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Teaching Mathematics to All Learners by Tapping Into Indigenous Legends: A Pathway Towards Inclusive Education

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Abstract

This study explored the use of Indigenous storytelling in the planning and teaching of mathematical content. In collaboration with Indigenous and non-Indigenous educators, a culturally inclusive mathematical lesson was developed, implemented, and reviewed in an elementary school in Northern Ontario. This study used a culturally authentic approach to address the current educational issue of diversity within the Ontario curriculum and education system. The results of this study suggested that utilizing Indigenous storytelling for teaching mathematical curricular expectations could benefit both Indigenous and non-Indigenous students. Storytelling can allow students to relate abstract mathematical concepts to their own lived experiences, to be exposed to diverse cultures, and to foster a positive and open learning environment that is conducive to academic and non-academic learning.

Keywords: diversity, curriculum, lesson plan, storytelling, culture

Introduction

The fundamental purpose of any education system should be to help all students learn the knowledge and skills necessary for achieving their academic and lifelong goals. With the growing number of culturally diverse learners in Canadian classrooms, the ability to *reach every student* is a key concern for many teachers across Canada. At the provincial level, Ontario is the second most diverse province in Canada, with the category *Visible Minorities and Ethnicity* accounting for 19.1% of the province's population, and about 50% of the entire population of Canada (Office of Economic Policy, Labour Economics Branch, 2016). According to The Ministry of Education (2009), it is critical to implement an equitable and inclusive education strategy in Ontario schools by embracing multiculturalism, human rights, and diversity as fundamental values. However, despite the growing emphasis placed on creating a welcoming learning environment for students of all ethnicities and cultures, there are ongoing incidents of discrimination in Ontario. As a result, in Ontarian schools, inclusion requires the continuing attention of educators and educational administrators.

The lessons and educational materials that teachers have traditionally developed and implemented in their classrooms are shaped by an educational system with a history of disregarding and marginalizing non-European cultures. With the dark shadow of residential schools looming over the Canadian educational system, the marginalization of Indigenous cultures is of particular

concern to modern educators. *The Royal Commission on Aboriginal People* (RCAP; 1996), which reported on the pervasiveness of colonialism in the Canadian school system, stated that an overwhelming lack of support for Indigenous and other non-European identities existed. There were virtually no Indigenous high school teachers; curriculum content was limited in its dealings with diverse languages, cultures, history, and political issues; the overemphasis on intellectual cognitive achievement in Western education was at the expense of spiritual, social, and physical development; and, on top of all these issues, students had very little to no decision-making ability in terms of how they completed their education. The result was that the schooling system typically eroded identity and self-worth, as it forced all students, especially those of Indigenous descent, to adopt Western beliefs and values at the expense of their own ethnic and cultural identities (RCAP, 1996).

In recent years, this has become an issue of great concern within Canada, which has led to many calls to action by the Truth and Reconciliation Commission of Canada and by The Ministry of Education (2009). More specifically, the lesson plan contained in this study aimed to honor the Truth and Reconciliation Commission's 62nd Call to Action, which called upon the "federal, provincial and territorial governments" in collaboration with educators, to "make age-appropriate curriculum on residential schools, Treaties, and Aboriginal peoples' historical and contemporary contributions to Canada a mandatory education requirement for Kindergarten to Grade Twelve students" (p. 7). It also related to the 63rd Call to Action, which called upon the "Councils of Ministers of Education" to address "Aboriginal education issues", including the "sharing information and best practices on teaching curriculum related to residential schools and Aboriginal history", and by "developing and implementing Kindergarten to Grade Twelve curriculum and learning resources on Aboriginal peoples in Canadian history, and the history and legacy of residential schools" (p. 7).

The majority of the work for providing a sound education to culturally diverse learners falls on classroom teachers who often have no clear idea of how to make this happen. Teachers often express that they know little about Indigenous culture, their students' diverse backgrounds, and more importantly, about what a culturally relevant pedagogy entails in mathematics education (Ezeife, 2011). The disconnect between what students learn in mathematics class and what they experience in their daily lives negatively affects learners who are ethnic minorities, especially those who are from Indigenous cultural backgrounds. According to Yao, "the situation of mathematical learning without a cultural comprehensiveness [would not] be able to make them feel a sense of intimacy while using teaching materials" and results in "mathematical learning without continuity for those children" (Yao, 2014, p. 96). When the curriculum lacks minority cultural perspectives in mathematics education, it is easy for educators to unwittingly "cause the mathematical learning without continuity for those children" who are not from Western European backgrounds (p. 96).

Additionally, in Canada, there are currently no official mathematics educational documents designed to guide teachers on how to integrate multicultural and Indigenous knowledge into their teaching. In addition, there is currently not culturally conscientious, widespread implementation of this type of knowledge in mathematics classrooms (Nutti, 2013). Teachers' acquiring of knowledge about their students' unique cultural backgrounds would enable them to make more personal connections with their students, and thus, would have a major role in creating a culturally inclusive mathematics learning environment.

In this sense, engaging students in their learning of mathematics requires teaching mathematics in a way that directly connects students to mathematics at a personal level. According to Modi (2012), storytelling can provide such a connection, by building a bond between teachers and their students within a culturally responsive and supportive educational atmosphere. Similarly, this study was designed to use storytelling as a meaningful framework for designing and conducting mathematics education research. This paper aimed to explore if storytelling can be used in planning and implementing math lessons, in order to create math learning opportunities that are authentic to Indigenous learners, and which also welcome learners from other diverse cultural backgrounds. There was one main question that this paper aimed to answer, and that will direct future research endeavors following this study: Can a culturally based math lesson produce inclusive teaching and learning opportunities for all learners?

It is essential to define some of the terms used in this paper. The term *Indigenous* is defined as “native to a particular country, region, etc., not brought from elsewhere” (Ezeife, 2011, p. 5). Therefore, in this paper, the term Indigenous refers to those people who were the original native inhabitants of Canada before European settler contact. The terms *diverse culture* and *multicultural* are used interchangeably to refer to all non-European settler cultures and backgrounds, including immigrants to Canada. The term *intercultural* means the connections and/or interactions between two or more cultures.

Literature Review

Oral Storytelling for Education

Oral storytelling is one of the oldest methods of teaching in both Indigenous and non-Indigenous cultures. Grandparents and elders have been teachers throughout history, passing their knowledge and traditions to their children through storytelling. According to Mutiarani & Izzah (2015), using stories for educational purposes is an effective teaching strategy, especially for teaching young learners with different cultural and linguistic backgrounds. Stories can connect learners and educators from diverse cultural backgrounds and tie various curricular content together in ways that provide a holistic educational experience for both the educator and the learner.

Hamilton and Weiss (2005) described stories as “the way we store information in the brain”, and as a sort of mental organizational method which prevents a students’ brain from becoming “a catchall closet into which items are tossed and hopelessly lost” (p. 2). Stories are more than just a means to engage learners; they are a connective tissue that joins all learning together into cohesive, memorable narratives. Rather than allowing information to be learned for the sake of a formative assessment and soon forgotten afterwards, stories can be a way to make learning come alive and live on in the class’s collective memory for months, and possibly years, to come.

Storytelling has been shown to be an engaging *hook* for lessons of various topics and subject matters in real-world classroom settings. In his dissertation, Shirley (2005) examines three American classroom teachers and their exemplary usages of storytelling as an engaging introduction to their classes. Stories were used as an engaging hook for lessons in grades 3, 4 and 6, in subjects such as social studies, science, oral communication, and even non-curricular teachings pertaining to classroom rules and policies. One of the teachers in Shirley’s study demonstrated how a seemingly unrelated story about her experience in Girl Scouts could be used

as a bridge to connect students' experiences to their lesson about South American animals. She used the story to introduce the idea of fearing spiders, which connected to the lived experiences of many of her students. This was an example of how oral stories could be used to activate students' prior knowledge, engage students, and create an inviting and encouraging classroom environment that is conducive to learning.

Storytelling has been explored as an aid for teaching students' metacognitive skills. In a study analyzing two groups of grade 4 students in South Africa, oral storytelling was used as a means of modelling learning and reading comprehension skills (Van Aswegen et al., 2019). By providing a fictional example of how children could use thinking and reading comprehension strategies to understand a text more deeply and easily, the use of storytelling led to the improvement of both groups in their metacognitive skills. The improvement was statistically significant; School A improved, over the two-year course of the study, by 41.5%, while School B improved by 94%. Due to the massive improvement observed in School B, this seems to suggest that oral storytelling could remove the barrier of requiring advanced decoding skills in order to practice metacognition, which may otherwise have barred students who struggled with reading to develop higher order thinking and self-reflective learning skills. While these studies were promising, more studies that examine the efficacy of oral storytelling as a classroom-based educational strategy are needed. Furthermore, it would be beneficial to understand the potential connection between storytelling and mathematical learning and performance which has been largely unexplored prior to this study.

Mathematics Education and Indigenous Storytelling

To teach mathematics, teachers should have an in-depth understanding and extensive knowledge of both math content and pedagogy. Researchers have indicated that in mathematics classrooms, "it is not only knowledge of content, on the one hand, and knowledge of pedagogy, on the other hand, but also a kind of amalgam of knowledge of content and pedagogy that is central to the knowledge needed for teaching" (Ball et al., 2008, p. 392). These two types of knowledge can be merged by utilizing a math-literacy integration approach. This approach involves connecting language arts and linguistic literacy to mathematical literacy.

Similar to linguistic literacy, mathematical literacy can be understood as a language that is shaped, used, and interpreted differently depending on the culture or social situation in which it is being practiced. While math can be a universal language of numbers and symbols, the way in which mathematics is practiced and discussed also influences what mathematics is understood to be in a given culture. For example, those who are deemed to be *good* or *bad* math students will depend on the cultural understanding of what a mathematically literate person should look and act like. Therefore, to teach mathematical literacy, educators must have knowledge of how the language of math is used in their socio-cultural context, as well as the ability to understand how students understand themselves and their mathematical abilities through the math discourse, they participate in.

If mathematical literacy is the ability to interpret, comprehend and communicate math concepts within a given socio-cultural context, then the concept of math-literacy integration becomes easier for educators and students to grasp. Mathematics is a culturally dependent form of communication, just as English, French, Ojibwe, or other languages are culturally dependent forms of communications. Thus, developing competency in the reading, speaking, and writing of math

becomes identical to the development of reading, speaking, and writing skills in language arts. This implies that getting the correct answers to math problems does not necessarily make one person more mathematically-literate than another, just as replying with accurate one-word answers to language arts prompts does not necessarily make someone more linguistically-literate than another. While correct answers within a discourse are valuable, they must be communicated in an appropriate and clear manner that would allow other people within that discourse to fully understand the answer, and the method by which it was found. Additionally, educators must be mindful that their teaching of mathematics does not discriminate against particular students, just as they must ensure their use of written and verbal language does not discriminate against any language arts students in their classroom. It is hoped that, by combining linguistic literacy with mathematical literacy, some of the educational tools and practices used to make language arts more accessible, comprehensible, and engaging to students of various abilities can also be used in the teaching of mathematics.

A math-literacy integration approach can be accomplished in part by using storybooks in the classroom that connect mathematics to language arts. However, rather than confining students' learning within a single story in a book, the lesson taught in this study required students to construct their own stories for their dice sticks and gardens, while also using the Indigenous story of *How the Flowers Came to Be* as a literary base for the mathematics lesson. The students' personalized dice sticks, gardens, and stories created throughout the lesson can all be understood as identity texts that are created by the students with the teacher's guidance and support. In this lesson, students were able to form a personal connection with the concept of addition through the creation of identity texts, as they used their own understandings and experiences within the structure of the lesson to develop a richer, more meaningful connection to mathematics.

Ezeife (2001, p. 26) asserted that "using storytelling in mathematics creates a link between Indigenous children's *classroom experiences* and their *early cultural socialization experiences*, which improves the Indigenous learner's relationship with mathematics content." Indigenous students have historically felt disconnected from Western academia, especially in the field of mathematics. Matthews (2015) discussed how he "turned [his] back on [his] Aboriginal identity" as "a means to survive" the Western-dominated education system (p. 103). He went on to say that, due to the widespread understanding of math as either an entirely abstract field, or conversely, an objective "absolute truth", students have been denied the ability to connect mathematics to their own cultural background. This was even more evident to Matthews (2015) as an Indigenous student amongst his non-Indigenous classmates. The existence of Indigenous mathematics, and the value of Aboriginal perspectives in mathematics, was ignored. Indigenous people across the globe have been assumed to be an inferior race expected to "die out", who have "no relevance in a technological, advanced, modern society" (p. 111). By introducing storytelling to mathematics classrooms through the construction of various identity texts, Matthews explained that students will be able to "learn new knowledge while supporting and valuing their cultural identity as Indigenous people" (p. 117).

Additionally, exposing non-Indigenous learners to Indigenous stories helps construct a safe, inclusive learning environment where all learners can understand and enjoy mathematics through their engagement in storytelling (Modi, 2012). Using storytelling as a teaching technique may also help children "develop the confidence to undertake a new learning activity or to venture into an unfamiliar intellectual domain, such as mathematics", especially if the story contains "rich

imagery, suspense, engaging themes and tantalizing information” (Colgan, 2014, p. 3). Overall, the inclusion of Indigenous storytelling in mathematics education could be a way to engage learners in mathematics, while also aiding in the creation of an inclusive learning environment for both Indigenous and non-Indigenous learners.

Yet, it is challenging for teachers to design a culturally inclusive math lesson that meets the expectations of the Ontario Mathematics curriculum and engages all learners by using storytelling as a technique in their classrooms. While teachers believe this approach is useful for normalizing and confronting issues related to cultural diversity in their classrooms, many teachers have expressed their concerns and struggles to implement storytelling as a teaching strategy in non-language arts subjects. This indicates that more research is required regarding the educational experience through storytelling, to guarantee the efficacy of culturally responsive math lessons for educators and learners (Ezeife, 2011).

Methods

Learn by Doing and the 3-Part Lesson Plan

Learn by Doing is the age-old apprenticeship system of knowledge and skill acquisition popular among many cultures worldwide, including Canadian Indigenous people (Ezeife, 2011). In this apprenticeship system, emphasis has been traditionally placed on hands-on, kinesthetic learning of knowledge and skills, such as hunting, dancing, beading and other cultural practices. This would be used in conjunction with one-way transmissions of information and teachings, such as through the telling of stories containing various traditional teachings, and by observing various tasks being performed by experienced community members (Williams & Tanaka, 2007). Learning by Doing contains kinesthetic, auditory, and visual components that can not be found in traditional math classes. Mathematics content is often taught without any connection to real-life contexts or situations in Western-traditional classrooms, where information is presented written down and work is often completed on paper.

The 3-part lesson plan structure is a familiar format for most Ontario educators. It was used in this study due to its familiarity, as well as its ability to implement Indigenous ways of knowing into a highly westernized curriculum. It provided an opportunity for a more traditional, observation-based method of learning and storytelling to be implemented as a *hook* for the first part of the lesson. The second part of the lesson allowed students to simultaneously Learn by Doing as seen in Indigenous cultures, while also constructing their own understandings of the content being taught, as part of the social overarching constructivist theoretical framework. The last part of the lesson plan allowed all students and educators to discuss their experience of the learning process and their stories and help the students to consolidate their knowledge as a class.

Before/Getting Started/Beginning

The *Before/Getting Started/Beginning* section was the first of three main sections of the lesson. It required an appropriate *hook* for obtaining children’s attention, in order to engage the children in their learning. This also involved awakening their prior knowledge on the topic being covered in the lesson.

During/Working on it/Middle

The *During/Working on it/Middle* section was the second part of the lesson, where the children were engaged in a guided task. Throughout this stage, the children were working on the task independently or in small groups. They were discussing the task with their peers, asking questions, and using their creativity to help them complete the task at hand.

After/End/Consolidation

The *After/End/Consolidation* section was comprised of highlights from the guided task, a summary of the children's learning, and additional practice of the skills or knowledge learned through the task. This was the last phase of the lesson where the children shared their solutions to the task with others and reflected on and revised their own solutions and learning processes. At this stage, the children engaged in metacognition and were encouraged to summarize or generalize the learning outcome for the lesson. They also practiced the application of their ideas and strategies through class discussion or self-reflection.

Incorporating Mathematics and Storytelling Using the 3-Part Lesson Plan

Children love to hear stories, as stories engage a child's imagination, feelings, and creative thinking. If a child was emotionally and mentally engaged by a story in the Before section of the lesson, then the During section of the lesson was secured. This would ideally allow for a smooth transition into the After section of the lesson, where students consolidated their learning as a class. The following example is of one lesson plan that was developed as part of this study, through the collaboration of the researcher with two participating first grade teachers from Northern Ontario, Canada.

The following materials were required for the lesson, and were prepared in advance:

- My Garden poster (Figure 1)
- Flowers pictures to cut (Figure 2)
- Key/Legend (Figure 3)
- Markers or crayons
- Non-toxic glue sticks
- School scissors
- Popsicle sticks

Start of the Lesson: Before (10min)

All of the students were asked to sit on the carpet and the instructor told them the story of How the Flowers Came to Be:

Long ago when the Creator was making life, He was feeling real happy. He truly enjoyed creating! He looked around at all the wonderful things He had made and thought to Himself, 'I am so happy that I want to make something special to spread my happiness.' He thought long and hard, and then said, 'This thing must be so pleasing that it will get a second look. It must fill the air with sweet smells that create happiness.' He thought some more, and then he added, 'But I also want it to serve a purpose. It must be able to be eaten and used as medicine.' So, after thinking long and happily, the Creator took bits of this and bits of that and bits of things that had never been and created the flower. He made tall ones and short ones, skinny ones and fat ones.

He made them every color imaginable. He was so satisfied with His new creation that He spread them all over the world for everyone to enjoy. (Hankes and Fast, 1999, p. 14)

Figure 1. My Garden Poster

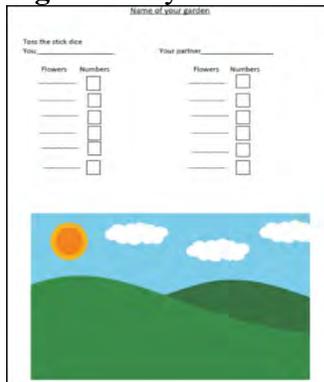


Figure 2. Flower Pictures

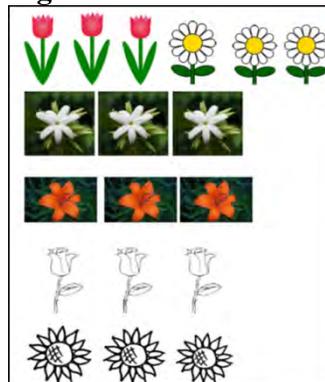
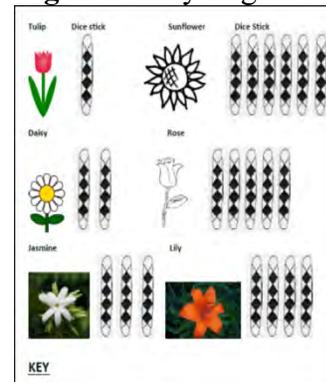


Figure 3. Key/Legend for Dice



As a class, the instructor led the student to write two sentences summarizing the story on chart paper. The objective of the lesson was for students to learn how to represent a number in different ways. The expected knowledge and skills from the curriculum that students should develop were the ability to:

- Collect and organize primary data
- Prepare a pictograph
- Display a variety of recording methods
- Pose and answer questions about collected data

In addition to this, teacher ensured that the students were allowing the children enough time to answer while activating knowledge with probing questions (Table 1).

Table 1: Probing Questions Used to Activate Knowledge in the Students

Question	Possible Arrangements of Picture
How many flowers do you see?	
What shape do you see?	
How many balls do you see?	
How many do you see now? (Change their arrangement)	

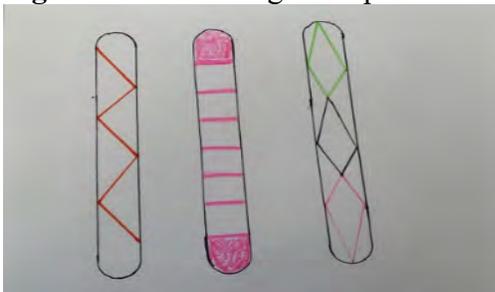
Middle Portion of the Lesson: During (20 min)

There were two ways that students were able to complete this activity: in pairs or individually. For this study, the teachers preferred doing it in pairs. The teacher explained that *Stick Games* have been played by many Indigenous peoples. The six sticks represent a six-sided die. To consider equity and diversity, the teacher showed a six-sided die to the class. Each group were given a pair of scissors, six popsicle sticks, several markers and crayons, a garden poster, a glue stick and three copies of the flower pictures. A copy of the key was displayed on the board for students’ reference. The key informed students which flower to choose for their gardens, based on the dice number they rolled. For example, rolling a 1 meant Tulip, rolling a 2 meant Daisy, and so on.

To begin the activity, each group decorated one side of each of the six sticks with the same design. Each group was able to choose a different design for their stick dice (Figure 4). The teacher

explained to the students how to read the dice after each toss. Each student was able to take a turn tossing their stick dice and count the number of sticks which landed on the desk with the decorated side facing up. The student read aloud the number to their partner. The number of sticks with the decorated side up was the dice number which determined the type of flower that was picked and cut for the garden. For example, if a student tossed the six-stick dice and only two sticks landed with the decorated side up on the desk, it indicated that a 2 had been rolled, and that a daisy should be cut from the flower pictures and glued to the garden poster. In pairs, each student tossed the stick dice six times and use the key to determine which type of flower to cut for the garden poster. After every toss, each student had to record the name of the flower and the related dice number on the garden poster. As they created their gardens, students were encouraged to give their gardens names, in order to make them more personable (Figure 1).

Figure 4: Stick Design Samples



The following were the guiding questions toward the learning goals and curriculum expectations:

- Can you show me all the 2's you see in your garden?
- How many roses does your garden have?
- How many tulips does your garden have?
- Does your garden have more tulips than jasmine flowers?

End of the Lesson: After (20 min)

The class participated in a gallery walk to see each pair's flower garden (Figure 5). Students tallied up the total number of flowers of each type and together, as a class and with the help of the teacher, created a physical picto-bar graph on the board using the pictures of the flowers (Figure 6). Students examined the conservation of numbers by comparing and contrasting the pictures.

The following were the concluding questions for success:

- During your gallery walk, which flower do you think appeared the most in the gardens? How do you know?
- Did you count or estimate?
- Now, by looking at the bar graph and without counting, which flower appeared the least in your gardens? How do you know?
- Which flower appeared the most? Is it close to your estimation?

An optional activity was also provided which let students explain the names they had chosen for their flower garden to promote communication and interactions.

Figure 5: Students' Gardens



Figure 6: Class Bar Graph



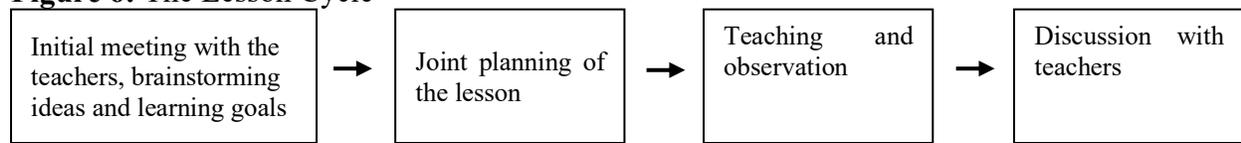
Sample

This lesson was taught to first graders in a Northern Ontario public school. The classrooms at this school had four self-identified Indigenous students integrated into the public school system, while most students (approximately 16) were from white settler cultural backgrounds. There were also three refugee children from Syria. In total, there were about 20 students in each class. The lack of Indigenous students included may be viewed as a limitation to this study; however, this was an accurate representation of Northern Ontario classrooms. The classrooms selected did not seem particularly diverse compared to the Canadian average because the school was situated in Northern Ontario, where most Indigenous students attended the schools in the surrounding Indigenous territories. Furthermore, according to the teachers, there were other students who were known to the community to have Indigenous family origins but did not self-identify as Indigenous. The fact that the teachers and the school's principal had a strong desire to participate in this study showed their desire to make Truth, Reconciliation, and Inclusion a reality for their Indigenous learners in mathematics classrooms throughout their school, regardless of their identification.

Empirical Model

This study used a phenomenological method integrated with a case study. This methodology is increasingly being recognized as a viable research method in the field of education (Yee, 2019), and was drawn from Yee's integration method, which involves using teachers' experiences, thoughts, and reflections on their professional practices as a key part of the data-collecting process. In addition, a phenomenological approach stressed the importance of the teacher-student relationship, as teachers need to be constantly aware of the emotions of each student, as well as students' personal and prior academic experiences (Shahbaz et al., 2020). This study applied the phenomenological method to examine mathematics teachers' experiences in implementing this lesson within the curricular mathematical content. It was aimed to demonstrate its practical use and significance to honoring Indigenous ways of knowing and creating an environment for all students to flourish.

Case study research is generally subjective, because researchers usually have close and direct personal contact with participants. While the subjective interpretation of results is an important aspect of both phenomenological case studies and of teachers' assessments of student progress, it can also cause the validity or credibility of such a study to be called into question. This was a concern that the researcher was mindful of, particularly during the data collection and interpretation process.

Figure 6: The Lesson Cycle

Researcher self-monitoring is a technique for establishing the credibility and validity of a study that occurs during the data collection and data analysis phase (Merriam, 1988). This technique was the approach taken in this study, which involves the researcher carrying out the inquiry in such a way that ensures no personal biases are involved. All efforts to refrain from any subjective judgement or intervention during the periods of research design and data collection were made, in order to preserve the validity of the study. For example, the researcher refrained from telling the teachers precisely how to implement the lesson, nor did she intervene during the implementation of the lesson in the grade 1 classroom, aside from asking students open-ended questions about their thoughts as they participated in the lesson.

To further establish and identify phenomena in a credible way, the researcher followed the suggestion of Robson (1993) which suggests confirmability in a research design should be incorporated to enhance the quality of a case study. The use of peer debriefing, such as presenting the data analysis and conclusions to colleagues on a regular basis during the data analysis stage, was also used in this study to foster credibility (Robson, 1993).

Data Collection

The development and implementation of the lesson would not have been possible without the help and insight of two outstanding Indigenous and non-Indigenous elementary teachers. The teachers chose their own pseudonyms: Wabanung and Tanya. The researcher collaborated with the teachers in order to create the lesson plan and attended both class instructional periods in which the lesson was implemented to record observations. Each instructional period took 45-50 minutes. The researcher observed the classroom and recorded the students' engagement in the activities and their interactions with teachers and peers as indications of the efficacy of the lesson.

After each instructional period, the researcher sat with the teachers and reviewed the details of their observations to confirm the validity of the content recorded and to establish trustworthiness in the findings. At the end of each meeting session, the teachers reflected on their instruction by answering the following questions:

- How do you know that your students have met the learning goals?
- How do you know that your students were engaged?
- How do you know that they felt included in the lesson?
- What worked well in the lesson and why?
- What will you do differently in the future if you teach the lesson again?

The decision of which comments from the students would be recorded and potentially analyzed in the results section of this study was mostly done by the teacher of each class. By allowing the teachers involved in the study to choose the comments they found the most poignant or interesting, this study hoped to demonstrate to teachers who are considering implementing storytelling into their teaching practice that the methodology has the power to engage all students in their

classrooms, regardless of the culture from which the students originate. In order to demonstrate the positive effect that lesson plans centered around storytelling had on students and teachers, and to show that students from different cultural backgrounds did indeed feel included and engaged in the storytelling-based lesson used in this study, recorded comments from students with a variety of cultural backgrounds was a priority for the teachers and the researcher. Ideally, the positive comments from a diverse selection of students will encourage educators to include Indigenous ways of knowing, such as storytelling, into their teaching practice, as they will be able to see how these educational approaches can benefit and include students of all cultural backgrounds in their increasingly diverse classes (Restoule & Chaw, 2017).

Findings

From Researcher's Notes: Highlights of the Students' Interactions in the Classrooms

The children had never seen or played with stick dice prior to the lesson. Three different sizes of popsicle sticks were available for the activity: large, medium, and small. Each pair of students could have six popsicle sticks of the same size. The larger popsicle sticks were given to the students with learning and mobility challenges (Figure 7).

Figure 7: Students' Decorated Stick Dice



The children were very excited to play with their stick dice, and to see how many sticks they would get with the decorated face up. The researcher noticed that most students counted the number of sticks with the decorated face up, but one student, K, was counting the sticks with the blank side up. The researcher paused at his desk to make sure that he understood how to use the dice sticks. He tossed the stick dice a few times and counted the blank sticks, however, when he wrote the rolled number in the tally chart next to the designated flower, all the numbers matched with the sticks with their decorated side up. When he was asked why he wrote four on his tally chart when he counted only two blank sticks, he explained:

*K: If I put four sticks with my two sticks then I have all of my sticks.

-Researcher: How many sticks do you have?

*K: The teacher gave me only six.

-Researcher: Why do you only count the blank sticks and not the decorated ones?

*K: I count only two sticks.

The student recognized that there were less sticks to count if he counted the sticks with the blank side up rather than the decorated ones. He was able to use reasoning skills to determine that, when the number of blank sticks was smaller than the number of decorated sticks, he could use subtraction instead of addition to more easily calculate the number rolled. This is a learning opportunity that would not have been available if students were to use a traditional, Western six-sided die instead of the dice sticks.

The Garden Display

It was suggested to teachers that they should display the children's completed gardens and initiate conversation about their creations. For this lesson, the wall and the board were used to display the students' gardens (Figure 7). Some groups of students volunteered to talk about their gardens. Some explained why they decorated each stick differently and not the same. L, one of the students, said "I colored my sticks like my grandmother's quilt, all different." Interestingly, H and J, two other students, had chosen an Ojibwa name, *Gitigan* for their garden. They explained to the class that their parents were teaching them their native language at home and *Gitigan* is the Ojibwa word for garden. M, a student from a Syrian refugee family, was encouraged by hearing this, and asked the teacher to help him write the name of his garden in his native language. He said "I named my garden *Hadika* [his pronunciation] because we speak Arabic at home. My mom only knows numbers in English." This led to creating a community of learners within the classroom, and the teachers took the opportunity to allow the students to learn from each other while they were explaining about their creations and their families. C, another student, got involved in the conversation and explained "I named our garden *gras* [with improper spelling] because we planted the flowers on the grass."

The Discovery

The children referred to their completed gardens while communicating with their peers. For example, toward the end of the class, a student named S was counting the number of roses that he colored red in his garden and then comparing them to the one that C did not color in his garden. S immediately realized that he colored two roses red and one rose blue but only one rose was not colored. He concluded that the number of colored roses were more than the non-colored ones. To show his findings to the class, he did a one-to-one matching of colored roses with the fingers on his left hand and the non-colored rose with the finger on his right hand to confirm that 3 is greater than 1.

The Bar Graph

Every teacher developed a particular way of teaching action for a specific purpose. In this lesson the teachers agreed to set up the picto-bar graph of the class gardens so the students would be able to make sense of the data visually; the longer the column is, the more of that specific type of flower was present in the class garden. The students were encouraged to compare the number of different flowers in the class garden without counting the flowers in each bar graph. L compared the numbers of daisies to the numbers of sunflowers:

*L: There are more sunflowers than daisies.

-*Wabanung*: How do you know?

*L: Because one daisy is hanging [at the bottom of the graph].

-*Wabanung*: What flowers appeared the least in the class garden?

*M: Tulip.

-*Wabanung*: How do you know?

*M: Because there are five tulips and...

*C, interrupting M: There are five daisies too.

*M: But tulips are smaller than daisies.

-*Wabanung asking M*: Are you comparing the size of a tulip with a daisy?

*M: Yes.

Wabanung paused and sensed that M might be thinking in his native language where perhaps the words *least* and *smallest* have the same translation in English. The bell rang and it was time for the teachers' reflections.

The Highlights of Teachers' Reflections After Teaching the Lesson

The teachers reflected after teaching the lesson by answering the following questions:

-Researcher: How did you know that your students have met the learning goals?

Both teachers indicated that the communication displayed by the students regarding their gardens provided evidence of their learning. This was reflected in, for example, their ability to identify five as being greater than three. The students could connect numbers to the number of flowers in their gardens.

-Tanya: In my class the learning moment was playing the dice game. My students did adding and subtracting in ways I have not seen before. I think a game does that to kids. Some of them used 'take away from' and 'part-whole' models to figure out how many sticks with decorated side are up on the desk.

-Wabanung: My students reflected on their own gardens and how to create patterns on the stick dice. They shared their own learning and corrected each other while reading the bar graph. I sensed the language of self and peer assessment through interaction among my students.

-Researcher: How did you know that your students were engaged? Or included?

-Tanya: The indication for me was that each student has tried to personalize his/her own garden by relating it to his/her native language or culture. This indicated to me that they have been engaged and felt included. Although the stick dice was unique to Indigenous culture, it was a universal game gadget and my students had little or no problem understanding the game.

-Wabanung: M's connection to the roses was powerful. He said that he drew roses on his stick dice because his mom planted some in their backyard in Syria. My students were explaining what kinds of flowers they have planted either on the pots or in their backyards. I felt in my class, the element of recollection was a powerful indication of inclusion through engaging in a meaningful activity.

-Researcher: What worked well and why?

-Tanya: Starting the class with a story that all of my students could relate to, in particular my Indigenous students, since the connection to the land is embedded in the Indigenous culture and passed on from generation to generation. I was afraid if my non-Indigenous students lost interest but playing the game kept them interested and engaged. The combination of the story and the game worked in my class.

-Wabanung: By making the gardens, the learning became visible through storytelling. The lesson promoted creativity rather than rote learning. The gallery walk required the students to practice their higher order of thinking skills, such as comparing and judging peers' gardens. The dice game was fun for them. My students love cutting and gluing pictures.

-Researcher: What will you do differently in the future if you teach the lesson again?

-Tanya: I will not ask them to design each dice stick the same. Instead, I will give them the freedom to decorate each stick dice... they did it anyway. I will ask them to draw their own flowers instead of

handing out the pictures of the flowers. As a result, I will be able to witness their creativity and understand more about my students' cultural background. If I use the pictures of the flowers, then I make sure the pictures of the flowers are the same size because a larger picture makes a longer bar graph with a fewer number of flowers in the bar. I will re-use the stick dice for probability games in the future lessons. For my next lesson, I would like to have a story where I have different cultural traditions together in one story.

-Wabanung: I would like to look into bringing technology to this lesson. I am thinking how my students can create virtual gardens while playing the game of stick dice. It is combining virtual and concrete learning tools. Isn't this differentiated instruction!

Both teachers commented that the culturally based lesson was an effective tool in their classroom. It did not only benefit the students whose culture had been explored in the lesson activity, but also those outside of that culture. Although they added that such lessons could help with the opportunities and the difficulties signified by their increasingly culturally diverse learners in the school, they were concerned that a teacher might encounter resistance from students in upper grades.

Conclusions

In the study, the essence of the teachers' reflection and conversations with the students revealed the following inclusive teaching and learning moments after implementing the lesson plan:

- Interactions between the teachers and students were appropriate to the math content, regardless of the students' cultural background (i.e., the class bar graph was produced).
- The story and game engaged the students in an academic task (i.e., dice game, a universal game, in connection to an Indigenous legend).
- Interactions among students happened regardless of differences in their cultural backgrounds (i.e., talks during gallery walk).
- Teaching moments went above and beyond curriculum expectations (i.e., M's possible language barrier).

Analysis of the teachers' interactions with the students showed that, in both classrooms, the students felt included in the lesson while making cultural connections to the mathematical content. For example, M talked about the rose garden in his home country and Hunter and Jacob chose an Ojibwa name for their garden. Analysis of the teachers' reflection showed that storytelling and playing the dice game helped in creating engaging and inclusive math classrooms. This approach to teaching mathematics will send a powerful message that all learners from both minority and majority cultures are included in the class's learning and can create a stronger class bond.

Practical Implications

The implications from and the recommendations based on the results of this study are addressed to two groups of professionals: 1) teachers, and 2) educational leaders or stakeholders. During the first interaction with the participating teachers, when the topics of mathematics, storytelling and games were brought out, the teachers did not think that a story from Indigenous culture or a dice game could promote inclusiveness or achieve their desired learning outcomes in their classrooms. During our final group discussion, the Indigenous teacher mentioned that she felt Indigenous knowledge was irrelevant to modern mainstream society, and she was concerned if her students would benefit from this older approach to teaching. The non-Indigenous teacher has discussed her

own lack of confidence in presenting another culture in a lesson which has resulted in personal doubts in her ability to conduct the lesson in an effective, culturally sensitive manner. Nevertheless, this may indicate that teachers' conceptions related to cultural diversity and their teaching practices were modifiable. Not only did the learners in the study benefit from a more culturally inclusive lesson, but the teachers learned more about themselves and their own capabilities as educators. However, while this appears to be a promising method of addressing cultural diversity in the classroom, more in-depth research studies should be conducted about teachers' conceptions about other cultures, and the biases that may persist in relation to teaching a culture that is not predominately their own.

The results of this study suggest that a multicultural storytelling approach to teaching mathematics should have more coverage in professional development workshops. The surprise teaching moments that could arise from this storytelling-based approach, such as when the teacher suspected M's use of the words 'least' and 'smallest' in his language differed from their use in English, are priceless in terms of understanding students' prior knowledge based on their backgrounds and adjusting their teaching accordingly to clear up any misunderstandings due to cultural differences. This study acts as a practical example of how teachers might integrate cultural diversity into mathematics and lays the groundwork for applying other culturally sensitive lessons and activities into other academic subjects and grade levels.

Theoretical Implications

As stated by Matthews (2015), each student's unique cultural background should be viewed as an integral part of their contributions to and comprehension of mathematics, rather than as a hindrance. M's use of the Arabic word for garden, *Hadika*, and Hunter and Jacob's use of the Ojibwe word for garden, *Gitigan*, shows that students from a variety of non-Western backgrounds were able to feel personally connected to their learning, and were able to apply their own cultural knowledge and identities to the creation of and story behind their gardens. This may be a particularly impactful approach for Indigenous students, as they can begin to see their own culture and experiences as valuable part of their mathematics learning, instead of feeling disconnected from themselves in pursuit of the highly Westernized *absolute truth* of math. This allows Indigenous students, as well as other minority groups, to see themselves as included and important in STEM subjects, and as a result, this may encourage Indigenous and other minority students to pursue higher education in science and math-related fields later in life.

Limitations and Further Research

It is worth noting that immigrant learners that are not represented in the curriculum might also face increased delay or resistance in terms of cultural integration and academic achievement. The teachers in this study were specifically concerned about incorporating Indigenous knowledge into their practice, which is intertwined with their very own history of being Canadian. However, teachers should also consider the needs of students from other non-Indigenous, non-European settler cultures. The research indicates that the type of cultural diversity present in each individual learning environment should be a guiding factor when designing lesson plans, as it was for this study. The teachers have also pointed out that some older students might show resistance towards a culturally integrated lesson. To lower or perhaps eliminate such resistance, it is recommended that further research studies such as this one be conducted in junior classrooms. This study was

based on a one-lesson experience that included a limited number of diverse students which is based on one case study. Future research could further assess the validity of the above conclusions in a larger sample of students over a longer period with different grade levels.

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