math concepts when I was in middle school in China. The other reason was that English was not the biggest barrier that stopped me from understanding since Math is a universal subject.

When I was taking my Math class in the U.S., I noticed that American students were allowed to use calculators to do their math work. While the local students used their calculators, I already did the calculations in my head and got the answers correctly. Moments like that made me feel proud of myself because they were the only few moments that made me look smarter than most people.

After observing how American teachers teach, I decided I wanted to become a teacher to serve more students to be successful instead of deciding who will be "successful" in the future for them. Therefore, I came to America for college. I studied ESL Education as my major for my bachelor's degree because I have been an English Language learner my whole life, I wanted to

help students who come from different language backgrounds to learn English because I understand the process of learning the language.

I taught ESL for one year, and I taught ELL language arts and Math mainly when I did my pull-out and push-in sessions during that year after graduating from college. I found out that I really enjoyed the process of teaching Math to my ELL students. I liked the part when I broke the big concepts down into smaller pieces to help my students understand the math concepts they are learning. When I taught math to my ELL students, I usually introduced the academic terms before teaching the concepts and then explained the academic terms (that my ELL students did not understand the meaning of), displayed the mathematical problem, and see if they could come up with any solutions, and then I will encourage them to discuss with their table mates. During that process, I will monitor their thinking process and language usage when they try to express themselves. This strategy also helps students to improve their social-emotional skills by interacting with their peers.

Rationale and Context

In America, the mass media contributed a lot to creating the stereotypical impression that “Asian people are good at math.” People in China also have the stereotypical impression that “American math is easier than Chinese math”. I almost believed it when I first came to the United States and studied Algebra II in a public high school in 10th grade. Back then, the language barrier was the biggest challenge for me. I did not understand a single word that was written in my textbook but only guessed what the concepts in each chapter were about based on the images. Luckily, Math is a universal subject. I learned linear algebra in middle school, and I had a strong foundation and memory about that unit. Soon, I became the best student in that class although I was clueless most of the semester (not understanding what my math teacher was

talking about due to the language barrier). With the support of my electronic dictionary, I had a clear understanding of the logic behind every word problem compared to other students; I was quicker when it came to identifying the relationships between numbers; I was one or a couple of steps ahead in calculating the accurate answer for each math equation while the other classmates were just about to pull out their calculators to solve the problems.

Despite how easy math was for me in American education, I did not completely believe in the stereotypical impression that “American math is easier than Chinese math.” I never understood the reason why I was a step quicker than the rest of my high school classmates and college classmates until I heard an interesting idea from my Math Education professor from Hamline University— language can be an element that affects someone’s math learning progress. He introduced how the Chinese language makes many math concepts more straightforward such as place values, fractions, etc. He also talked about how many bilingual students (fluent in both Chinese and English) would choose to think in the Chinese language when it comes to solving math problems.

When I was a student teaching at an elementary school in the West St. Paul district, I helped co-teaching Fractions in a Fourth-grade classroom. The students had a hard time understanding the concepts of fractions because they could hardly identify the meaning of numerator and denominator. In English, a fraction reads from top to bottom, and the English does not explain the relationship between the denominator and numerator that clearly. However, when I observed a Chinese lesson about fractions in the Chinese Immersion school last year, the Chinese teacher taught the students reading the fractions in the Chinese way, which was from the bottom to the top (from the denominator to the numerator) with the word 分 (shared to). In Chinese $\frac{2}{3}$ is read as “三分之二” (Three shared to two, more telling the story of “three apples

are shared to two people"). Fraction is a hard concept, but the Chinese language makes the relationship between numbers more straightforward to provide a solid foundation for students' understanding of mathematics.

Now being a first-grade homeroom teacher who teaches at a Chinese Immersion school in the United States, I had a chance to witness one of my students (who is an English speaker) thinking and speaking about her math problem-solving process in Chinese. It made me interested to willing to investigate more about math education.

To help my students have a solid foundation in mathematical concepts, such as place value, I decided to create a math lesson pacing chart based on the curriculum the Chinese immersion school uses that aligns with the Minnesota Math standards (2022 Version).

Summary

This chapter talks about my personal math learning experience in America and the reasons why I want to work on this project. My professional experiences of teaching math in both English and Chinese helped me understand more how the Chinese language would benefit students' math learning process. The purpose of this Capstone project is to help my students have a solid foundation in math learning. The next chapter will include a literature review of research and articles based on how the Chinese language benefits math learning.

CHAPTER TWO

Literature Review

Introduction

People need mathematical skills in their daily lives. It can be used when finding the cost during grocery shopping, gathering information from graphs, making plans in an organized way by scheduling events at different periods, and so on. However, Math can be abstract for people to understand when they first study this subject. There are many symbols people need to learn and understand such as numerals, and different ways to express mathematical thinking processes such as math operations, symbols, fractions, decimals, percentages, etc. As people study more about the world, they start using mathematics as a tool to help them explore their surroundings. Therefore, Math Education plays an important role in human lives, especially starting in the primary education age.

Mathematics is a universal subject that is expected to be studied all over the world. Mathematics in different countries can be taught differently based on the cultural and linguistic background. Some of the linguistic backgrounds can benefit students to conceptualize mathematics. For example, numbers in the Chinese language follow the “Base Ten” system. The number words show how a number is composed directly by its place value (Han & Ginsburg, 2001). Since each Chinese character is pronounced as one syllable, counting numbers in Chinese can be easy and fast for students. Therefore, the students who study mathematics in Chinese will have a deep understanding of the place value concept. Additionally, students who are used to pronouncing a number in Chinese will increase their math fluency and automaticity because their thinking process in Chinese will be faster and more straightforward compared to English (Geary et al., 1996).

In today's world, Chinese immersion programs have become popular in the educational field all around the world. Many research results show that starting Math and language learning at a young age is important. I mainly work with first-grade students during the school year. Creating math learning materials in Chinese has become one of my biggest projects. This literature review aims to better understand the essential question of this paper: *How does a teacher effectively teach mathematical concepts to first-grade students in Chinese?*

Chapter Two starts with describing the essential components of successful math education. The key for students to have strong foundational skills in mathematics is to be sensitive and flexible with the numbers they are working with. Some of the foundational skills include students' number sense, math fluency, and math automaticity (Tsao & Lin, 2012). Once students increase their math fluency and automaticity, they will be able to enter the higher-level process of problem-solving in mathematics.

Next, this review will explore more what Math education in Chinese looks like. It will go over the nature of the Chinese language, and how beneficial the Chinese language can be when it comes to learning math. The review starts with the nature of the Chinese language, and then it describes how the Chinese language names each number by the "Base Ten" system.

Lastly, the review talks about what the Chinese immersion programs look like. It introduces that immersion is a method of learning a language, and students will be exposed to the target language most of the time at schools because the teachers will use 50% to 100% of the target language to teach (Santamaria, 2013, p.13). The Chinese immersion programs meet the needs of long-term time intensive study to master the Chinese language, and they also help students to be successful academically (Jacobson, 2013).

Math Education

For students to master mathematics, having strong foundational skills in being sensitive to the relationships between numbers will help them speed up the problem-solving process by applying different calculation strategies (Tsao & Lin, 2012). Some of the main skills include students' number sense, math fluency, and math automaticity.

Number Sense:

Students' number sense is their ability to understand the relationship between numbers and quantities and how they are affected by math operations (Frisco-van de Bos, Koresbergen, & Van Luit 2014; McIntosh, Reys, & Reys, 1992; Toll, Kroesbern, & Van Luit, 2016). If a student has good number sense, then they will be able to be fluent in estimating and judging quantity, recognizing if answers are logical, problem-solving in mind flexibly, moving between various mathematical representations quickly, and selecting representations that are efficient (Kalchman, Moss, & Case, 2001).

In order to have high-level skills in number sense, students do need to understand how numbers can be linked to different visual representations of the same quantity set. Students also need to understand that quantities can be nonsymbolic, such as tally marks (Frisco-van de Bos et al., 2014). Cain, Dogget, Faulkner, and Hale (2007) designed The Components of Number sense model for teachers to develop their instruction that helps students master number sense. The components include quantity, numeration, equality, base ten, forms of a number, proportional reasoning, and algebraic and geometric thinking.

Understanding the concept of quantity is important because it is not just theoretical knowledge that only appears in textbooks, but it applies in people's daily lives (Faulkner, 2009).

For example, students can apply their understanding of quantities to divide an apple pie when they are learning the concept of division.

Numeration is the ability for students to decode mathematical language and apply this ability within their numeration system which groups at a rate of ten (Faulkner, 2009). Students first apply the mathematical concepts and strategies with smaller numbers, and then they will gradually be able to apply the knowledge with big numbers. The students will be able to advance their abilities in calculations that include math operations with multi-digit numbers, multiplication, and division. Students will deepen their understanding in numerations including base-ten concepts. (Carpenter et al., 2015)

Base-Ten is the decimal system that people use. It has ten digits to represent all numbers (Cain et al., 2007). Developing the abilities of base-ten will help students to count increasing units of ten.

Equality is represented as an equal sign. The equal sign shows that two mathematical expressions have the same value (Falkner, Levi, & Carpenter, 1999). The left mathematical expression of the equal sign has the same value as the right mathematical expression of the equal sign. However, students tend to have some misconceptions as they learn more about the equal sign in math. Many students will see the equal sign as showing two things are the same instead of equal in value (Faulkner, 2009). Some students will treat the equal sign as a directional symbol. They would think the answer is always on the right side of the equal sign. For example $2+3=5$, students might view this mathematical equation as $2+3\rightarrow 5$. The math expression “ $2+3$ ”’s value is 5, and the math expression on the right side is also “5”. The values for both mathematical expressions are the same, which is 5. It is important to let students understand the meaning that the equal sign is showing an equal value (Faulkner, 2009).

Once students have a better understanding of the concept of equality, then they can get to know and be flexible with different forms of a number. This concept ties to equality in that numbers can be represented in various forms without changing their value (Faulkner, 2009). Students need to understand that a number can be expressed using the standard numerical form, written form, expanded notation, or a visual representation such as a dot pattern. Faulkner (2009) suggested that students should always be asking themselves a question, “Do I like the form a number is in?” This question encourages students to change the form of a number to make it easier or more familiar for them to work with. Being flexible with different forms of a number can happen in different levels of mathematical explorations, such as regrouping to add multi-digit numbers, simplifying mathematical expressions, or converting mixed numbers to fractions that are greater than one (Faulkner, 2009).

Proportional reasoning requires students to contrast and compare the similarities and differences between numbers in quantities (Faulkner, 2009). Providing different opportunities for students to think logically about the concepts of ratios, rate, quotients, and fractions can build these skills that are related to proportional reasoning (Lesh, Post, & Behr, 1998). In order to have a strong sense of proportional reasoning, students can be given instructions that involve real-world proportional relationships (Faulkner, 2009; Lesh et al., 1998).

Algebraic thinking incorporates students’ abilities in examining and recognizing patterns, analyzing and representing relationships, making generalizations and assessing how things change (Schielack & Seeley, 2007).

According to Van Hiele theory (1957), geometric thinking incorporates a progression through five levels: visualization, analysis, abstraction, deduction, and rigor where each level incorporates its own language and symbols (Ban Hiele, 1999). In order to build a strong number

sense in geometric thinking, children need to be given consistent interaction opportunities starting at an early age through play in geometry (Van Hiele, 1999).

There are correlations that have been made between the early development of number sense and later success in mathematics (Bellon, Fias, & De Smedt, 2019; Moffett & Eaton, 2019). Students' deep understanding of the relationship between numbers and math operations including addition, subtraction, multiplication, and division will benefit their conceptualizing process for higher-level mathematical knowledge (Bellon et al., 2019).

Math Fluency and Automaticity:

Math fluency is the ability to solve mathematical problems accurately. One result of fluency is math automaticity. Math automaticity is the ability to recall math facts or number facts in a short amount of time. Math fluency and automaticity usually work together as students get more familiar and sensitive with their number sense in order to efficiently solve higher-level mathematical problems that require multiple steps (Poncy, Skinner, & Jaspers, 2007).

One study tested 155 students on basic multiplication facts. They found that 13 percent were fluent. Of the same 155 students, only 3 percent were able to solve complicated questions related to multiplication, and these 3 percent of the students also showed fluency of multiplication (Baker & Cuevas, 2018). This shows a strong correlation between the ability to quickly access basic facts and being successful in higher-level mathematical thinking. One reason for this connection is that by knowing the basic number facts, the cognitive load is much less when approaching problems (Allen-Lyall, 2018).

Another study looked at the correlation between number fact automaticity and math proficiency on a state standardized test. The team found that there was a strong correlation between math fact knowledge and overall test scores in fourth grade and fifth grade (Brewer et

al., 2017). These results showed that as math becomes more complicated, a strong foundation of number facts is beneficial to be successful in mathematics learning. Baker and Cuevas describe, “There are studies that have found math fact automaticity to be a predictor of performance on general mathematics tests.” (2018, p. 3)

Math Education in Chinese

Mathematical content in different countries can be taught differently. Language and cultural background can be some of the reasons that cause math to be taught differently. Different languages can benefit students’ process of conceptualizing mathematics in different ways.

The Nature of the Chinese Language:

Like any other language, Chinese is a special language. Unlike English, Chinese is a tonal language, and there are 4 tones in Chinese: high level, rising, falling-rising, and falling. Each tone can represent a different character with different definitions. (Padilla, Fan, Xu & Silva, 2013) For example, high-level mā “妈” means “mom”, rising má “麻” means “numb”, falling-rising mǎ “马” means “horse”, and falling mà “骂” means “curse”. Therefore, the tones play an important role in understanding the Chinese language. The meaning of a word or a sentence can be delivered differently if people accidentally mispronounce any character.

On the other hand, the writing of the Chinese language is also really important. According to Fortune (2012), the written form of the Chinese language is not phonetic-based or Latin-alphabet-based character-based, but it is character-based. Writing Chinese characters is difficult because they are made of different combinations of strokes (Padilla et al., 2013). Some Chinese characters can be simple, and some can be complicated. The easiest Chinese character can only be one stroke, such as “一” meaning “one”. Some complicated characters contain over 50 strokes like “雷”, meaning “thunderclaps” (Dennis, N., 2023).

Math Education in Chinese:

Math education in different language backgrounds can benefit students in different ways. Math Education in Chinese will benefit students to be more sensitive to the number sense, and it will increase students' math fluency and automaticity. Math Education in Chinese also benefits students' understanding of some mathematical concepts such as fractions.

As Chang (2008) described math education in Chinese, "Several characteristics of the Chinese language, particularly the structure of its number and counting systems, have been credited in the aid of acquisition of number terms and concepts in children." (p.3) One thing about Chinese that benefits students conceptualizing mathematics is the base ten number system. The base ten number system in Chinese displays how number terms are composed of the tens and ones units directly (Geary, Bow-Thomas, Liu, & Siegler, 1996). Students, especially younger kids, find it easier to learn how to count in Chinese based on the base ten number system (Han & Ginsburg, 2001).

The base ten number system does not only benefit students' ability to count numbers in Chinese, but it also benefits students' understanding of place value. In English, numbers 11-19 can be confusing for students as they learn numbers within 20. For example, number 11 is pronounced as "eleven", and number 12 is pronounced as "twelve". It is hard for students to connect the number terms with the standard numerical forms. The teen numbers 13-19 can be more confusing since the English terms for those numbers are the opposite of the standard numerical forms (Geary et al., 1996). The word "nineteen" delivers the idea that the number "nine" should be at the front instead of the "ten". However, numbers in Chinese are way easier for kids to understand compared to English. In Chinese, "10" is "shí". Number "11" will be "shí yī" meaning "ten (shí) and one (yī)", which is $10+1$. The same language acquisition concept applies to other different numbers such as "20". Number "20" is pronounced as "èr shí", which

means “two (èr) tens (shí)”, just like 2×10 . Numbers in Chinese emphasize the place value in a clear and direct way so that people can analyze numbers in the most convenient way. The well-designed base ten Chinese number system has a consistent rule to form the number terms, which makes counting and conceptualizing place value easier compared to English (Han & Ginsburg, 2001).

According to Stigler, Lee, & Stevenson (1986), “Another theory of linguistic influences on number learning is the notion that number terms in Chinese have shorter pronunciation durations than those in English, which may enable speakers to have greater digit spans than their English-speaking counterparts” (as cited in Chang, 2008, p.3). Due to the short pronunciation durations, students will be able to remember the number terms quickly in Chinese, and it may influence the way they work on basic math problems (Geary et al., 1996). In other words, students who can speak Chinese may have an advantage when solving math problems because of the less time they need to spend on number pronunciation (Chang, 2008). This advantage may also increase their math fluency and automaticity in order to be mathematically successful.

Math Education in Chinese Immersion Setting

Language Immersion

There are many ways to learn a foreign language, and being in a language immersion environment is one of them. “Immersion” is a method of learning a language (Santamaria, 2013). Most students who participate in language immersion programs experience 50 to 100 percent of instructions given in a language other than their first language (Santamaria, 2013). Teachers in language immersion programs must be “fully proficient in the language(s) they use for instruction” (Santamaria, 2013, p.13).

Shrum and Gleason (2005) mentioned that a language immersion program mainly helps students learn academic content in the target language so that the students will be fluent in the target language and be able to understand the culture behind the language they are learning in (Santamaria, 2013).

Chinese Language Learning:

Fortune (2012) described the challenge of mastering Chinese language literacy skills (reading and writing) as taking more time than other languages. It is equally difficult for both Chinese native speakers and non-Chinese speakers (Fortune, 2012).

Jacobson (2023) stated that compared to learning other European languages, the process of learning the Chinese language is more complicated due to the combination of its character-based writing system, Pinyin pronunciation system, and tones. Chinese immersion programs meet the needs of long time intensive study to master the Chinese language. Therefore, Chinese immersion is a great way to learn Chinese (Jacobson, 2013).

Students who study in a Chinese Immersion program will have a huge improvement in Chinese language learning. Students' mathematical conceptualization process will be benefited since they are studying math in Chinese. Therefore, people can expect that many students who study at Chinese immersion schools will receive some benefits of being more successful in Mathematics.

Summary

Mathematics is an important subject for people to start learning at a young age. To enter high-level mathematical problem-solving, students need to have strong foundational skills in mathematics. These foundational skills include number sense, math fluency, and math automaticity.

Many studies show that the Chinese language deepens students' mathematical conceptualization process in the place value concepts based on the "Base Ten" system, in which each number is pronounced directly as it is represented numerically (shows the place value directly). In Chinese, each character only contains one syllable. Therefore, counting in Chinese can be easy and fun for students. They will have a more straightforward understanding of the concept of place value. That way, students will be more flexible and sensitive with their ability of number sense.

Immersion programs are school programs that give students 50%-100% of instructions in the target language. Students who study in an immersion program will be exposed to the target language most of the time because "immersion" is a way for students to learn the target language. In Chinese immersion programs in Minnesota, most teachers need to speak Chinese fluently. The students will be taught language arts, math, social studies, and science in Chinese. According to how efficient math education in Chinese could be, the Chinese immersion program will help students become successful in mathematics learning.

Chapter Three will introduce my project based on a pacing chart of teaching math lessons in Chinese to first-grade students. It will be based on the math curriculum that is used by many Chinese immersion schools in Minnesota. The pacing chart will be broken down into weekly teaching pace that shows the lessons that would be taught in my classroom to create learning, engagement, and understanding.

CHAPTER THREE

Project Description

Introduction

Math is a universal subject. People study mathematics and use mathematics to explore the world around them. Learning mathematics at an early age is important. Students establishing a strong foundation in this subject will benefit their mathematical problem-solving later in life.

My research question for my capstone project is: *How does a teacher effectively teach mathematical concepts to first-grade students in Chinese?* After reflecting on the literature review, I have created weekly pacing charts, some weekly lesson plans, Google slides, hands-on activities, and summative assessments that align with the 1st-grade Primary Mathematics (2000) curriculum that my school uses.

This chapter provides an overview of my capstone project including a summary of research and theories that support my project, the framework, the setting, the audience, the assessments, and the timeline of creating the project. Lastly, the chapter will briefly describe the final chapter of my capstone writing, Chapter Four.

Project Description

I am a first-grade classroom teacher at a Chinese Immersion school in Northeast Minnesota. In most immersion schools, students usually spend 50 % to 100 % of their instructional time using the target language that is provided by the immersion program (Santamaria, 2013). I speak 100 % Chinese to teach language arts, math, social studies, and science to my first-grade students. At my school, we were asked to use the *Primary Mathematics* (2000) curriculum to help students conceptualize mathematics in Chinese. There are 19 mathematical topics taught to our students throughout the school year: numbers 0-10, number

bond, addition, subtraction, ordinal numbers, patterns, numbers to 20, shapes, length, weight, comparing numbers, graphs, numbers to 40, numbers to 100, fractions, money, time, multiplication, and division. Although some of them seem like big topics for first graders to learn, such as multiplication and division, they were more like a simple introduction to the big concepts. The students will learn more about these topics as they get to higher grade levels.

As I was teaching math in Chinese, I noticed that some of the students will have a great time exploring the new concepts on their own, and some of the students will have a hard time understanding the concepts. The ones who were having a hard time understanding the concepts were mainly struggling with the Chinese language. I noticed that my math class is not only a subject matter class, but it is also a language class.

To help my students become successful in mathematical learning, I need to start focusing on scaffolding the language learning piece first, and then gradually dive into the concepts. Providing visual support and planning some hands-on activities would benefit young kids to learn new concepts efficiently. Therefore, I decided to create Google slides to provide visual support to help my students understand the Chinese language. Additionally, planning hands-on activities will encourage students to apply their mathematic knowledge and also motivate them when it comes to math learning. My project will also include pacing charts to help teachers keep track of how much time each unit is supposed to spend.

Framework

The school district I teach in uses a Primary Math U.S. Edition curriculum (2000) to teach students from 1st grade to 6th grade. It follows the Singapore Math framework: concrete, pictorial, and abstract (CPA). Mathematics is an abstract subject. There are many symbols that students need to understand their representatives such as numbers, math operation symbols,

graphs, and so on. Students will need to start with something that is concrete. At the beginning of each unit, the teacher will provide hands-on objects for students and provide enough space for them to explore. Then the teacher will gradually let the images take place to represent mathematical concepts. Finally, students will transfer the concrete and pictorial representations to abstract.

I will create a pacing chart as the main project to help teachers know the teaching objectives for each week follow the same sequence as the Primary Mathematics curriculum so that students will have an organized learning sequence as they dive deeper into the mathematics world. I will also have Google slides, lesson plans, and some hands-on activities for the first unit, which is “Numbers 0-10” as an example of teaching Math in Chinese.

Setting and Audience

My school has about 852 students enrolled in grades Kindergarten through 8th grade, and there are approximately 113 students enrolled in 1st grade. It is its own district, so the student population of this school district is small. According to the Minnesota Department of Education, 45% of students in my school district are white, 1% of students are Native Americans, 26% of students are Asians, 3% of the students are black or African American, 6% of the students are Hispanic or Latino, and 18% of students who have two or more race background (Minnesota Report Card, 2022). There are 6.9% of the students are qualified for English Language Learning services, 7.3% of the students are qualified for Special Education services, and 19.9% of the students are receiving free/reduced-price meals at my school (Minnesota Report Card, 2022). In 2019, 55.5% of the students met or exceeded the state standards in math. However, 45.5% of students met or exceeded the state standards in math in 2023 (Minnesota Report Card, 2022). In

my opinion, the pandemic that happened since 2019 impacted students' academic learning in a bad way.

The audience of my curriculum project is my first-grade math classes. The students I teach are between the ages of six to seven. In my classroom, 37% of the students are white, 25% of students are half white and half Asian, 25% of the students are Asian, 7% of the students are Somali, and 3% of the students are African American. In my class, there are about 14% of the students are considered high risk for math performance based on the formative and summative assessments I give to my students.

Assessment

One of the important components of a set of curriculum is assessment. Based on my research question, I want to make sure my students' conceptualization process is accessible when it comes to learning a new mathematical concept. Throughout creating the pacing chart, Google Slides, and weekly lesson plans along with the Primary Mathematics curriculum, I will use both summative and formative assessments to assess my students' learning progress.

The formative assessments such as hands-on activities, table talk, and exit tickets will help me monitor students' learning progress right away so that I would know how to support my students' individual needs. In my math classes, I encourage my students to discuss with one another when I display a math problem. This discussion format helps students with their critical thinking process, improve their social-emotional skills, and utilize target language skills. It also helps me monitor students' thinking progress as I listen to their discussions. Hands-on activities are another formative assessment I like to use in my classroom. Kids at a young age love doing hands-on activities. Instead of only listening to the teacher, hands-on activities provide them with

chances to apply their knowledge to something fun. The hands-on project for each unit also helps me to monitor students' understanding of mathematical concepts.

The summative assessment for each unit can be unit tests. The unit tests are great ways for me to monitor my students' understanding of the math concepts as a whole group. It helps me to see if there are any concepts I need to reteach due to unclear instructions. It also is a way to help my students understand what are the areas they are not clear with so that they can reach out to me or their peers for extra help.

Timeline

The timeline I created for this project was to begin creating my project in early September 2022 to early June 2023. My curriculum project is mainly used in my first-grade math classes throughout the school year. I will be developing the pacing chart for the first-grade team to use as I teach my first-graders. In June 2023, I reflected on the result of my students' understanding of first-grade math concepts throughout the school year. As the new school year is coming up soon, I will continue to reflect and update the pacing chart throughout the 2023-2024 academic school year. To achieve this goal, I will record each first-grade teacher's feedback during the weekly team meetings throughout the school year on a Google Doc.

Summary

The capstone project I will create provides enough visual support for my young Chinese language learners and enough space for their mathematical brains to explore on their own. The project will align with the Primary Mathematics curriculum (2000). It includes weekly pacing charts, weekly lesson plans, Google Slides, hands-on activities, and Unit Tests. Chapter 3

discusses how my project builds align with the Singapore Math CPA framework: concrete, pictorial, and abstract. My setting and audience will be my first-grade students.

In Chapter Four, I will reflect on the project I created, its strengths, and its challenges. I will also describe my next steps in updating my project based on my reflection. Chapter Four will be the conclusion to my capstone project on how my project will benefit First Grade Math Education in a Chinese immersion setting.

CHAPTER FOUR

Conclusion

Introduction

Math is everywhere in people's daily lives. It can be used when finding the cost of items during grocery shopping, gathering information from graphs, making plans in an organized way by scheduling events at different periods, and so on. Therefore, having strong mathematical foundational skills plays an important role in people's lives, especially in young learners. As I stated in my introduction, my goal as an educator is to help my students have a solid mathematical foundation during their first-grade mathematics learning journey.

My research question for my capstone project is: *How does a teacher effectively teach mathematical concepts to first-grade students in Chinese through the Singapore Math format?* addresses an important perspective of Mathematics education in the language immersion setting. Learning language in a language immersion setting helps students effectively learn language. The students who study at a Chinese immersion school not only achieve high proficiency in Chinese language learning but also need to succeed academically. Therefore, the students who participate in a Chinese immersion school study all the essential subjects (Language Arts, Mathematics, Social Studies, and Science) in Chinese.

Teaching Mathematics in the Chinese immersion program can be challenging but rewarding at the same time. However, the Mandarin Chinese language helps students efficiently conceptualize mathematical concepts in different ways. Firstly, the Chinese language uses the base ten number system in naming numbers. The base ten system in Chinese shows how number terms are composed of tens and ones directly (Geary et al., 1996). The base ten system motivates students, especially young kids, to easily learn to count numbers in Chinese. Not only that, but

the base ten system also helps students have a deeper understanding of place value (Han & Ginsburg, 2001).

Moreover, the Chinese language provides a huge convenience in that each number term in Chinese has shorter pronunciation durations than in English, which enables Chinese language speakers have a more convenient way to remember and master certain mathematical skills such as remembering math facts, increasing math fluency (Geary et al., 1996). Students who can speak Chinese may have an advantage in solving math problems due to the less time they need to spend on number pronunciation (Chang, 2008).

In this chapter, I provide an in-depth reflection on my project– the pacing chart of the Math lessons taught at my school. I will discuss the successes and challenges I faced while creating this project. The pacing chart of the Math lessons was designed to align with my school's Singapore Math curriculum called *Primary Mathematics*. There are 19 Units in total introduced in the *Primary Mathematics* curriculum. This chapter will review some of the literature from Chapter Two and how it supported the project I created. I will also discuss the implications and limitations of my project as well as what next steps this project has encouraged me to take for creating Math lessons in the future.

Creation and Implementation

I have learned a lot about myself as a Chinese immersion teacher who teaches students Mathematics in Chinese throughout the process of writing my Capstone. I have always thought that math learning would be boring for most people, and I have always been afraid of teaching math in the past. However, I had no idea teaching math could be a fun process for many teachers, and that the process of learning math can be an interesting journey for young children. When writing Chapter Two, I was inspired by the number of studies that show how beneficial the

Chinese language can be when it comes to math learning. According to my personal experience of using Chinese to learn Math when I was little, I feel that I became a better researcher as I worked on my capstone project by relating my learning experience. I was able to grow as an educator through the process of my research as I learned more about teaching mathematics in Chinese.

Creating the pacing chart itself along with the curriculum our school uses was a little challenging for me. It was not the type of work that required me to start from scratch and had to create the learning sequence timeline completely all by myself. However, figuring out the logical weekly pacing for each Unit, key concepts for each topic, matching up with the Minnesota Mathematics Standards (2022 version), and thinking of the materials each week or each lesson might need were the challenging parts throughout the creation process. Throughout the process of creation, I kept asking myself questions like, “Does this pacing chart work for the rest of the team members?” “Is there any part that does not make sense to the rest of the team?” “Am I creating the project through the students’ learning perspectives?” Creating a pacing chart made me more grateful for a well-developed curriculum to use because they are really useful and it helps teachers save time and focus on teaching their lessons.

I did not have a pacing chart as a guideline during the first year of teaching math, and I struggled daily about what concepts I should teach and how long I should spend. I started drafting more during my second year of teaching at the Chinese immersion school, and I noticed that I was more clear with the amount of time I should spend on each topic and how I could deliver the concepts to my students in a more effective way.

When I first started drafting the pacing chart, I struggled a lot with the topics’ order and the learning objective design. After scheduling many meetings with my team lead and my

content expert, who is an experienced classroom teacher who worked at the Chinese Immersion School for six years, I gradually got to know the essential concepts for each unit as I teach. The pacing chart helped me understand the learning objectives in each unit, and it helped me reflect on my teaching progress if I was generally ahead or behind the schedule. If I were behind what the pacing chart designed, I would spend some time reflecting if there was any part of teaching went wrong, did not match my students' needs, I was teaching ineffectively, or if I needed to change the time for the unit I was teaching after communicating with the rest of the team members to see whether they were having the same issue. If I was ahead of what the pacing chart designed, then I would spend some time recording some of the teaching strategies that were utilized and went well to reach my students' needs, and I would also discover some fun activities for my students to strengthen their process of conceptualizing the mathematical concepts. Communicating with my team members frequently also helped me get direct feedback from other people's perspectives so that I can improve the pacing chart in an effective and better way.

Implications and Limitations

Having a pacing chart is nice for teachers to keep track of the teaching objectives for each week, how much time they should spend on each topic, and the mathematic skills that students should master. The pacing chart can be helpful to teachers, especially the ones who travel from a different country and trying to work in a new working environment. Starting something from scratch and learning the new working environment's expectations can be challenging for many new teachers. Therefore, I hope that my capstone project and the pacing chart I created can be useful to the rest of my team members and new team members in the future.

After analyzing the pacing chart I created, I realized that the biggest limitation of the pacing chart is the lack of differentiation. It provides the general idea of each week's objectives

for teachers to teach, but there is a lack of flexibility for the students who are at different levels of math and language skills. Students who are higher than the grade level skills will not have enough recourse to work on something more challenging. Students who are below the grade level skills will not be able to catch up due to the lack of resources and time. Sometime in the future, I would like to discuss with experienced classroom teachers who are great at differentiation to guide me on how to add these features to my pacing chart.

Next Steps

Although there were some limitations to my project, I enjoyed the process of creation. I feel it is a needed and useful resource for the first-grade team at the Chinese immersion school. This project has inspired me to continue my research in the field of math education. I believe there is still so much I can discover and learn about the relationship between math education and world language, especially in Chinese. One thing I am interested in developing the flexibility of this pacing chart in both math education and language learning. Another thing I am interested in researching in the future is ways I can also involve the Chinese cultural background along with the Chinese language in teaching math to my first-grade students. I believe it would encourage my students to feel proud of themselves as they are in the process of mastering math skills in a language other than their mother tongue. It would also encourage them to be motivated global citizens who are eager to learn math from different cultural and linguistic perspectives.

My journey with creating a pacing chart for the first-grade math lessons is only the beginning. I plan to use this pacing chart next year as well. I want to see how much I can develop the pacing chart to benefit the teachers, especially the ones who traveled from China and need to have clear guidance about the first-grade math concepts being taught in America. I also want to see how much the students can benefit from the existence of this pacing chart; students will be

able to expect and predict what is being taught daily so that they will understand and feel more comfortable during Math class.

Summary

Math is the foundation of our world, and students need to master basic mathematical skills to access higher and more complicated mathematical problems. My capstone project requires me to explore more about math education for early learners, and it has increased my excitement and interest in math. Now, I have a stronger desire than ever to spread my passion for math education to the teachers who struggle with what and how to teach. I also have a strong desire to explore more about math education to benefit my students' math learning progress. In this chapter, I discussed the successes and challenges I faced while creating this project. I explained the implications and limitations of my project as well as what next steps this project has encouraged me to take. In this paper, I was able to share my journey of brainstorming, researching, forming, and creating my capstone project, the pacing chart for math lessons that are taught at a Chinese immersion school.

As I wrote throughout the paper, I recognized that not all students will grow up liking math, and not all teachers enjoy teaching math, especially in a foreign land. However, I am more confident than ever after my research and the pacing chart I created, that my colleagues will have a basic guideline of what to teach. Once the teachers are clear with the objectives of each lesson, the students will also have clear goals of what mathematical skills they will be learning.

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