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Teacher-Directed Collaborative Action Research as a Mediating Tool for Professional Learning in Rural Contexts

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Abstract

Through a single-case study design, the research study described in this article examined one rural Canadian school division's use of teacher-directed, collaborative action research (TDCAR) as a mediating tool for teacher learning within a professional development (PD) initiative known as the Numeracy Cohort. The PD initiative brought together a dozen K-12 teachers from across a very small (but geographically distanced) school division in Manitoba, Canada. In addition to learning about several strategies for teaching mathematics and improving student numeracy skills, the teachers in the Numeracy Cohort engaged in collaborative action research projects, designing materials and implementing new strategies in their unique, often multi-grade, rural classrooms. In addition to the changes and improvements noticed by teachers through their collaborative action research, findings from the study illustrated several strengths of TDCAR, including the autonomy it afforded teachers to engage in work directly related to their classroom contexts, its ability to foster collaboration between colleagues, and its ability to build connections across schools within a diverse rural context. Findings from the study also suggested that consideration should be given to both ways of supporting the action research process, and the complexities of facilitation in rural settings if TDCAR is to be used as a mediating tool for learning.

Keywords: rural, teacher professional development, collaborative, action research, numeracy

Introduction

Rural school districts in Canada face significant and unique challenges in terms of supporting teacher professional growth. Small budgets and shortages in funding, due to declining enrolments and funding models that do not accurately take into account the real operating costs of schools in remote and rural communities, can make it difficult for rural educators to find relevant professional development (PD) opportunities that fit within the budgets of school districts (Clarke, Imrich, Surgenor & Wells, 2003). In addition, geographic distances between rural communities and schools, as well as between such communities and urban centres (where many PD opportunities are held), increase not only the operating costs of school districts, but also the transportation costs and time required for teachers to meet face-to-face for PD opportunities (Clarke et al., 2003; Peterson, 2012; Skyhar, 2018). Such challenges make it difficult for some of the most physically and professionally isolated educators in Canada to access relevant and meaningful PD.

While many rural organizations look to local PD models to mitigate challenges related to geographic distances and funding, other challenges (even within local contexts) emerge in relation to teacher PD. For example, rural educators often find themselves isolated from colleagues who share similar workloads or teaching specialties within their own schools (and even districts), making it difficult to engage in collaborative inquiry (Howley & Howley, 2005). This is of particular importance given the attention that has been paid to PD (and more specifically collaborative PD strategies) as a vehicle through which instructional quality and rural-urban achievement gaps might be improved (Clarke et al., 2003; Cochran-Smith & Lytle, 2009). In addition to professional isolation, many rural divisions experience a lack of staff to support PD efforts in rural contexts, such as coaches, consultants, and substitute teachers for teacher release (Glover, Nugent, Chumney, Ihlo, Shapiro, Guard, Koziol & Bovaird, 2016). This can lead to insufficient internal capacity in rural districts for leading and supporting PD initiatives from within. Given the challenges faced by rural districts in Canada, the question of how to develop local PD models that draw on local strengths and mitigate local challenges to the provision of quality PD for rural educators is of critical importance. Finding ways to provide cost-effective PD opportunities that address the needs of rural educators is essential to providing equitable and high-quality instruction for rural students.

Teacher-directed, collaborative action research (TDCAR) has been described as a potentially effective alternative to traditional forms of professional development in rural Canadian school districts, given the obstacles that they face in relation to PD (Peterson, 2012). While many school divisions focus on sending teachers out to larger urban centres for PD opportunities, a practice that expensive and time consuming given the distances involved, those engaging in TDCAR have been able to support teacher professional growth within local communities. In addition, TDCAR has the potential to provide teachers who may have had “few opportunities in the past to engage in professional development that was emergent, embedded in practice, ongoing, and teacher directed” (Goodnough, 2010, p. 176) with opportunities to focus on local educational issues of their choosing – issues that are relevant in their school contexts and directly related to their practice and their students’ learning.

Addressing what has been described as a need for research on rural teachers’ professional learning and ways of supporting such learning (Glover et al., 2016; Peterson, 2012; Peterson, McIntyre, & Glaés-Coutts, 2018), this article reports on a rural teacher PD model that used TDCAR to support teacher professional growth (in the area of mathematics instruction and student numeracy) across geographically distanced schools in a southern Manitoba school division (equivalent to school districts in other provinces). The model, which was designed specifically to mitigate local PD challenges and provide collaborative opportunities for numeracy teachers in the division, engaged teachers in what were termed Mini Action Research (MAR) projects. These TDCAR projects allowed more than a dozen K-12 teachers in the division to work collaboratively on numeracy topics and issues relevant to their classroom contexts, within a professional learning community known as The Numeracy Cohort.

Relevant Literature: Teacher-Directed, Collaborative Action Research in Rural Contexts

As previously mentioned, TDCAR has been described as a structure that holds tremendous promise for rural school districts, given the geographic and capacity-related challenges they face. TDCAR begins with questions derived from the everyday work of teachers, and allows teachers, with the help of a mentor (often a colleague or university researcher), to design and implement new or refined practices, studying the impact of their new practices through systematic data collection and analysis (Peterson, 2012). Teachers participating in this type of learning process typically engage in cycles planning, acting, observing and reflecting, within collaborative groups focused on similar goals (Goodnough, 2010; Loucks-Horsley, Stiles, Mundry, Love, & Hewson,

2010). Through its focus on the specific contextual needs of teachers, its support for teachers engaging in the action research process, and its attention to social interaction and collaboration, TDCAR holds tremendous potential for both the construction of new knowledge, and educational improvement efforts in rural contexts.

Several strengths of TDCAR have been cited in relation to both teacher professional learning, generally, and rural teacher PD, specifically. One of the strengths of such models is the professional autonomy they provide teachers, honouring their existing knowledge, and allowing them to decide, for themselves, where to focus their improvement efforts and learning (Peterson, 2012). Rural educators often work in contexts that are unique: low teacher-pupil ratios, multi-grade classrooms, high teacher turnover, distances between schools, close connections with community, and resource limitations are but a few of the differences that are common in rural contexts (Clarke et al., 2003). By allowing rural educators the autonomy to focus on contextually relevant issues, and to create locally grown solutions to those issues, TDCAR generates engagement in professional learning, and commitment to common, locally relevant goals (Chance & Segura, 2009). Colleagues, within such collaborative groups are able to support each other to work on common areas of interest, and to reflect on their practice. It is this opportunity for reflection with colleagues that is often cited by teachers in rural contexts as a powerful strength of collaborative action research (Peterson, 2012).

In addition to opportunities for reflection with colleagues, another strength of TDCAR is that it requires educators to adopt an inquiry stance (Cochran-Smith & Lytle, 2009; Vaughn, Parsons, Kologi, & Saul, 2014). According to Cochran-Smith and Lytle (2009), “when practitioners work from an inquiry stance, every site of professional practice becomes a potential site of inquiry” (p. 121). Through continuous reflection and inquiry, educators not only develop an appreciation for the importance of ongoing inquiry in their practice, they also develop the skills necessary for engaging in collaborative action research, such as gathering and assessing student data, and using it to inform changes in practice that support student learning. In rural contexts, the development of such skills can be empowering for teachers as they see themselves as capable of enacting research and contributing to the broader field of education (Peterson, 2012; Vaughn et al., 2014). In addition, by recognizing their role as knowledge creators or generators (including their own ability to design new approaches to instruction and assessment, support student learning, create curricula and resources relevant to their contexts, and share their knowledge with other educators), rural educators are also able to develop greater confidence in their practice, and a stronger sense of professionalism in terms of contributing to the broader field (Goodnough, 2010; Peterson, 2012).

Although many strengths of TDCAR have been cited, there are also several challenges that have been described in relation to such models. These include the time that it takes to engage in ongoing cycles of action research and to collaborate with colleagues (Loucks-Horsley et al., 2010; Peterson, 2012), difficulties with determining the focus of the research or formulating research questions (Goodnough, 2010; Peterson, 2012), issues related to recognizing action research as a legitimate form of professional development and system improvement (Loucks-Horsley et al., 2010), problems related to the readiness of action research participants (Loucks-Horsley et al., 2010), support needed for teachers to engage in data analysis and report writing (Peterson, 2012), and tensions with other initiatives in rural contexts (Peterson, 2012). TDCAR models, despite their promise for rural contexts, require hard work and commitment from those involved in them (as participants or as facilitators). They also require norms of collaboration, trust, collegiality, and mutual accountability to be successful. Attention must therefore be paid to the conditions necessary for their success within rural contexts.

Research Methods

Background and research context

The PD model that was the subject of the research was put into place in the fall of 2013 in a very small rural Manitoba school division (with approximately 1000 students and 90 teachers). Despite the small number of teachers and students, the division was comprised of several schools spread across a large geographic area, including: two public high schools, five public elementary schools, and seven Hutterian schools (the Hutterian schools were located in faith-based communal living settlements in the division. Hutterian schools were owned by the community; teaching staff for the schools were provided by the local school division). As a result of the large number of schools and small numbers of teachers in the division, geographic separation and teacher isolation were significant challenges when it came to teacher PD. Most teachers did not have colleagues in their schools that taught the same grades or subject areas, making collaboration difficult. Consequently, there was significant interest from teachers and leaders in the division in finding ways to promote collaboration across the distances that separated schools.

The PD model implemented by the rural school division was known as “The Numeracy Cohort,” and was designed to provide opportunities for collaboration amongst divisional teachers with the overarching goal of improving mathematics instruction and student numeracy outcomes. As part of the initiative, six pairs of teachers from across the geographically diverse division were recruited to create a collaborative PD cohort. A quarter time (0.25 FTE) facilitator position (the Numeracy Coach) was also created to lead the Numeracy Cohort over the first two years (the initial commitment made by school board). The teachers that were recruited spanned Kindergarten through Grade 12, and initially included two high school teachers (one from each high school forming a pair), a pair of teachers from each of the three largest public elementary schools, two teachers from the two smallest public elementary schools (one from each forming a pair), and two Hutterian teachers from two of the seven Hutterian schools in the division (forming a pair). Where possible, pairs of teachers were recruited that taught the same grade levels or high school math subjects (although this was not possible in all cases). This facilitated collaboration between teachers, and enabled teachers to act as critical friends. The Cohort of twelve teachers (a thirteenth teacher was also added in year two) met face-to-face for day-long sessions four or five times per year, in addition to using other school and divisional PD days (and release time) to get together in small groups. Face-to-face meetings were held centrally in the division with teachers having to travel a maximum of 96 km round trip to attend meetings. All in all, Cohort teachers had contact with other Cohort teachers most months of the school year.

At face-to-face sessions, teachers were exposed to a variety of strategies and topics related to mathematics teaching and learning, including: math games, mathematical processes, using math workstations, math talk, Guided Math, math assessment scores, and deep learning in math. Teachers also engaged in TDCAR (in the form of the MAR projects previously mentioned) at face-to-face sessions and in their classrooms between sessions. These projects were documented on Mini Action Research Forms (*Figure 1*), which were adapted from the work of Cathryn Smith (2014) and involved the generally accepted action research cycles of planning, acting, observing and reflecting (Goodnough, 2010).

Name: _____		Mini Action Research Form		Date: _____	
Plan			Act		
Reflect			Observe		

Figure 1. Mini Action Research Form.

While a few of the teachers engaged in some cycles of MAR on their own, most of the Cohort teachers elected to conduct collaborative action research projects, designing instructional strategies and materials related to commonalities in their teaching contexts with other Cohort teachers, and focusing on many of the strategies that were the emphasis of face-to-face sessions. The Numeracy Coach, in response to the needs of teachers, planned face-to-face sessions that provided information on topics of interest. For example, when several teachers expressed an interest in using math workstations or rotations in their classrooms, a faculty member from a nearby university was brought in to present on ways of using workstations to promote student numeracy. Small groups working collaboratively on MAR projects were also sent out to external PD opportunities together to support their action research work, and follow-up time was provided to put into practice what they had learned from external sources. Some examples of external PD opportunities attended by small groups of Cohort teachers included problem-solving workshops, classroom visits to teachers using math rotations and math recovery strategies, and workshops focused on using math workstations. The final aspect of face-to-face sessions worth noting is that they included significant time for discussion and reflection. In addition to interviews conducted at the beginning and end of the school year with the Numeracy Coach, and online prompts for reflection, Cohort teachers engaged in oral and written discussion and reflection regularly at face-to-face sessions. Teachers were encouraged not only to set goals and design changes in practice, but also to reflect on how changes in practice impacted student learning outcomes. Moreover, they were encouraged to reflect on their own learning as part of the Numeracy Cohort, and to provide feedback to further guide the trajectory and offerings provided at face-to-face sessions or through external PD opportunities.

Theoretical framework: Social constructivism

Teacher PD is often viewed from a social constructivist perspective. Social constructivists, in addition to seeing knowledge as constructed by the individual as new ideas and phenomena come into contact with existing beliefs and knowledge, see the learning process as one that occurs simultaneously in a social setting that is inextricably linked to the learning that takes place (McCullagh, 2012; Palincsar, 1998; Pistsoe & Mailia, 2012; Richardson, 1997, 1999). Drawing from the Vygotskian (1978) notion that social interaction is critical to the learning process, social constructivists recognize the importance of the social context, social interaction, and human engagement in the construction of new knowledge (Skyhar, 2020).

TDCAR is an approach that is aligned with several social constructivist principles. It recognizes the importance of the social context through its focus on providing teachers with opportunities to collaborate with colleagues within a community of practice (Lave & Wenger, 1991). It also provides teachers with the autonomy to work on contextually relevant goals, respecting the contexts in which teachers work, and engaging them in inquiry about their own practice. Through the collaborative nature of TDCAR, social interaction is fostered between teachers, allowing them to come into contact with new ideas, all within a trusting and collegial community of learners that are focused on similar goals. Moreover, cycles of action research (involving planning, acting, observing and reflecting) engage teachers in an active process that requires changes in practice and reflection about the impact of their changes on student learning. New ideas are able, within the context of this type of teacher PD, to rub up against existing ideas about teaching practices and student learning, allowing teachers to construct new understandings and grow as professionals.

Social constructivism, as a theoretical framework for this study, provided a lens through which to look at the Numeracy Cohort model. By paying attention to the ways in which the Numeracy Cohort, as a TDCAR model, fostered social interaction and teacher engagement, all within a social context that promoted dialogue and reflection, the effectiveness of the model could be examined.

Case study design

A qualitative single case study design was utilized in order to facilitate a study of the Numeracy Cohort after two years of its operation. Single case study, a suitable methodological choice for an in-depth study of a single unit or bounded system (Creswell, 2007; Flyvbjerg, 2011; Merriam, 1998; Stake, 1995), allowed for both a detailed examination of the PD model designed by the division, and thorough consideration of the unique context in which the model was implemented. Through the use of multiple embedded units of analysis (Yin, 2009), including the perspectives of teachers, the PD facilitator, principals, and the superintendent of the school division, the effectiveness of the model was examined in relation to both its ability to mitigate PD challenges, and its effectiveness in supporting teacher learning in the area of mathematics instruction and student numeracy. This article extends previously published findings (Skyhar, 2020) about the effectiveness of the model (in terms of mitigating rural challenges and supporting teacher professional growth), to look more specifically at the strengths and weaknesses of TDCAR as a mediating tool for teacher learning. As such, the research question addressed in the extended study was the following:

What are the strengths and challenges of using teacher-directed, collaborative action research (TDCAR) as a mediating tool for teacher professional learning within the locally constructed rural professional development model known as the Numeracy Cohort?

Participants

Following approval by the University of Manitoba Education/Nursing Research Ethics Board (ENREB), participants were recruited for the study in June 2015, providing four different perspectives for analysis. The first perspective was provided by the Numeracy Cohort teachers, themselves. While the initiative began with twelve teachers, one teacher left the Cohort after the first year (later choosing not to be part of the research study), and two new teachers joined the Cohort in its second year of operation. In total, fourteen teachers were part of the Cohort at some point in time, and thirteen of them agreed to participate in the research study. A second perspective was provided by six out of eight of the principals of the Cohort teachers. They agreed to participate in a focus group discussion about the two-year initiative from a school leader's perspective. The superintendent of the division provided a third point of view through an interview conducted for the study as well. Finally, while not a direct participant in the study, my own perspective as the facilitator of the PD initiative was captured through the use of facilitator notes during the implementation of the Numeracy Cohort model. These notes provided a fourth perspective for analysis in the research study.

My own positionality as both the researcher and facilitator of the PD initiative requires some clarification. Over the two-year period that was the focus of the study, I was both a 0.75 full time equivalent (FTE) high school teacher and a 0.25 FTE Numeracy Coach, charged with facilitation of the PD initiative. I had been involved in conceptualizing and constructing the Numeracy Cohort model, in collaboration with the superintendent of the school division, and was heavily invested in its success. My decision to research the model came out of both the requirements of my Ph.D. program to conduct a research project, and out of my own desire to assess the model's effectiveness and share the findings with the broader field of rural education. Bracketing off my dual roles became somewhat easier for me in June of 2015 when I left the school division to take a university position elsewhere in the province. This move enabled me to finish my facilitator role prior to engaging in the data analysis portion of the study.

Data collection and analysis

As is common in case study research, multiple forms of data were collected for use in the study (Cohen, Manion, & Morrison, 2011; Creswell, 2007; Merriam, 1998; Yin, 2009). Both primary data, or data collected for the sole purpose of the research study; and secondary data, or data created during the two-year initiative and later collected with permission from the division and the Cohort teachers, were collected. Primary data consisted of an interview with the superintendent, a principal focus group discussion, and a teacher focus group discussion, all conducted by me (as researcher) in June of 2015. Secondary data included three sets of teacher interviews (conducted by me as facilitator in the fall of 2013, spring of 2014, and spring of 2015), facilitator notes (consisting of written reflections recorded after my own planning sessions, face-to-face sessions with Cohort teachers, and meetings with administration over the two year period), and artifacts from Cohort operations (such as MAR forms, presentations made by Cohort teachers, teacher reflections, and facilitator materials such as agendas, attendance sheets, and charts of teacher goals and Cohort activities).

NVivo, a brand of Qualitative Data Analysis (QDAS) software (Bazeley & Jackson, 2014) was used for organizing, coding, and analyzing data from the study. Data were imported into the software, enabling the use of folders to separate different forms of data. The software was then used to engage in two distinct cycles of coding. Coding began with *a priori* codes (codes drawn from the literature reviewed); additional codes also emerged throughout the coding process. In the first round of coding, all primary data and most of the secondary data (teacher interview notes and facilitator notes) were coded. Following the collapsing and reorganizing of codes, all data

(including artifacts from Cohort operations) were coded again in a second round, using the new collapsed and reorganized code structures. Analytic memos were kept during the coding process to document emerging ideas and preliminary thoughts. These memos were also included and analyzed as an additional data source once the initial two cycles of coding were complete. The diagram below (Figure 2) provides an illustration of how codes were collapsed and organized into coding structures during data analysis.

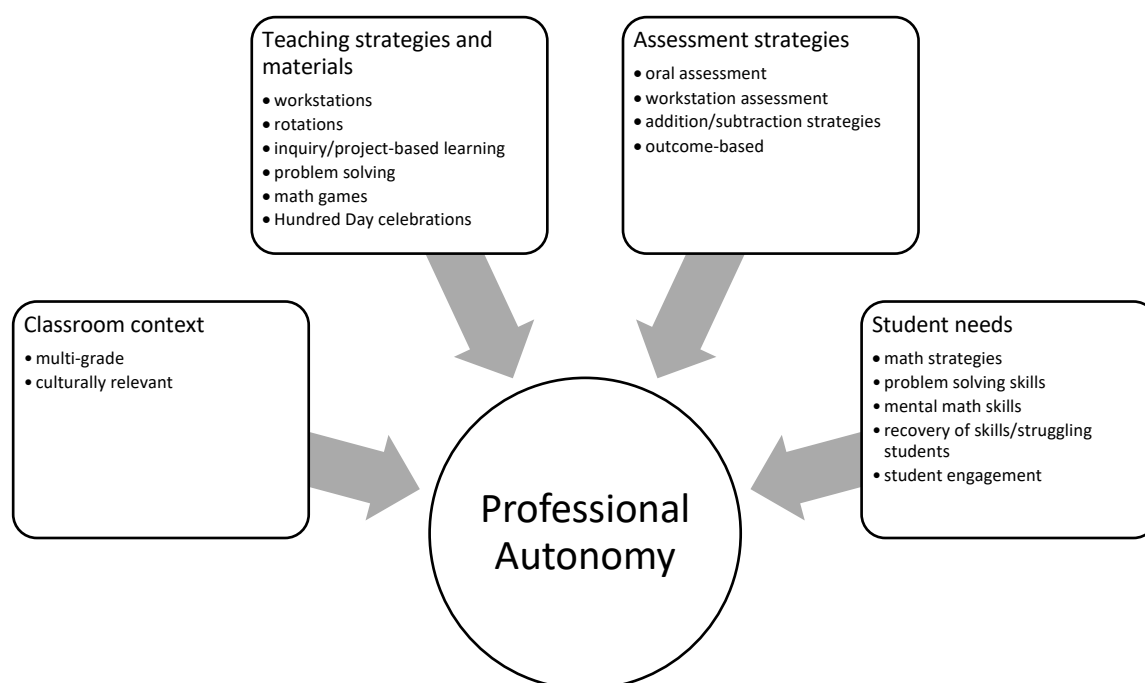


Figure 2. Sample Code Structure.

In the example above, classroom context, teaching strategies and resources, assessment strategies, and student needs (along with their subcategories) were placed below *professional autonomy* as an overarching theme. Together, they became a coding structure related to professional autonomy, one that included all of the subcategories and individual codes related to a much broader concept originally derived from literature on TDCAR. In total, there were five different overarching themes (with coding structures) identified in the study as outlined in Figure 3 (below).

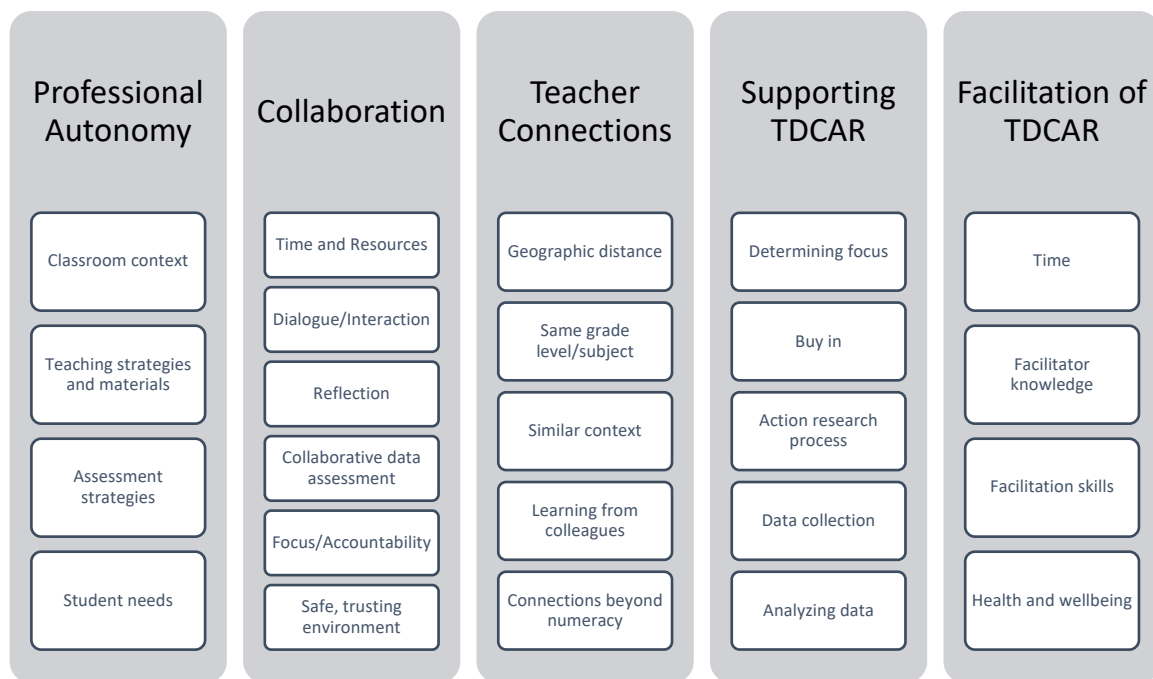


Figure 3. Coding Structures Informing Findings.

The five overarching coding structures/themes that emerged through the analysis phase of the study provided the basis for the study's findings.

Findings

The findings in this paper include both strengths and challenges that emerged in relation to the use of TDCAR within the Numeracy Cohort initiative. Building on what has been previously cited by other authors (e.g., Peterson, 2012) the findings from this study explore several of the positive aspects of TDCAR as a mediating tool for teacher learning, and some of the challenges that should be considered in relation to its use in rural contexts.

Providing teacher autonomy

One of the key strengths of the Numeracy Cohort model (and the MAR projects) cited by teachers in the study was the professional autonomy it afforded them to focus on areas of practice that were of interest to them, and that were relevant to their classroom contexts. As might be expected when working with teachers from K-12, the teachers in the study had a variety of interests, which were reflected in the action research projects they engaged in. From developing new assessment tools, to creating culturally relevant mathematics activities for Hutterian students, to designing and implementing new teaching strategies and materials (such as workstations, project-based learning, and games); the Numeracy Cohort teachers engaged in action in their classrooms that fit their interests, the needs of their students, and the contexts in which they worked. While it is not possible to capture all of the cycles of action research engaged in by all of the Cohort teachers over a two-year period, *Table 1* and *Table 2* (below) provide examples of two of the larger collaborative projects engaged in by Numeracy Cohort teachers, including their goals, the actions taken by the teachers, the data sources used to evaluate the effectiveness of their actions, and their observations and findings.

Table 1

Early Years Group Collaborative MAR Project

Group	Teachers (pseudonyms) grade levels	Goals for MAR projects	Actions taken/New teaching practices adopted	Data sources	Teacher observations and findings from data
Early Years Group	Carl <i>Grade K-3 (multi-grade)</i> very small school	To improve instruction, student understanding, and student engagement by developing hands-on math workstations focused on mental math (addition) strategies	3 out of 4 teachers went to an external math PD opportunity on workstations Organized a follow-up day to share resources and information from workshop and to create workstations for use in their classrooms (on addition strategies – e.g. doubles, make ten, doubles plus one, counting on, part-part-whole, etc.)	Observations of students in class and at the Hundred Day celebration Student records of addition strategies used Video recording of workstations in action (in Ellen's classroom – recorded by Carol)	Teachers noticed higher student engagement (students asking for workstations in class and high engagement at the Hundred Day), more confidence from students about strategies (they were able to talk about specific strategies better), increased participation from students (safe environment), less down time in class (students eager to get to next workstation), and specific improvements in individual students' mental math abilities (through observation and assessments)
	Mark <i>Grade K-1 (multi-grade)</i> Hutterian school		Implemented use of workstations in their individual classrooms	Reflection and discussion about their own practice(s)	Guest (substitute) teachers also noticed an improvement in student ability levels when visiting the classroom
	Carol <i>Grade 1</i> same school as Ellen		Organized and carried out a multi-school Hundred Day celebration using strategies from workstations (and other strategies developed together). Approximately 30 workstations in total were created for 58 students in attendance Presented their work and findings to colleagues at a divisional PD day in April		In terms of teacher practice, the group found it was easier to keep focused on curricular strategies for their grades, to use consistent vocabulary, and to assess student understanding. They also noticed it was easier to differentiate for student needs with the workstation structure – they could send a tub/workstation with an educational assistant to help a student work on a strategy they had not mastered yet (e.g. doubles plus one)

Table 2

Middle Years Group Collaborative MAR Project

Group	Teachers (pseudonyms) <i>grade levels</i>	Goals for MAR projects	Actions taken/New teaching practices adopted	Data sources	Teacher observations and findings from data
Middle Years Group	Sierra <i>Grade 7-8 (multi-grade)</i>	To improve student engagement through the use of real world/inquiry-based projects	Year 1 – Developed a Gr. 8 project called “The Shopping Spree” and assessment rubric. Used in classrooms and shared and discussed student products (posters and spreadsheets)	Observations of students working on projects	Teachers noticed increased student engagement through observations, exit slips, and oral assessments
	Eva <i>Grade 7 & 8</i>			Exit slips (teacher prompts related to self-efficacy and engagement) – used in year 2	Students understood percent of a number better. Anecdotal stories of individual student engagement and success were also shared, including students sharing projects at student-led parent-teacher conferences
	John <i>Grades K-8 (multi-grade)</i> Hutterian school	To develop authentic assessments for assessing projects	Year 2 – 4 teachers attended a problem solving workshop and met the next day (for follow-up). They revised “The Shopping Spree” (alternative products such as dioramas, videos, computer sketching programs, etc. were added, exit slips were designed, and Gr. 6-8 multi-grade outcomes were included)	Student final projects – spreadsheets, posters/other products	Teachers noted that alternative forms of assessment to paper and pencil tests (e.g. oral interviews, rubrics, etc.) allowed some students to express their knowledge and learning more effectively
	Sean <i>Grade 6-8 (multi-grade)</i> <i>teaching principal</i> very small school		Teachers met to reflect on implementation of changed Shopping Spree project and student data. They also developed and then tried out a new project and assessment called “Vacation Time”	Assessment rubrics and other teacher assessments (oral)	Teachers found the projects took a lot of time
			Presented their work and findings to colleagues at a divisional PD day in April	One teacher moved from group projects to individual projects for Vacation Time to facilitate individual student assessment	One teacher moved from group projects to individual projects for Vacation Time to facilitate individual student assessment
				Teachers found that this type of task and assessment lent itself to multi-grade instruction and assessment. They were able to have students do the same project, but get at application of different percentage discounts for different grade levels (e.g. whole, fractional and decimal percentages, and percentages greater than 100%)	Teachers found that this type of task and assessment lent itself to multi-grade instruction and assessment. They were able to have students do the same project, but get at application of different percentage discounts for different grade levels (e.g. whole, fractional and decimal percentages, and percentages greater than 100%)

The TDCAR projects outlined in *Table 1* and *Table 2* illustrate some of the different ways in which Numeracy Cohort teachers were able to address their unique classroom contexts through the action research they engaged in. In addition to trying out new strategies (such as workstations or problem-based learning) in the hopes of improving student learning, the Cohort teachers designed strategies and materials for use in the multi-grade contexts in which many of them worked. Having the autonomy to create materials and strategies for use in their unique classroom contexts allowed the teachers to better meet their own professional needs, and to meet the varied needs of their students. For these reasons, teachers cited professional autonomy as a significant strength of the Numeracy Cohort initiative, something that can be attributed specifically to the inclusion of TDCAR.

In addition to the comments and artifacts provided by teachers, data from the study included several alternative viewpoints that supported the importance of professional autonomy in the initiative. The facilitator notes included many comments about the importance of meeting the individual needs and interests of the Cohort teachers, as did comments made by principals in the focus group discussion. Moreover, the superintendent of the division connected the importance of the autonomy afforded teachers to individual and collective construction of meaning in comments such as the following:

I think within the Cohort, itself, I think that they've become much higher level thinkers about numeracy in their practice. They are not relying on the expertise of the person who wrote the textbook, or the expertise of the person who wrote the curriculum. . . They have the tools where they're interpreting these things themselves and applying it in the context of their classroom and their learning environment . . . they can be very critical about what will work, what does work, what won't work and choose good practices. And I think that's the best thing about a constructivist model (Superintendent Interview, 2015).

As noted by the superintendent, TDCAR provided teachers with the autonomy to focus on their own practice, including what worked (or did not work) within their own classroom contexts. Together, the teachers constructed their own understandings of strategies for improving student numeracy by planning, enacting, observing, and reflecting on changes to practice designed for their local contexts and the needs of their students.

Providing opportunities for collaboration with colleagues

Another important strength of the Numeracy Cohort model cited by teachers in the study was the opportunity to collaborate with colleagues. Data from the study included several comments like the following: "I valued time to collaborate with colleagues. This enabled me to stretch my thinking on several topics. The cohort helped me organize and focus on mini-action plans moving towards reaching my goal" (Sean, April Written Reflection, 2014). Numeracy Cohort teachers noted that in addition to being immersed in content about mathematics instruction at face-to-face meetings, dialogue and interaction with colleagues (at face-to-face meetings or in small group settings) challenged their thinking, allowing them to grow as professionals. For example, in the middle years collaborative group (see *Table 2*), Sean, Eva, Sierra and John challenged the thinking of one another through their discussions about implementing "The Shopping Spree" project, and their perceptions of student understanding as evident in the data they collected. The result of these discussions was the inclusion of a broader range of student products (such as dioramas, videos, computer sketching programs, etc.), the inclusion of more and varied evidence of student learning (including exit slips and oral defenses/teacher-student interviews), and the inclusion of multi-grade (Gr. 6-8) outcomes the second time they used the project with students.

In addition to dialogue, reflection, and discussion, Numeracy Cohort teachers noted that collaboration with other colleagues also fostered both accountability and focus in terms of moving forward with their MAR projects. Having other colleagues depending on them to do their part, and times when they were asked to report on their learning to the larger Cohort group, motivated the teachers to stay focused on working towards their goals. Eva (one of the middle years collaborative group) described it this way:

I have always wanted to do this. . . What it has done is it's kicked my butt into getting it done and actually doing it. And if you have other people going, "Yeah, let's do this," then it's sort of like . . . Well, it's like exercising, right? You never go out for your walk until your girlfriend is at your door, going, "Are we going?" Then you go. So it's . . . that collaboration I think helps with the . . . the push. (Eva, June Interview, 2015).

Eva's comments help illustrate the power of collaboration in TDCAR. While engaging in action research focused on their classroom contexts was an important element of the Numeracy Cohort that contributed to its effectiveness for teachers, it was collaboration with colleagues that helped to motivate teachers and stretch their thinking in ways that otherwise might not have been possible.

Building connections across rural schools

One of the main reasons the teachers in the study valued opportunities to collaborate with colleagues in the small rural division, was the geographic and professional isolation many of them experienced due to the distances between (and small staff sizes in) several of the schools. Building connections with other teachers in the division was extremely important for teachers participating in the Numeracy Cohort, especially for those who were in the smallest and most isolated schools. One example of the importance of building such connections was provided by John, likely the most isolated teacher not only in the Cohort, but in the division. John, who was responsible for teaching all subjects and students in his Hutterian school (from K-8), had no colleagues in his school with whom to collaborate, let alone colleagues that taught the same grade levels and subjects. After participating in the Numeracy Cohort initiative, John said the following

I think being part of the Cohort has lifted the gates of that isolation that we had. Like we've now had a chance to discuss with other teachers . . . and being able to collaborate with them. And another thing is that the group that I was working with was really good at doing the multi-grade. We set up those projects for Grade 7, for Grade 6, for Grade 5, and even below if we need it. (John, June Interview, 2015)

While the TDCAR John and the middle years teacher group engaged in was incredibly important in terms of John's learning about project-based learning, it was also important in terms of his ability to build connections with other teachers in the division. In John's own words, the Cohort "lifted the gates of isolation" for him, allowing him to develop relationships with other educators in the division, and to engage in collaboration that fostered both his own learning, and the learning of others.

Another example of the ways in which important connections were built through the Numeracy Cohort initiative was provided by Carl, a teacher who was new to both the division and the profession when the initiative began. Also in a geographically isolated school, Carl was one of only three teachers in his building. Carl noted the following in an interview after his first year participating in the Numeracy Cohort:

It was a big help, I thought, as a first year teacher, [be]cause when you're at a small school, and everyone's teaching different grades, sometimes you feel like there may be no one to talk to if you do come across an issue. But having someone like [Sean] who has experience and teaches multi-grades, and is in a similar situation to me . . . I feel like I can relate with him and it made me feel at ease, I guess. You have someone to lean on is what I'm trying to say. (Carl, June Interview, 2014)

Carl developed relationships with most of the other Cohort teachers over the two years that were the subject of the study. As a new teacher, he appreciated not only hearing about strategies for engaging students in learning about math, but also having colleagues to run ideas by, or ask questions of when he needed.

From a social constructivist perspective, the inclusion of TDCAR in the Numeracy Cohort model provided opportunities for social interaction that previously did not exist in the school division. Through teachers' recognition of the importance of collaborative opportunities and the significance of having connections with colleagues in other schools in the division, the way that TDCAR can function as a mediating tool for the social construction of new understandings can be seen. The TDCAR projects engaged in by Cohort teachers promoted teacher learning by providing rich social contexts in which teacher engagement, dialogue and reflection could take place. Teachers, principals, and the superintendent all acknowledged the importance of the social context created on teacher learning. For example, one of the principals said the following in their focus group discussion:

The collaborative, safe learning environment . . . if the teachers participating in the Cohort didn't feel as though the environment was safe, they wouldn't be here. They need to feel as though they can make mistakes, try new initiatives, and when they make mistakes, come back to the Cohort meeting and explain why things went wrong. And then maybe some other teachers around the table can provide them with suggestions on how to improve or make changes next time so that it works better. And . . . finding out what other teachers are doing at other schools is very valuable to me. (Principal, Focus Group, 2015)

The TDCAR projects engaged in by teachers physically brought teachers together into a social context, and fostered social interaction focused on the common goal of improving student numeracy skills. In this way, the projects became a mediating tool for teacher professional learning as teachers discussed their practice and reflected on the impact of the changes they were making.

Supporting the use of action research

Just as authors such as Loucks-Horsley et al. (2010), Goodnough (2010), and Peterson (2012) have noted challenges related the use of action research as a tool for teacher professional learning in previous literature, several challenges surfaced within the Numeracy Cohort initiative related to teacher buy-in and readiness to engage in TDCAR. As the facilitator of the initiative, my own notes documented challenges related to choosing topics to focus on, issues related to getting teachers to see the importance of collecting and analyzing student data as opposed to relying on anecdotal perceptions of improvement, and challenges related to overall familiarity with the action research process. Action research was not a common strategy in the school division in terms of teacher PD, and as a result, required explanation and careful promotion. Teachers in some cases had to be convinced that it was worthwhile to collect student data for their own learning (as opposed to for the organization). Many teachers also took some time to learn what

cycles of action research looked like, including what to focus on, what interventions to try, what data to collect as evidence of student understanding, and how to analyze that data to determine the effectiveness of their interventions.

Facilitating TDCAR in a rural context

Within the literature on TDCAR in rural settings, it is common for university researchers (or teams of researchers) to provide support and facilitation for groups of educators engaging in collaborative action research (Goodnough, 2010; Peterson, 2012). However, not all rural divisions wishing to engage in such forms of professional learning have partnerships with university researchers, or the capacity, internally, to lead these initiatives for themselves. This was the case in the division that implemented the Numeracy Cohort initiative. While the division was able to create a quarter time Numeracy Coach position for facilitation of the initiative, the facilitator notes from the study suggest that as the facilitator, I struggled with having enough time to devote to the initiative (at only a quarter time), something that affected both my stress level and my health. In April of 2014, I wrote the following in my facilitator notes:

Personally, in February and March I had some health-related issues that largely prevented me from being as active as I would have liked. It is worth noting because I have come to realize (after seeking medical advice) that my health issues seem to be stress-related. I find myself wondering about the sustainability of a model like this for the facilitator. Is it reasonable for one person to facilitate this with only 1 hour a day (0.25 time)? Maintaining a 0.75 teaching load on top of this is certainly difficult and has taken a toll on me physically, mentally, and emotionally. (Facilitator notes, April 9, 2014).

In addition to stress and health, I also struggled, as a facilitator, with having the knowledge base needed to support teachers in relation to K-12 mathematics curricula (including strategies for use at multiple levels), and the facilitation and research skills needed to support teachers through the action research process. The facilitator notes I kept over the two-year period illuminated several of the challenges I faced in terms of my own feelings of self-efficacy; moreover, it was evident in the facilitator notes that the stress and health concerns I experienced were due, at least in part, to my own lack of experience, training, and familiarity with supporting teachers through the TDCAR process. Teachers expressed a need for strategies that would support student learning, close gaps in student achievement, and improve student engagement in mathematics. My own background as a high school mathematics teacher (and Ph. D. student) provided me with a basic level of understanding about mathematics content, mathematics pedagogy, and research methods, but many of the skills needed to engage in facilitation of Numeracy Cohort were skills that I was forced to learn very quickly while already in the role of Numeracy Coach. Bringing in presenters on topics related to mathematics instruction, arranging for classroom visitations so Cohort teachers could see other teachers implementing strategies of interest, sending groups of teachers out to external workshops on topics of interest, and taking on the responsibility of learning about strategies (such as instructional strategies or data analysis strategies) and then sharing what I had learned with Cohort teachers, were some of the ways I managed the expectations and needs of the teachers participating in the Numeracy Cohort. This was not easy, however, and even though teachers cited both content and leadership as strengths of the Numeracy Cohort model, the facilitator role took a toll on me, both in terms of my sense of self-efficacy, and in terms of my health.

Conclusion

The research study that was the subject of this paper, supported and extended previous findings about the strengths and challenges of using collaborative action research models in rural settings in several ways. Just as Peterson (2012) noted the importance of providing opportunities for teachers to focus on their own areas of interest, data from the Numeracy Cohort study indicated that teacher autonomy was a key strength of the PD model. Having the ability to focus on what Clarke et al. (2003) referred to as “the unique classroom” (p. 4) allowed teachers in the Cohort to design classroom resources and strategies for use in their multi-grade contexts, something they had described as a professional need at the beginning of the initiative. Moreover, teachers began to see themselves as knowledge creators or generators (Goodnough, 2010), decision-makers (Vaughn et al., 2014), and contributors to the field (Peterson, 2012; Peterson et al., 2018), sharing ideas and resources with other teachers in and out of the Cohort, and hosting a PD day for other teachers in the division.

In addition to the importance of teacher autonomy, findings from the study illustrated two other key strengths of collaborative action research in rural contexts: providing opportunities for colleagues to collaborate and building connections between educators across geographically distanced schools. These collaborative opportunities and connections provided teachers with openings to engage in dialogue and reflection about their experiences and assumptions, something that has been described by Peterson (2012) as “integral to adult learning” (p. 2). Drawing from social constructivist theory, the collaborative opportunities and connections developed through the Numeracy Cohort initiative provided a social context in which learning could take place through social interaction, mediated by the collaborative action research teachers engaged in. Whether it was individuals like Carl bouncing ideas about numeracy and teaching off of other Cohort teachers, the collaborative middle years group learning together how to develop multi-grade and culturally relevant numeracy tasks for students, or the early years group collaboratively creating workstations and developing ways to use them for assessment and student support, the TDCAR that teachers engaged in provided a vehicle through which ideas were able to rub up against each other. This interaction allowed the teachers to socially construct new understandings about teaching and learning that might not otherwise have been possible. The findings from the Numeracy Cohort study suggest not only that it is critically important in rural contexts to find ways of bringing teachers together to collaborate and to engage in learning, but that TDCAR specifically can be an effective mediating tool for teacher learning through its ability to foster social interaction focused on teaching and student learning.

Aside from the strengths illustrated through the Numeracy Cohort study, two areas of challenge were also identified around supporting teachers through the action research process and the complexity of leadership in rural settings. While the findings support challenges cited by previous researchers related to teacher buy-in and readiness to engage in action research (Loucks-Horseley et al., 2010), determining the focus of action research (Goodnough, 2010; Peterson, 2012), and supporting teachers through data collection and analysis (Peterson, 2012); findings from the study also extend discussion about these challenges to include the impact they have on facilitators of collaborative action research in rural contexts. The Numeracy Cohort initiative, with a quarter time facilitator both illustrates that TDCAR can be implemented locally, within the budgetary constraints of small rural divisions (Clarke et al., 2003), and that there are challenges associated with smaller versions of PD projects that have been implemented at much larger scales. Such challenges bear consideration when TDCAR is considered for use at the local level in very small rural contexts.

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