

INCIDENTS OF INTRUSION: DISRUPTIONS OF MATHEMATICS TEACHING AND LEARNING BY THE TRADITIONAL WESTERN WORLDVIEW

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This paper reports on a theme, the intrusion of the Traditional Western worldview, emerging from an ongoing study of the impact of teachers' engagement in the Transreform approach to the teaching and learning of mathematics on students' affective and cognitive responses to and achievement in mathematics. Newly theorized (Russell & Chernoff, 2011, 2012), the Transreform approach occurs when the teaching and learning of mathematics is grounded within an Indigenous worldview. This paper identifies and analyzes incidents captured within the study's data that demonstrate ways in which the Traditional Western worldview can intrude on an Indigenous worldview and upon the teaching and learning of mathematics.

Keywords: Elementary School Education, Teacher Beliefs

A recently emerging thread of research has theorized about the relationship between aspects of mathematics education and two different worldviews: the Traditional Western worldview and an Indigenous worldview. In particular, this research has theorized about the relationships between the two worldviews and constructivist teaching and learning in mathematics (Russell & Chernoff, 2011); the math wars (Russell & Chernoff, 2012); and the marginalization of Indigenous students within mathematics teaching and learning (Russell & Chernoff, online first). Emerging from this body of work, is the proposition that there exists a third option within the math wars context, sitting outside of the spectrum of the two camps of traditional and reform approaches to mathematics teaching and learning, that of the Transreform approach (Russell & Chernoff, 2012, online first). The Transreform approach to the teaching and learning of mathematics (described in detail below) theorizes that it is possible to move beyond the dichotomy of the math wars, and in doing so, provide a space in which the teaching and learning of mathematics becomes accessible to all students.

The purpose of this paper is to report on some initial findings of a study designed to determine the impact of the Transreform approach to the teaching and learning of mathematics on both the affective and cognitive domains of students in elementary mathematics classrooms. The findings presented in this paper however, focus not on the results of the change, but on how teachers experience the change to the Transreform approach. In particular, this paper will report on instances where the Traditional Western worldview has disrupted the teaching and learning processes, and the struggle of teachers to recognize these intrusions for what they are and to determine how to respond to them in ways that are grounded within an Indigenous worldview.

In upcoming sections of this paper, the setting of this study, methods used to collect data and analysis of that data will be presented. Prior to these discussions however, a quick explanation of three key concepts, that of the Traditional Western worldview, an Indigenous worldview and the Transreform approach to the teaching and learning of mathematics, which make up the theoretical framework for this study, is in order.

Theoretical Framework

Worldviews, which are the basis of the theoretical framework for this study, define what knowledge and ways of knowing are (most) valued by those who hold the particular worldviews. This does not imply that everyone within a group identified by a worldview's name holds that particular worldview, rather that it is commonly held by most in the group. With this understanding of worldviews, the foundational characteristics of the two worldviews considered in this study, the Traditional Western and an Indigenous worldview, are now presented.

The Traditional Western Worldview

Within the Traditional Western worldview, the characteristics of knowledge and ways of knowing that are valued focus on absolutes and truth. Of most importance, the Traditional Western worldview values knowledge that is linear, singular, static and objective in nature. As a consequence, the Traditional Western worldview seeks one correct answer and one right action, resulting in specialization and abstraction being indicators of greater knowledge. With respect to how to find that one correct answer or action, methods whose results can be replicated and measured for validity, such as the Scientific method, are to be used. Moreover, as such methods require the isolation of what is being studied, the resulting knowledge is also compartmentalized, isolated, and categorized to maintain its validity. Finally, because the written word does not change over time (without intentional outside interference), it is held to be the way to preserve truth (Kovach, 2009; Little Bear, 2000). The Traditional Western worldview, because of its emphasis on singularity of truth, answers and methods, has very little variance in its enactment within Western societies.

An Indigenous Worldview

An Indigenous worldview however, does not have the restriction of singularity; rather it values diversity. As a result, there is no one Indigenous worldview, but many different Indigenous worldviews, each responsive to the conditions, places and times of the people that hold those particular worldviews (Kovach, 2009; Little Bear, 2000). Despite the natural occurrence and possibility for variation within Indigenous worldviews, there are common characteristics that can be identified and used to define an overarching Indigenous worldview. This common Indigenous worldview is grounded within the importance of relationships (physical, social, emotional, and intellectual) to people and to the physical and spiritual world. As a result of the importance of relationships, knowledge that is valued in an Indigenous worldview is connected to the place in and for which it is gained, with abstraction and compartmentalization being possible, but not the ultimate goal. As well, subjective knowledge, with its strong ties to the emotional and social realms, is knowledge that is valued, along with the objective knowledge that the Traditional Western worldview seeks. The valuing of subjective knowledge allows personal experience, observation and intuition to be considered valid sources of that knowledge. Diversity in ways of knowing and knowledge are not only valued, but sought, and as a result the individual becomes important because of what they can contribute to the group. Thus, knowledge is to be sought in order to give back to the greater good of the community, the world, and the cosmos. Finally, within an Indigenous worldview, truth, which changes with time and place, can be captured and held within oral language (Kovach, 2009; Little Bear, 2000).

Research referred to at the beginning of this paper used these two worldviews as lenses through which to view and analyze different facets of mathematics education. For example, the math wars, and in particular, the two approaches to the teaching and learning of mathematics which have come to represent a dichotomy within those wars (traditional and reform), have been viewed through these two lenses (Russell & Chernoff, online first). The result of this analysis has

been the theorizing of the possibility of a third approach to the teaching and learning of mathematics: the Transreform approach, which allows for the nullification of the dichotomy that has driven the math wars for more than two decades. This approach is discussed in more detail below.

The Transreform Approach to Teaching and Learning Mathematics

Prior research (Russell & Chernoff, online first) has posited that when considered through the lenses of the Traditional Western worldview and an Indigenous worldview, the two opposing camps on the teaching and learning of mathematics in the math wars (traditional and reform) form a strong alignment with alternate worldviews. In particular, it was found that the approaches of the traditional camp strongly position themselves within the Traditional Western worldview, while the approaches of the reform camp are reflective of the values of an Indigenous worldview. Moreover, moving beyond the question of which worldview best matches each of the math wars camps, it was also noted that within an Indigenous worldview the approaches of the traditional camp in the math wars are not negated, but already exist as one of many possibilities.

Alternatively, there is no room within the Traditional Western worldview for the approaches to teaching and learning espoused by the reform camp. As a result, it is theorized that, if the teaching and learning of mathematics is grounded within an Indigenous worldview, the approaches used by both camps (traditional and reform) are viable and appropriate. In other words, the approaches to teaching and learning of mathematics found within both the traditional and reform camps of the math wars are possible within a mathematics classroom grounded in an Indigenous worldview. Thus, within an Indigenous worldview, the two camps of the math wars become two of a set of possible approaches, and the dichotomy of the two camps is eliminated. Teaching and learning of mathematics that is grounded within an Indigenous worldview is what has been termed the *Transreform* approach to the teaching and learning of mathematics. “In the Transreform approach, the diversity of mathematical knowing and the precision of mathematical knowledge exist in harmonious exchange” (Russell & Chernoff, online first).

These three concepts, the Traditional Western and an Indigenous worldview and the Transreform approach to the teaching and learning of mathematics, form the theoretical framework for this research study. Next, the participants, research methods and methods of data collection used in the study are described in final preparation for the analysis of a limited number of examples (due to page limitations) from the study.

The School and Participants

This study is being held in a small rural elementary (K-6) community school in western Canada. The town in which the school is located is adjacent to a First Nations reservation and at least 90% of the students at the school are of First Nations or Métis descent.

There are four elementary teachers involved in this study, Sharon, Elizabeth, Lena, and April, who teach grade 2, 4, 6 and an ungraded class respectively. The ungraded class consists of a maximum of 7 students, primarily between the ages of 6 and 8, with the students being identified by the end of Kindergarten as not yet ready to enter grade 1. As the students in April’s class progress in their learning (for up to a maximum of 2 years), they are gradually integrated into the grade 1 or 2 classrooms. Of the four teachers, only Elizabeth is not of First Nations or Métis descent.

The teachers involved in this study reported two reasons for wanting to participate: to improve their students’ mathematics achievement (by grade 6, a majority of the students are still learning outcomes from the grades 3 and 4 mathematics curricula) and to support their students in developing a positive affective response to mathematics and mathematics learning.

Method

The teachers involved in this study were initially given an introduction to the concepts of the Traditional Western worldview, an Indigenous worldview and the Transreform approach to the teaching and learning of mathematics. On a weekly basis, the researcher conducts in-class observations. In addition, monthly full-day meetings with the teachers and researcher are held in which experiences over the past month are shared, questions arising from those experiences are explored, and plans are made for future teaching and learning activities. During these meetings, the teachers and researcher shape their ideas and work within the theoretical framework of the study.

Data Collection

During in-class visits, data in the form of observational notes, photographs, audio recordings and surveys of the students are collected. At the full-day meetings with the teachers, data in the form of observational notes, audio recordings, and teacher questionnaires are collected. Portions of both the in-class and full-day meeting audio recordings were selected, transcribed and verified by the participants for use in this paper.

The teachers also designed and implemented pre- and post- assessments for determining their students' affective responses to mathematics and level of academic performance related to the mathematics they were learning. The instruments (and results) were discussed with the researcher, with attention paid to the worldview in which the instruments were grounded.

From the data collected, a selection of four incidents, one for each of the teachers, was chosen as a representative example of a disruption of their teaching and learning of mathematics by the Traditional Western worldview. These incidents are now analyzed for evidence of such an intrusion.

Analysis

Due to the limited space of this paper, the four incidents presented for analysis must necessarily be considered without the data 'story' that surrounded them. That is, evidence of how the approach to the teaching and learning of mathematics by the participant teachers prior to each incident had been grounded in an Indigenous worldview, and thus was representative of the Transreform approach. However, speaking in generalizations, each incident was preceded by the teacher focusing on the building of relationships, looking for diversity in approaches and solutions, and contextualizing of the teaching and learning. Although these four incidents are a very limited number of all the data collected, they and their analysis are representative of the entirety of all such incidents within the data collected to date.

Sharon and the Hundred Chart

On a meeting day with the teachers, Sharon stated "I can't wait to find out how my class did on the hundred chart puzzle task today". Sharon explained that the task involved the students being given portions of a hundred chart, cut out like puzzle pieces, on which only one or two numbers were pre-recorded for the students. The students were to fill in the blank squares on the puzzle with the appropriate numbers (as it would be on the hundred chart). During a short break in the meeting, Sharon went to her classroom to check how her students had done with the task.

Upon returning to the meeting, Sharon expressed disappointment because her students had been unable to do the puzzle task. As Sharon explained what the substitute teacher had said happened, she interjected with a personal note: "I can't blame the students for finding the task hard. The hundred chart is so confusing – I don't know why it was made that way – it's not the

way I would have made it. I would have made it like a *Snakes and Ladders* game. Start at the bottom left and wind back and forth until you get to the top left. That makes more sense”. Although the other group members agreed that the hundred chart was not arranged the way they would do it, all of the teachers agreed with Lena when she said “But – that’s the way the hundred chart has to be, so the students just need to know it”. Sharon decided that she would need to spend more time repeating some of the things she had done previously with her students so that they “got it”.

There are two aspects of this incident that provide evidence of the Traditional Western worldview asserting its authority over the situation. First, the group immediately rejected the possibility of alternate hundred chart arrangements in favour of the one correct one; “the way the hundred chart has to be”. If the teachers, at that point, had in fact been completely grounded in an Indigenous worldview, the discussion of alternative hundred chart designs would not have been curtailed by the existence of a standard hundred chart that is commonly used.

The second point at which the Traditional Western worldview disrupted the discussion was with Sharon’s explanation of what she felt she needed to do next. Her plan was not based upon contextualization, building of relationships or diversity of knowledge and ways of knowing, as one grounded in an Indigenous worldview would be. Instead, Sharon was planning to repeat what has been done before in order to have her students gain the knowledge needed. The singular nature of her response, there is one right way to teach and learn this topic, and since it has been done already it needs to be done again, is also an example of the Traditional Western worldview interfering with the teaching and learning of mathematics being grounded in an Indigenous worldview.

Elizabeth and Arrays

At the beginning of a particular class observation, Elizabeth informed the researcher that her students had been exploring representing multiplication statements using arrays. The task that she gave the class, originating from an intensive professional development that Elizabeth had been involved in a few years before, was one that she had used “with success in previous grade 4 classes”. After a series of activities in which Elizabeth had asked students to identify the multiplication statements represented by arrays (comprised of dots) that were shown using an overhead projector, Elizabeth then gave the students the task of creating an array to represent the multiplication statement of 3×4 .

Prior to the start of the class, Elizabeth had told the researcher that she was looking forward to the discussion of “which way should we draw the array”. However, the discussion did not happen. Elizabeth reported that “the activity collapsed” as she had to deal with a large number of students who were starting to draw puppies, Sponge Bobs, and pineapples. Elizabeth came to me and said: “What do I do, they are all off task – drawing pictures – not dots. None of the previous classes ever did this. Perhaps I should move off of math for a while and then come back to the arrays”. During the recess break that followed the class, the researcher had the opportunity to talk to some of the ‘off task’ students and it was revealed that, in fact, the students had been drawing arrays, but not arrays of dots – arrays of puppies, Sponge Bobs, and pineapples.

Because her students were not creating arrays of dots, Elizabeth concluded that they did not want to, or could not, do the task. She inferred that this group of students was deficient in its understanding of the mathematics because what the students were doing was not right according to her past experiences. This expectation of singularity of approach to a task is foundational to the Traditional Western worldview, but not an Indigenous worldview. In this way, the teaching and learning of mathematics in Elizabeth’s class had been intruded upon by the Traditional

Western worldview.

April and the Bag of Beads

During a recess break on a day that the researcher was doing in-class observations, April told the researcher that she was struggling to get her students to understand the partitioning of whole numbers to 10. She explained that she had the students working on a task in which they were shown a bag and were told that it contained a certain number of beads (some yellow and some blue), say 8. The students were then asked questions such as “if there are 3 yellow beads in the bag, how many blue beads are there”? April explained: “they just can’t do it ... it’s been like this with every class I’ve ever tried this activity with. They just never get it. We do it over and over, but they just can’t do it. They never get partitioning, no matter how many times we do this activity”.

Similar to Sharon and Elizabeth, April was struggling with her students not being able to carry out a task she has given to them. What is different in the case of April’s task was that it has never been successfully completed in any of April’s classes, yet it still carries the same kind of assumed authority that Sharon’s and Elizabeth’s tasks also held. Thus, this too is an example of the Traditional Western worldview, and in particular the belief in the one right way, intruding into, perhaps even taking over, a mathematics classroom.

Lena and the Curriculum

Part way through this research study, the teachers were also given an unrelated opportunity (as part of an in-school professional development plan) to start or join an existing professional learning community (PLC). In response, Elizabeth, April, Sharon and Lena decided that it made sense for them to make their PLC part of the research study, preferring to “continue to work with math rather than start something else as well and not get anything done in either case” (Lena).

After setting a required SMART goal for the PLC, the teachers began planning units for the teaching and learning of mathematics using Backwards Design. As they were developing their plans, Sharon, Elizabeth, and April all discussed their struggles with creating their assessment tools based on the outcomes they had chosen, but Lena’s struggle began even sooner. The instant Lena had to look into the curriculum document to determine the outcome and indicators she and her students would be focusing on a dilemma emerged. For Lena, the curriculum outcomes and indicators were limiting and even judgmental: “When someone comes into my class, they don’t look and say ‘look at what they can do with multiplication, factors and multiples’, they say ‘where are the words multiplication, factors and multiples’? We use the words eventually, but I’m more concerned that my students understand what they are doing”. Pointing at the outcome she selected from the curriculum document, Lena continued, “but this is what I will be judged on by someone coming in my class from outside – on the words, not on what my students understand”.

Written in single, and as a result often convoluted, sentences, Lena felt the curriculum outcomes and indicators were telling her that there was one right way to know mathematics. In essence, she was struggling with a Traditional Western worldview interpretation of the mandate of the curriculum outcomes (probably not without good reason) in contrast to her Indigenous worldview approach to the teaching and learning of mathematics. Lena’s resolution to the conflict was to write the outcome in the space provided on the planning template, and then to never look back at it again. Thus, Lena did not fully reject this intrusion of the Traditional Western worldview into her teaching and learning of mathematics, but unlike the other three teachers, she was able to deny it absolute authority with respect to her planning for the teaching and learning of mathematics in the classroom.

Conclusion

As demonstrated in the analysis above, when attempting to engage in the Transreform approach to the teaching and learning of mathematics, that is, when attempting to ground oneself in an Indigenous worldview, there are many ways and times in which the Traditional Western worldview can disrupt the situation; asserting the authority of its values of singularity, correctness, and validity over those of the values of an Indigenous worldview. As has been demonstrated, such intrusions of the Traditional Western worldview can happen when student use and understanding of pedagogical tools (such as the hundred chart) do not produce expected results; when students engage in unexpected ways with tasks perceived to be ‘tried and true’; when students are unable to engage with tasks that are assumed to be effective; and when teachers are asked to merge outside forms of authority (such as a curriculum document) with their approach to the teaching and learning of mathematics. Moreover, with the possible exception of Lena’s encounter, the examples considered in this paper demonstrate that not only can the Traditional Western worldview intrude upon the teaching and learning of mathematics grounded within an Indigenous worldview – it can derail a teacher’s attempts to use such a Transreform approach.

Discussion

Not included in the analysis above are the ‘after’ stories. In each instance cited, the researcher and teacher(s) were able to engage in discussions through which it was possible to eliminate, or at least divert, the specific disruptions by the Traditional Western worldview. For example, when Sharon presented her specific problem to the teachers, the researcher suggested that each teacher explain how they would organize the hundred chart if it was their choice. Sharon decided that she would try such an activity with her class in order to determine how her students were thinking about the whole numbers to 100. One week later, Sharon’s students were completing a hundred chart that showed only the multiples of 5 and which was spiraling clockwise from the center of the chart (a pattern that the students determined for themselves). Moreover, the students were creating their own hundred chart puzzle pieces for their classmates where the organizational scheme of the originating hundred chart had to be determined by the student who got the particular puzzle piece. Sharon was pleased with the resulting confidence her students demonstrated, stating: “and they can even use the regular hundred chart”.

In the case of Elizabeth and the arrays, the researcher and Elizabeth discussed what the purpose of the task was, after which, Elizabeth decided that restricting her students to using dots had nothing to do with understanding multiplication. Moreover, she came to view the restriction of using dots as being characteristic of the Traditional Western worldview, highly abstracted and devoid of context. Elizabeth later reported that by allowing the students to use representations of their own choice, and through the sharing and discussing of the representations that the students created, her class progressed rapidly in their attainment of the multiplication outcome.

April was able to overcome the assumed authority of the ‘beads in a bag’ task by discussing what partitioning is and where it could be found in daily activities. The result was that April returned to her classroom, provided her students blue and yellow beads and had them answer (in a way that made sense to each particular student) the question, “if you were putting 8 of these beads in the bag, how many would be yellow and how many would be blue”? Since then, April shared with the teachers in the study how her students are “really getting a good handle on partitioning”. She now views the original task as “okay, but not important”.

Finally, Lena, by refusing to acknowledge the curriculum outcome beyond writing it down, had not allowed the intrusion of the Traditional Western worldview to completely disrupt her planning, has since reported finding a place for that outcome in her Transreform approach to teaching and learning mathematics. In her struggle with the words of the outcome, Lena came to embrace those words within her larger and diverse understanding of the mathematics, and consequently her students are now also “saying multiple and factor all the time when they are talking to each other”.

Thus, because of having an opportunity to talk about what was happening at the moment of an incident of intrusion by the Traditional Western worldview, the teachers were able to find room for the point of disruption within their grounding in an Indigenous worldview without having to sacrifice that worldview. The teachers did report however, that had they not been afforded such opportunities they were not confident that they would have overcome these moments of disruption. At a recent meeting, Elizabeth said to the researcher: “You always know what to ask us, what to make us think about, so that we see that we are being Traditional Western. I never see it myself”. However, later in that same meeting, Sharon said: “You know, I was just thinking about a class I had yesterday, and I realized that I had unintentionally shut down the possibility for the students to bring in their own ideas. I’m going to go back to that tomorrow and try something different”. In this instance, and without outside interference, Sharon was recognizing and questioning a disruption by the Traditional Western worldview.

For the teachers in this study, the change from the Traditional Western worldview to an Indigenous worldview is one that “just makes sense” (April), but it is also “challenging at times” (Elizabeth). The assumed singular authority of the Traditional Western worldview by the worldview itself (and thus by much of the society in which these teachers live and work) makes it possible for the Traditional Western worldview to “slip in and take over” (Lena). Whether these four teachers will be able to recognize (and overcome) such future incidents of disruption on their own remains to be seen.

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