School Leaders as Participants in Teachers' Professional Development: The Impact on Teachers' and School Leaders' Professional Growth

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Abstract: Over a two-year period, approximately 70 teachers from 18 schools participated in an on-going professional development program as part of a study to promote the teaching and learning of numeracy. Principals and other school leaders were invited to participate in the professional development program alongside their teachers, which 20 leaders from 11 schools chose to do. Throughout the project, data were collected from teachers and participating school leaders using surveys, interviews, and workshop discussions to investigate teachers' and leaders' professional growth. The findings showed that school leaders' participation in teacher professional development programs has a positive influence on the capacity for teachers to enact and reflect on new knowledge and practices. They also revealed a positive influence on the professional growth of the leaders themselves. This study has implications for the design of professional development and for school leaders and teacher educators.

Introduction

There is general consensus in the literature that continuing professional development is necessary for building teachers' capacity to improve their knowledge and practice with the ultimate goal of promoting students' learning. However, such professional development represents a substantial investment of time on the part of the teacher and a significant financial investment on the part of the school or educational authority that funds it. As such, it is essential to identify factors that lead to positive outcomes from professional development. The factors that impact on the effectiveness of teachers' professional development are varied, and there is no consensus on how to analyse or promote the effectiveness of professional development (Justi & Van Driel, 2006). There is, however, general agreement that systemic factors can impact on teachers' learning and practices. According to Kershner, Pedder, and Doddington (2013), school organisational limitations and differing school cultural practices can act to constrain teachers' professional learning. There is little doubt that school leaders can have a significant influence on teachers' capacity to enact professional learning in their classrooms and it is essential that school leaders support,

encourage, and recognise teachers when they take the initiative to engage in professional learning (Goldsmith, Doerr, & Lewis, 2014; Lachance & Confrey, 2003). To date, research on the influence of school leaders has focused on the actions of school leaders within the school context in terms of supporting (or otherwise) teachers' participation in professional development and their work in the classroom afterwards.

Our study took a different perspective to address the question of whether the engagement of school leaders as *active co-participants* in teacher professional development has the potential to positively influence teachers' and indeed the leaders' professional growth and if so, how and why this might be the case. This investigation took place within a broader three-year study that focused on ways to enhance the teaching and learning of proportional reasoning, a key aspect of numeracy. The study employed educational design research to design and implement a series of professional development workshops for Year 4 to 9 teachers. The professional development model was characterised by a number of key features including cluster-based workshops; voluntary school leader involvement; regular workshops over a period of two years, with practitioner research between each workshop; and shared reflection on practice at each workshop. This paper presents findings on the impact of the participation of school leaders from the perspectives of both participating teachers and school leaders.

Literature
Teacher Change

Within the research literature, teacher change is described from numerous perspectives. It has been variously portrayed as something imposed on or done to teachers through engagement with experts, as something that occurs through experience or adaptation in the classroom, or as a process of personal development on the part of the teacher (Clarke & Hollingsworth, 2002; Justi & Van Driel, 2006). According to Clarke and Hollingsworth (2002), teacher change as an expected outcome of professional development is best viewed as growth or learning and yet, many professional development programs have failed to adequately consider the process through which teacher change occurs. Concerned about this issue, Guskey (1986) argued that a model of teacher change should recognise the relationship between changes in teacher practice, beliefs, and attitudes along with change in students' learning outcomes. He proposed a model in which teachers' attitudes and beliefs are changed after they have perceived changes in student learning outcomes as a result of their own changed classroom practices. More recently, this and other similar models have been criticised for their linearity and failure to recognise the potentially cyclic nature of the process of teacher change (Coenders, 2010; Opfer & Pedder, 2013) and it is now recognised that teacher change occurs through more complex and interconnected processes in which teachers engage as active learners within professional learning communities.

To account for the complexity and interconnected nature of the numerous aspects that impact on teacher change, Clarke and Hollingsworth (2002) proposed the Interconnected Model of Teachers Professional Growth (IMTPG), shown in Figure 1. They argued that teachers shape their own professional growth through active learning, reflection, and participation in practice and professional development programs. According to this model, change occurs in four domains: the Personal Domain (comprised of teachers' knowledge, beliefs and attitudes); the Domain of Practice (including all professional experimentation and preparation); the Domain of Consequence (salient outcomes and inferred consequences perceived by the teacher); and the External Domain (external sources of information or stimulus).
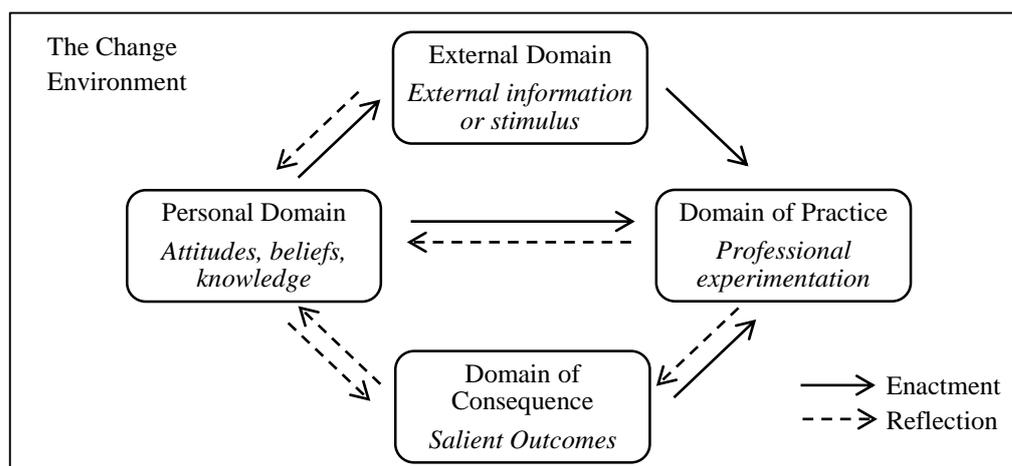
Figure 1: The Interconnected Model of Teacher Professional Growth (Clarke & Hollingsworth, 2002, p. 951)

The mediating processes of reflection and enactment are mechanisms by which change in one domain can lead to change in another. Teacher growth occurs through interactions involving two or more domains together with reflective or enactive processes within the Change Environment. The Change Environment may act to constrain or afford change in each domain or it may influence the mediating processes of enactment and reflection and hence, teachers' professional growth (Clarke & Hollingsworth, 2002). Clarke and Hollingsworth (2002) described a number of facets of the Change Environment including provision of opportunities to attend professional development, school subscription to professional journals, support from school leaders to experiment with teaching strategies and engage in discussion with colleagues, and provision of opportunities to share and reflect on one another's practice.

While much research has focused on characteristics of effective professional development (see Garet, Porter, Desimore, Birman, & Yoon, 2001; Guskey, 2003; Luke & McArdle, 2009; Penuel, Fishman, Yamaguchi, & Gallagher, 2007), less is known about the factors and processes that support and promote individual teachers' professional growth during professional development programs (Clarke & Hollingsworth, 2002; Zwart, Wubbels, Bergen, & Bolhuis, 2007). Kennedy (2010) pointed to the need to understand the situational factors that impact on teachers' practices. According to Clarke and Hollingsworth (2002), since growth can occur through a variety of networks, professional development should be designed so that participants can enact change in many ways and through varied change sequences. They argued that the factors that constrain or afford change must be identified so as to inform the design of professional development.

The IMTPG illustrates the complex nature of teacher change and demonstrates the multiple and diverse change pathways that may occur for individual teachers. According to Clarke and Hollingsworth (2002), the model can also be used as an analytical, predictive, or interrogatory tool to examine professional learning contexts, thereby allowing its use for a range of research questions. It was used for all three purposes by Justi and Van Driel (2006) to investigate the development of science teachers' knowledge of models, and has also been used as a means of understanding teacher learning during peer coaching (Zwart et al., 2007), for investigating chemistry teachers' action research programs (Mamlok-Naaman & Eilks, 2011), and more recently by Goldsmith et al. (2014) as a framework for synthesising literature about mathematics teachers' professional learning.

According to Martin and Hand (2009), teachers are often reluctant to change their teaching practices, especially if they have previously proven successful, and that asking teachers to make such a shift requires support. Jeanpierre, Oberhauser, and Freeman (2005) argued that it is necessary to study the kind of support that would allow teachers to accomplish this kind of change. There are two components of the IMTPG that we argue are essential considerations when evaluating the effectiveness of professional development programs to support teacher change and promote teachers' professional growth. These are the External Domain, which is distinguished from the other three domains by its location outside the teacher's professional world, and the Change Environment, which is the particular context (e.g., school, community, faculty) within which the teacher works (Clarke & Hollingsworth, 2002). The External Domain includes aspects as diverse as professional conversations with colleagues and others, professional readings, policies and educational systems that shape the teacher's learning, curriculum, and professional development programs (Clarke & Hollingsworth, 2002; Goldsmith et al., 2014). Both the External Domain and the Change Environment are beyond the teacher's own professional domain and yet they have the potential to strongly influence teachers' professional growth.

The Role of School Leaders

In a review of the literature on mathematics teachers' learning, Goldsmith et al. (2014) utilised the IMTPG to identify the research foci of studies since 1985. Of the 106 studies included in the final review, over half of the studies had sample sizes of less than 10 teachers, almost half focused on K to Year 5 teachers, and less than one-third collected data over the course of at least one year. Only 6% focused on professional development characteristics and 5% on system characteristics. Several papers drew attention to the importance of administrative support in promoting teachers' professional growth; although this was not always the central focus of these papers (e.g., Bright & Prokosch, 1995; Lachance & Confrey, 2003) and the details about the nature of the support from school leaders that would achieve this goal were limited. Indeed, according to Drago-Severson (2012), school leaders struggle to find ways to create school climates that are supportive of teachers' growth and which promote improved practice. These arguments suggest that greater knowledge is needed about how successful school climates are created and the strategies employed by effective school leaders.

In general, research about teachers' professional learning has drawn attention to the importance of strong leadership to promote teacher growth. In order for professional learning to be sustainable over the long-term, it is necessary to create effective professional learning communities (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). According to Stoll et al., this requires the development of a school-wide culture with an expectation of collaboration and reflective dialogue about practice, both of which promote individual as well as group learning. They pointed to the need for active support from school leadership. Fullan (1992) suggested that the quality of leadership in a school can have a profound effect on the nature of that school's culture, while McLaughlin and Talbert (2001) concluded that the influence of school principals on teacher communities is related to their ability to set appropriate conditions through such activities as management of resources and relationships with teachers. Common themes in the literature around what is required of leaders include the need for them to provide access to professional development and encourage experimentation (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010); foster learning (Law & Glover, 2000); to model what they value, such as classroom practice (e.g., Louis et al., 1995); and to promote professional learning by creating the conditions for teachers' professional growth (Leithwood, Jantzi, & Steinbach, 1999). These are all approaches that relate to the Change

Environment within which teachers work. While it has been argued that these are essential elements, exactly what leaders can and should do in order to achieve and sustain these goals is not always clearly articulated in the literature.

It appears that there are two key areas in which school leaders might influence the professional growth of teachers. The first of these is their capacity to influence the Change Environment in which teachers work by providing opportunities to attend professional development and access to other professional resources and by supporting and encouraging teachers to experiment in their classrooms. The second sphere of influence is school leaders' capacity to provide input into the External Domain of the teacher, for example, through engaging in professional conversations with teachers, reflecting on practice with teachers, or by teaching model lessons. This paper addresses these areas through a focus on the perceptions of the teachers and school leaders who co-participated in teacher professional learning. It examines what these perceptions were and describes key themes that emerged during the project and the ways in which leaders' participation in professional development influenced teachers' professional growth. It also focuses on the potential of such participation and the ensuing involvement of the leaders and teachers in their school contexts to change the leaders' own professional domains, a question that to date has not been addressed in the literature.

Method
Overview of the Study and the Professional Development Program

A three-year study, which focused on numeracy and in particular, promoted the teaching and learning of proportional reasoning across the curriculum, was conducted in two Australian states: Queensland and South Australia. The study, which aimed to investigate changes in teachers' knowledge and their teaching practices associated with proportional reasoning, while at the same time focusing on students' learning, adopted an educational design research (EDR) approach (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). EDR involves the iterative development of solutions to practical problems (McKenney & Reeves, 2012), results in the creation of usable products and research insights, and involves close interaction among researchers and participants (Reeves, McKenney, & Herrington, 2011). An advantage of EDR is its ability to allow researchers to consider and account for the complex contexts of diverse classroom settings (Barab & Squire, 2003; McKenney & Reeves, 2012). This approach is also compatible with with the IMTPG because it acknowledges that teachers' learning is recursive and iterative, occurring via a series of cycles of design, enactment, reflection, and evaluation.

During the first two years, teachers and school leaders attended a series of professional development sessions, which were presented within clusters, each consisting of a secondary school (Years 8-12) and two to five neighbouring primary schools (Years P-7). The nature and timing of the workshops were negotiated with school principals, deputy-principals, heads of curriculum, and key teachers. Workshop content was the same across the clusters, although the activities and resources were adjusted to cater specifically for the contexts, student populations, and teacher backgrounds in particular schools or clusters. The delivery of the workshops differed between the two states due to a number of logistical constraints. The South Australian workshops were conducted over four full days, one each semester for two years, whereas the same material and activities were presented to the Queensland teachers in the form of eight half-day workshops, once every half-semester for two years. Because of the close proximity between researchers and Queensland participants and the frequency of workshops, there were more opportunities to interact and collect data

via interviews and reflection sessions in the case of Queensland participants. For this reason only the data for the Queensland participants are presented here.

The professional development model used a series of research cycles. The activities and strategies presented in each session were designed to incorporate as much active learning as possible with the participants experiencing the activities as their students would. The strategies and activities were not prescriptive and teachers were free to adapt them for use across year levels, curriculum areas, or to cater for individual student needs. Between sessions, the participants planned and implemented classroom activities related to the content of the preceding professional development session. The following session included time for feedback, reflection, and discussion among the participants and the research team. These feedback and sharing sessions informed the design of future workshops to ensure that each workshop was responsive to the learning and experiences of the participant teachers and leaders.

Participants

The Queensland component of the study involved approximately 70 middle school teachers (Years 5-9) from 18 schools in four school clusters located in diverse socio-economic areas. Two clusters were in large provincial cities and the schools were located in low socio-economic areas. The schools in the other two clusters were located in mid – high socio-economic areas, one in the inner city and the other in the outer suburbs of the same city. The backgrounds of the participating teachers were diverse in terms of age, experience, and cultural backgrounds. The teachers in some schools volunteered for the program, however in the majority of cases, primary schools chose to involve all the teachers from a particular year level or to send all teachers of Years 5 – 7. High schools tended to allow teachers to volunteer, while some included all mathematics-science teachers and others included a group of teachers from a range of curriculum areas. Over the course of the program, there was very limited attrition, other than teachers leaving the schools due to retirement or transfer.

Prior to commencement of the project, the leaders of all schools were invited to co-participate in the workshops alongside the teachers and while some school leaders attended on an ad hoc basis (usually dependent on other school or departmental commitments that conflicted with workshops), 20 school leaders (eight principals and deputy-principals and twelve curriculum leaders) did so consistently. These leaders came from 11 of the 18 schools. The leaders from most schools in two clusters attended the workshops, including school principals, deputy-principals, primary school heads of curriculum (HOCs), and secondary school heads of department (HODs). The curriculum leaders from all schools in another cluster participated without principals or deputy-principals. Leadership participation was less consistent in the fourth cluster, with some schools sending teachers only and others sending curriculum leaders alongside teachers. The decision of school leaders who chose not to participate was entirely their own and they were not asked to provide explanations regarding their decisions. Prior to conducting the study, ethical clearance was obtained from the university ethics committee and from both state education authorities in which the study was conducted. Written consent was obtained from all participants. Participation was voluntary with the participants free to withdraw at any time.

Data Collection

The contexts of the participants in this study were quite diverse. Because it is likely that the experiences and perspectives of the participants in such a study are context dependent, it was necessary to ensure that all perspectives were revealed by using multiple data collections (Lachance & Confrey, 2003; Merriam, 1998), which included interviews, surveys, school visits, informal discussions, and workshop sharing and reflection sessions. Following the third and eighth professional development workshops, participating teachers and school leaders completed open response surveys to investigate their perceptions of several aspects of the professional development program, including their perceptions of the school leaders' participation. Several questions were framed using the IMTPG so that participants had the opportunity to reflect directly upon the outcomes of their participation in terms of knowledge, practice, or salient outcomes. The participants were given time to complete the surveys at the end of each session and those absent on that day completed them online. Over the two-year period interviews were conducted with individual teachers and participating school leaders. Again, the IMTPG was used to frame questions to gather data that would allow a focus on each of the change domains, the relationships between domains, and the influence of the Change Environment. Examples of survey and interview questions are shown in Appendix 1.

Members of the research team visited schools between workshops to observe classes, conduct interviews, and hold informal discussions with participants. Meetings, interviews, and discussions were audio-recorded. Field notes were used to record pertinent comments from the reflection and discussion sessions during each of the professional development sessions. A summary of data collection methods and respondents is shown in Table 1.

Data collection	Timing	Respondents
Survey 1	After Session 3	15 school leaders, 35 teachers (20 with leaders, 15 without)
Survey 2	After Session 8	15 school leaders, 60 teachers (43 with leaders, 17 without)
Interviews	Ongoing from end of first year	11 school leaders, 19 teachers (12 with leaders, 7 without)
Reflection sessions	During each of Sessions 2-8	All participants present

Table 1: Summary of Data Collection Methods and Schedule

Data Analysis

All responses were transcribed verbatim. The responses were coded to identify emerging themes, the identification of which was guided by a pragmatic approach, taking the theoretical framework and the research focus into account (Patton, 2002; Saldaña, 2013). As the review proceeded, further categories and new codes were generated or existing codes were refined to reflect emerging themes. To ensure the internal validity of the analysis, coding in all steps was undertaken independently by the first two authors. Outcomes were compared and discussed, with re-coding where necessary until agreement was reached (Cohen, Manion, & Morrison, 2000).

The responses were also read for indications of learning or changed behaviour. Following the approach used by Zwart et al. (2007), change was indicated by statements that

- expressed something that the participant had learned;
- expressed a desire to change a practice or a description of a changed behaviour or practice;
- suggested that the participant's thinking had changed;

- included verbs that implied change, such as gain, move, change, modify; or
- indicated a new insight, surprise, or uncertainty.

Each of the selected responses was coded in terms of alignment with one or more domains or to the Change Environment. Previous research has not focused on the Change Environment within the IMTPG despite its potential to significantly impact on teachers' professional growth (Clarke & Hollingsworth, 2002). We considered a focus on the Change Environment to be an important inclusion in our study because we were interested in (1) whether the school leaders acted in ways that influenced the teachers' Change Environments and (2) aspects of the Change Environment that influenced changes within the domains for teachers (or leaders) or their capacity for enactment or reflection. Statements connected to the Change Environment included references to support or feeling supported, for example, freedom to experiment with teaching strategies; opportunities to act on professional development back at school; opportunities to engage in discussion with colleagues or to share or reflect on one's practice; or provision of support of a logistical nature, such as planning time or physical resources.

Results and Discussion

This paper focuses on the question of how and why the engagement of school leaders influences teachers' professional growth and whether such participation also influences the leaders' personal growth. This section focuses on both aspects. Firstly, it examines the professional growth of the school leaders by presenting data from interviews and surveys completed by the school leaders. This is followed by an examination of the ways in which they influenced the teachers' professional growth or created a change environment that promoted it.

In the sections that follow, codes are used to indicate the component(s) of the IMTPG reflected in each survey or interview comment (PD = Personal Domain; ED = External Domain; DP = Domain of Practice; DC = Domain of Consequence; CE = Change Environment).

Professional Growth of School Leaders

The analysis of the interview and survey data from the school leaders revealed a number of change sequences. The school leaders' co-participation with their teachers in the professional development program resulted in the professional growth of the leaders themselves. Certainly the most commonly described change was the influence of the professional development activities (ED) on the leaders' knowledge and understanding (PD), which led to a range of reflective or enactment responses. The leaders described various changes to their Personal Domains and there was evidence that changes in the External and Personal Domains led to changes in the Domain of Practice of all school leaders. Additionally, all but one of the leaders described salient outcomes (DC) that they felt were the result of changes in their practice. The following examples are provided to illustrate change sequences as articulated by various school leaders.

The first example is from a secondary school Head of Department (Mathematics) who attended all sessions with teachers from her mathematics department as well as teachers from her school who taught in subject areas beyond mathematics. She described how her knowledge (PD) changed as a result of her involvement in the project:

I have a greater understanding of where proportional reasoning fits into the different key learning areas and the importance of an interactive hands-on approach to teaching proportional reasoning. I need to provide tools and activities that can facilitate that learning. I've also gained an appreciation of the need for the concepts to be embedded in other subject areas. (Survey)

This statement suggests that reflection on the workshop material and discussions (ED) led to an increased understanding (PD) of how she could better support the teachers or to ensure that proportional reasoning was made more explicit across the curriculum (i.e., the teachers' ED) These changes in her knowledge (PD) led to her enactment of new ideas that resulted in changes in her work as a curriculum leader (DP):

I have tried to integrate proportional reasoning into the activities we use for the students and to make proportional reasoning explicit in the whole school numeracy booklets … We now have a school numeracy committee and everyone is free to implement new ideas or to share their ideas with others. (Interview)

This last statement illustrates her reflection on the way in which her changed practice led to salient outcomes (DC). These changes to curriculum and the school's approach to numeracy development are examples of how the leader's professional growth can influence the External Domain and Change Environment of teachers.

Interactions with teachers from other schools during the workshops provided additional sources of information (ED) that led to other changes in her knowledge (PD). For example, 'I now have a much better understanding of what the primary school is doing in this area… so that we can align our curriculum, strategies, etc.' (Interview). This increased understanding prompted her to increase her interactions with the local primary schools (DP) by implementing Mathematics and Science days of excellence to promote primary students' proportional reasoning through a range of hands-on and problem-based activities.

In the previous example, co-participation and the resulting interactions with teachers led to changes in the leader's External Domain, which prompted further change in other domains via reflection and enactment. Other leaders had similar experiences. For example, another secondary school Head of Department stated that, 'Listening to how the primary school teachers teach the content and the concepts (ED) has really helped me to understand the minds of the primary school students when they first come to high school (PD).' (Survey) He described changes that had resulted from reflection on the professional development (ED): 'I now look for proportional reasoning moments (DP). I see most photographs as an opportunity (PD). I have a much better understanding of the various forms of proportional reasoning and where they are used (PD)' (Interview). The enactment of these new forms of knowledge led him to embed numerous ideas and activities from the workshops into the school curriculum (DP) as well as sharing ideas and strategies with staff:

I've used as many concrete examples as possible and we've used the penguin activity as an assignment. I'll also review the Australian curriculum to find out where our successful activities, such as Barbie and Ken can fit and whether they're best used as assessment or learning tools – or both. Ideally, it will be both. I'd also like to be more explicit with proportional reasoning for the staff in faculty meetings by showing them where it fits into the curriculum so they're more likely to use it themselves. (Interview)

By adapting the curriculum and providing information and opportunities for discussion at faculty and planning meetings, he was influencing the External Domain of the teachers.

The third example focuses on a primary school Head of Curriculum who, unlike the secondary school curriculum leaders, has no scheduled classes and is focused full-time on

curriculum and teacher development. The following comment illustrates multiple processes of reflection:

> I've realised that it's not enough to wait until Year 6 to teach fractions or ratio – it's not possible without the basics (PD). … The workshops (ED) have allowed me to reflect on the whole school curriculum and on what strategies can be used from the foundational year right through to allow students to develop better proportional reasoning (PD). This is what I'd like to look at as a school (DP). We need to focus more on how to move our students from additive to multiplicative thinking and do more work on patterning and fractional work. … I think we tend to go too quickly to numbers and algorithms and don't do enough of the manipulative work, for example, using blocks, working backwards and playing (DC). (Interview)

> Reflection on what she had learned through the professional development program (ED) led to changes in her knowledge and understanding of what might be needed to support students and teachers in her school (PD). Identification of the need to change the curriculum and support teachers and students to work differently led to ideas about what she might do differently (DP). One of the salient outcomes she noted (DC) was that despite all teachers in her school being involved in the professional development, some were finding it difficult to enact the new ideas in their classrooms or to change their practices. In an effort to influence the Change Environment and support the teachers to embed more ideas from the workshops in their teaching, she devised other strategies to support them (DP) and continued to reflect on the outcomes of her actions (DC):

> We all did the Australian census activities online and I've written 'Problem of the Week' questions for the whole school. The Year 5 teachers have taken these questions into their classrooms and are working on them with the students each week … I've been trying to think of things that involve the kids more – even if the teachers are not so involved I figure that if the kids are involved, the teachers will become more involved too. (Interview)

These examples from curriculum leaders illustrate the complex interplay between the changes in domains and the ways in which the processes of reflection and enactment occur. A similar situation was evident in the change sequences identified for the school principals. The following case of a primary school deputy principal provides an illustration. Despite not having a teaching role, several changes were identified in her knowledge and beliefs (PD) as a result of participation in the professional development program:

> I've realised how proportional reasoning is a part of so many aspects of everyday life – not just maths. I can see the value in using those 'teachable moments' – linked especially to world events to support students in the development of these skills….Using 'hands on' problem solving and relational and comparative situations that are present in all aspects of life can show students how this knowledge can assist their understanding of their world. (Survey)

This new knowledge led to a number of changes in her practice (DP), which included becoming actively involved in the planning sessions with the Head of Curriculum (HOC) and teachers:

> As part of our team planning sessions, myself and the HOC have spent time discussing with the teachers how these proportional reasoning strategies can enhance the children's learning of concepts. We have looked for ways to implement a whole school approach to this. (Interview)

This comment also illustrates one of the many ways that school leaders can contribute to the External Domain of their teachers by engaging in professional discussion with them.

Part of the strategy to implement a whole school approach was based on reflection on salient outcomes that she had observed (DC). She realised that some teachers were reticent to try new ideas in their classrooms and perceived this as being related to their concern not to 'get it wrong'. Reflecting on these observations led to further change in her Personal Domain and Domain of Practice:

> I need to provide teachers with support but also permission to take risks and try new strategies with their students – I am encouraging the teachers to model their thinking to the students – errors are OK! It's what we do with the error in the journey to finding the right answer. It has to be a team approach. (Survey)

Despite her earlier perceptions that some teachers were challenged by the new ideas, reflection on the ways in which such changes to her practice (DP) had benefited the teachers (DC) led to the observation that:

> There's now a greater understanding of strategies and how to develop those teachable moments … We've raised awareness of the importance of proportional reasoning and the teachers are feeling more confident to use those strategies as part of teaching across the learning areas. … The teachers are working on this collaboratively. (Interview)

These examples of leaders' professional growth as a result of participation in teacher professional development were not isolated. Indeed, all leaders described multiple ways in which their personal domains had been impacted by their participation in the project. These changes involved increased knowledge of proportional reasoning content and its place in the curriculum but by far the greatest focus for the leaders was their increased understanding of the ways in which teachers needed support and their changed belief in their own roles as enablers of change for the teachers. This increased understanding led to multiple changes in practice. All leaders spoke of making curriculum changes or providing more flexibility in curricula so that teachers could try different approaches with their classes. Almost all of them described strategies that they were using to encourage teachers to change their practice or to engage students in proportional reasoning, either in class or through other activities. The comments included in this section have been chosen as representative examples of the growth sequences that leaders experienced, not only during the professional development sessions, but equally importantly as a result of their work with teachers back at school. Participation in the professional development certainly led to changes in the leaders' own External and Personal Domains and it was their efforts back at school to develop a positive and supportive Change Environment for their teachers that led to more complex change sequences involving their Domains of Practice and Consequence. Often these change sequences were complex, iterative, and at times reciprocal, supporting claims made by Opfer and Pedder (2013) that changes in one domain can be contingent on changes in another. These examples also serve to illustrate the ways in which professional growth of the school leaders was related to their recognition of the importance of their own roles in supporting teachers to enact new ideas and knowledge from the professional development sessions. They responded to this by changing their practice in multiple ways, such as adapting curriculum, becoming involved in planning and reflection sessions with the teachers, and promoting the teachers' work in the school community. The following section elaborates on the ways in which school leaders impacted on the teachers' professional growth.

The Influence of School Leader Participation on Teachers' Professional Growth

In the surveys, the participants were asked to comment on their perceptions of the co-participation of school leaders and teachers in the professional learning program. Analysis of the responses revealed a number of themes, common to both teachers and leaders. These

themes focused on the development of a whole school culture, support at the school, promotion of a shared knowledge base and a sense of collaboration or teamwork, and exposure to new perspectives. All of the themes were relatively similar in terms of prevalence, however, although they were common to teachers and leaders, occasionally the perceptions of the two groups reflected somewhat different perspectives. Some representative comments are presented here under each of the identified themes for each participant group to illustrate the ideas and perspectives that were voiced.

Promoting a School-wide Culture

This theme was prevalent in both teachers' and leaders' responses. All of the school leaders perceived the development of a school-wide culture as necessary to embed the goals of the professional development and that they were better able to do this as a result of their involvement in the professional development. They felt they were well placed to ensure that all members of the school community were informed or 'on board' with the program. One secondary school principal talked about 'ensuring that strategies are used across the curriculum so that it's not seen as just the domain of maths teachers'. Others talked about the need to include parents and support staff so that the program became 'an addition to the school culture'. The need to promote a school-wide culture was closely linked to the leaders' view that this was necessary to support the teachers. One principal used the phrase 'it's everybody's business,' when describing his view on how the outcomes of the professional development should be embedded in the school. These perceptions reflect the importance placed on ensuring that the Change Environment was conducive to supporting teachers to make changes to their practice.

Without exception, the teachers had similar views that the leaders' involvement raised their knowledge and awareness, which allowed them to promote a school-wide culture. This is something the teachers felt was part of the leaders' role (as distinct from their own responsibility) : 'the admin can assist in building a culture of proportional reasoning across the school community,' and 'the school leaders can place emphasis on it – stress the importance of the project in the school'. The teachers felt it was necessary that the leaders participated so that they would 'see value of this PD,' and thereby 'reinforce everyone's commitment'. Other teachers felt that attending the workshops allowed school leaders to better integrate the ideas at school. They talked about leaders promoting 'alignment with school values, vision, and school priorities'; to 'integrate the ideas of proportional reasoning across the whole school'; and of 'the capacity to implement at the whole school level'. One teacher described this as 'getting everyone to participate so the ideas from the workshop are likely to be spread school-wide'.

Support for Implementation at School

The second major theme was support for teachers to enact and reflect on their professional learning at school, another important aspect of the Change Environment. While this theme was similarly evident in teachers' and leaders' responses, the leaders assumed responsibility for this, whereas the teachers positioned themselves as recipients of the support. The leaders felt that their increased knowledge as a result of participation in the professional development allowed them to provide more informed support. Several mentioned specific strategies, such as assisting teachers in class, helping teachers to identify ways to implement the activities in their classes, supporting teachers to attend the workshops, or scheduling opportunities for teachers to share learning at staff meetings. Other comments were more general, for example, 'Admin can provide team support and encourage

engagement back at school,' and 'I know the messages my staff are getting and am therefore better positioned to support them in all aspects of the project'. The school leaders also influenced the teachers' External Domains, using curriculum development as a means of supporting teachers: 'We are aware of the focus (of the professional development) so we are able to ensure emphasis in curriculum and planning'. This was more particularly the case for curriculum leaders: 'Leaders at different levels use the information in different ways. The HODs (Heads of Department) are more likely to continue using the strategies over a longer period of time for their school,' and 'Attending is great because we keep in touch with what is happening in the classrooms, follow up and incorporate it within the planning'.

The teachers' perceptions also suggested that leaders' participation promoted their capacity to support the teachers: 'Having the admin attend with me has been a great support,' and 'the HOD has been at all the workshops with me and so encourages implementation of the ideas back at school'. Providing more tangible support such as additional planning time or resources also contributed to teachers feeling more supported, and to processes of enactment: '(The principal) gives us time off after each workshop to do some planning. … He is supportive and we have the rest of the day to work on this … It's why we're all so happy to do a bit more because he's so behind us,' and 'My school and department are very supportive of any changes and I have the resources to support nearly any activities I choose to run with my students.'

The teachers who attended without any school leaders also perceived that having leaders participate in the program led to increased support and that without it, making change is more difficult. For example, 'If your HOC is there then the model can be used from the top down and that helps everyone. My school does not have a HOC here though, which is a disadvantage.'

Collaboration and Shared Understanding

Although this theme was more prevalent in the teachers' responses than those of the leaders, both teachers and leaders spoke of opportunities to work together in a collaborative environment. The leaders described continuing the collaboration from the workshops when they returned to school: 'The team approach means that the projects undertaken become a team effort because admin and teachers are working on them collaboratively.' An important outcome of collaboration for the leaders was the notion of building shared knowledge and understanding. The phrase 'everyone is on the same page' was commonly used to reflect this perception. School leaders felt that they were better placed to understand what the teachers were learning and how this impacted on their practice at school: 'We have common knowledge and understanding'; 'The teamwork that is encouraged means that we and the teachers have a common language and also shared understandings'; and 'We can keep in touch with what is happening in the classrooms'.

The teachers also had a sense of collaboration and teamwork as a result of leaders' participation: 'It makes the whole process a collaborative team effort'; and 'Co-operative work means more support and greater understandings'. For some teachers, collaboration was connected to their need for leaders' support: 'I have the comfort of knowing that all levels are aware of the needs of the students, and the strategies needed for improvement'. The opportunity to develop shared understanding and knowledge through discussion and other collaborative efforts suggests that this form of interaction is an important means through which to contribute information and ideas, thereby influencing one another's External Domains and potentially, Personal Domains.

New Perspectives

The data suggested that co-participation in professional development by teachers and school leaders provides the opportunity to both hear and voice new perspectives, heightening awareness of what others think and feel. This is another way in which the leaders and teachers became mutual contributors to one another's External Domains. This theme was common to both groups, however, there were some differences in the ways in which leaders and teachers positioned themselves and one another. The leaders often positioned themselves as facilitators of discussions: 'We can discuss ideas together,' and 'It allows leaders to facilitate teacher reflection and discussion', while others described 'sharing different practices with one another,' and the opportunity for 'interchange of ideas between participants'.

The idea of hearing new perspectives and having their own perspectives and ideas heard by school leaders was a more dominant theme for the teachers: 'another perspective is always good'; 'I have become aware of others' perspectives'; 'When leaders participate, a wider range of experiences is brought to the table'; 'Sharing ideas and strategies with different staff - there's a variety of thinking and personal experiences.' Several comments reflected the perception of discussions between leaders and teachers as learning opportunities: 'They can share their experiences and insights with teachers. It's nice to have a range of opinions, thoughts and ideas and to brainstorm with people who may see things from a different perspective to us and to glean ideas from them,' and 'There's discussion about the topic and we gain insight on what can be implemented in the classroom'. Teachers generally viewed such interactions as mutually beneficial: 'We are able pick their brains on certain issues and also we can provide feedback to them,' and 'They can share their knowledge with us and keep in touch with what is happening in the classroom'. Several teachers described teacher – leader interactions as an opportunity to provide leaders with insights into the challenges faced by the teachers: 'They can learn what is going on in classes'; 'It helps them to understand what needs to happen in the classroom'; 'They can understand the need for physical resourcing'; and 'Having management involvement is beneficial as they are made aware of the added pressures teachers face'.

Perceptions of Teachers without Co-participating Leaders

There was a profound difference between the comments of teachers whose leaders participated on an ongoing basis and those whose leaders attended intermittently or not at all. These teachers were far more likely to identify constraints than opportunities to use their learning at school. They often focused strongly on time and curriculum constraints: 'Resourcing and time limitations – the curriculum is so prescribed so time is factor. It also takes too much time to do the physical things – take pictures, download, share, discuss,' and 'We need more time – time for everything. We get a list to do and by the time we move to the next thing, there's more to do. With the new curriculum, it will be a new challenge'. Rather than feeling that their leaders were co-partners in enacting new ideas and knowledge, several teachers' comments suggested a 'them and us' perception: 'There are conflicting school priorities and overloaded agendas …' and 'There's a crowded curriculum and pedagogy that admin sometimes demand'. Other teachers felt isolated at school because other faculty members weren't engaged or because leaders hadn't prioritised the new ideas:

> It would mean that we have to drop lessons to incorporate or change lessons to use proportional reasoning ideas that I believe would work well. Other staff members do not have their heads around what proportional reasoning actually means. They just see it as ratio. (Primary school teacher)

There are only two of us that are currently participating so it's not a focus for the whole team. It'd be excellent if it was a greater focus within the faculty so that when we plan units the proportional reasoning activities are written in straight away (Secondary school teacher).

There were clear differences between the perceptions of those teachers whose leaders attended the workshops and those whose leaders did not. The perceptions of these teachers reflect findings in the literature about professional development programs that have either not been successful or have not been sustainable. Shulman and Sullivan (2015) described several reasons why initiatives failed, all of which at least to some extent related to school leadership. Problems included the expectation of strict adherence to curriculum, administrators' expectations or requirements being counter to the classroom strategies promoted by professional development, and lack of time for teachers to implement the professional learning. They referred to principals who 'gave lip service to the project' but whose 'actions belied their words' (Shulman & Sullivan, 2015, p. 275).

Summary and Conclusions

This paper has addressed the potential of school leaders' active co-participation in teacher professional development to influence leaders' and teachers' professional growth. This study contributes to knowledge in numerous ways; firstly, through the novel application of the IMTPG to the professional growth of school leaders and elaboration of the model that reveals the professional growth of both leaders and teachers. Secondly, the results suggest that co-participation by leaders in teacher professional development can have a profound influence on teachers' professional growth. The teachers felt supported and perceived that the leaders' co-participation led them to encourage teachers' experimentation and to value the professional learning of the teachers. This finding reflects the arguments in the literature that leaders must provide such a school climate if teachers are to develop professionally (Loucks-Horsley et al., 2010; Louis et al., 1995; Stoll et al., 2006). The results of the study further contribute to knowledge about teacher professional learning programs, showing that leaders themselves undergo professional growth and are themselves changed through this co-participation. Furthermore, we have found that leaders and teachers contribute to one another's professional learning and that the use of the IMTPG allows this mutual influence to be mapped via the domains of the model.

Throughout the professional development process leaders gain new knowledge and understanding by participating in workshops alongside teachers but perhaps more importantly through their varied interactions with teachers in their schools, which result from this participation. Their enhanced knowledge leads to a deeper understanding of the ways in which they can support teachers. This is an important finding in light of suggestions in the literature that school leaders can find it challenging to create school climates that support teachers' professional growth (e.g., Drago-Severson, 2012; Zwart et al., 2007). This study has found that such support is diverse and tends to be the result of leaders' reflection on the changes in their Personal Domains, which in turn often leads to enactment of new practices and processes in their capacity as leaders (changes in their Domains of Practice). At the same time, reflection may lead to the identification of salient outcomes (changes in the Domain of Consequence), either for students or teachers, which again may prompt further changes in the leaders' practice. In this study, the changed practices of leaders led to positive changes in both the External Domains of the teachers and the Change Environment in which the teachers worked.

The school leaders provided input into the teachers' External Domain through
- Creating flexibility in curriculum expectations and embedding an explicit focus on proportional reasoning in curriculum documents;
- Engaging in collaborative planning with teachers;
- Sharing ideas and strategies for classroom activities;
- Modelling classroom practices or team teaching with teachers;
- Providing opportunities for individual and collective reflection on practice through staff meeting discussions, coaching, and mentoring.

At the same time, teachers influenced the External Domains of school leaders through sharing of ideas and the opportunities to gain insights into teachers' perspectives. In this study, both the leaders and teachers valued the opportunity to share their views and experiences with each other. The teachers perceived interactions related to their professional development as being somehow different to other professional discussions with leaders. Their perceptions suggest that involving leaders in teacher professional development provides opportunities for teachers and leaders to become co-contributors to changes in one another's External Domains. The second significant area upon which the leaders had a positive impact was the Change Environment. The interactions between the domains of the leaders and teachers are summarised in Figure 2.
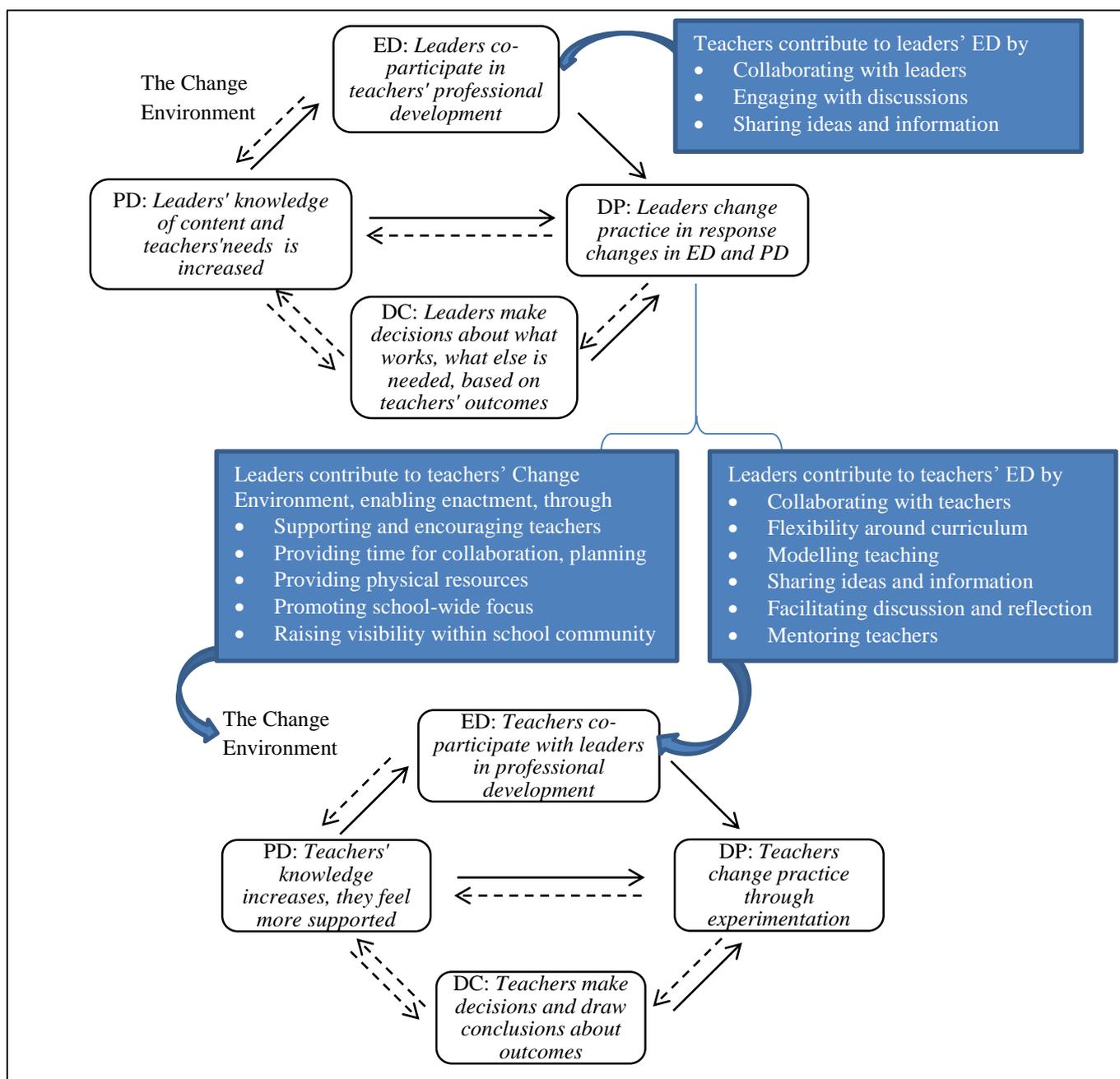
Figure 2: The Modified IMTPG Showing Mutual Influences of Leaders and Teachers

Clearly, school leaders have the capacity (and responsibility) to create a Change Environment that affords rather than constrains teachers' professional growth. In this study, the leaders who participated in the professional development program were committed to creating a positive Change Environment. They used a range of diverse strategies to positively influence the Change Environment by:

- Giving support and encouragement to the teachers and 'permission' to experiment;
- Providing time for discussion, reflection, and sharing with colleagues and school leaders, as well as time for planning;
- Providing physical or technological resources to facilitate teaching or experimentation with teaching strategies or new learning experiences;

- Raising visibility within the wider school community (e.g., parent meetings; 'problem of the week' for students or teachers; discussion of proportional reasoning on school assemblies; or foregrounding the ideas in the school newsletter);
- Facilitating and expecting a school-wide focus through policy or by embedding proportional reasoning in whole school programs and curricula.

We concur with the statements of Kershner et al. (2013) and Kennedy (2010) that school organisation and culture can indeed act to constrain teachers' professional learning and certainly in the case of our study, many of those teachers whose leaders were not involved voiced reasons why they felt their actions at school were constrained. On the contrary, the teachers in this study whose leaders co-participated found that there was a positive school-wide culture and they felt supported to experiment with new ideas and practices. A supportive school culture not only impacts strongly on the effectiveness of professional development but also its sustainability (Stoll et al., 2006) and as such is a critical aspect of the teachers' Change Environment. The various means by which school leaders in this study provided support illustrate the ways in which professional growth of the school leaders led them to promote Change Environments conducive to teachers' enactment of change and reflection upon it. Such support creates conditions that encourage teachers to participate in learning communities (McLaughlin & Talbert, 2001). The co-participation in professional development provided the teachers and leaders with ongoing opportunities for dialogue, to learn and discuss together, share new ideas, and develop shared understandings and reflection, creating a sense of collaboration, which according to Lumpe (2007) is an essential element of a professional learning community.

School leaders and teachers alike felt a strong commitment to enacting the professional learning in their schools through collaborative effort, which according to Bandura (1997) leads to a collective efficacy among participants, and in turn creates a more positive environment. Although there was a strong sense of collaboration, there were sometimes differences in the ways in which the leaders and teachers positioned themselves and each other. For example, the leaders' comments suggest that they positioned themselves as being responsible for enabling the teachers to enact and reflect on their new learning back at school. Part of this responsibility included promoting school-wide understanding and awareness of the changes. The teachers positioned their leaders in a similar way and expected the leaders to provide this and other more tangible support, such as physical resources.

The literature around the role of school leaders in teachers' professional development to date has focused largely on their provision of access to professional development opportunities and provision of resources in the school setting (e.g., McLaughlin & Talbert, 2001). Jeanpierre et al. (2005) and Drago-Severson (2012) argued that further knowledge was needed about the kinds of support and strategies that successful school leaders use to promote school climates that support teachers' professional growth. The current study contributes to this need by providing evidence that a significant and powerful means by which to promote supportive school climates is through leaders becoming active co-participants in teachers' professional development activities. The co-participation by school leaders signalled to teachers that their school leaders valued their efforts and were supportive of and knowledgeable about the changes they were making in their practice. Further, the increased knowledge and active involvement on the part of the school leaders allowed them to develop a school culture, such as that promoted by Stoll et al. (2006), in which there was an expectation of collaboration, reflection on and dialogue about practice, and sharing of ideas and strategies, not only among the teachers but between teachers and leaders.

This study has contributed to the literature about professional learning by showing that school leaders and teachers influence one another's professional growth in multiple

ways, through their interactions with one another during workshops and at school and through the ways in which they reflect and enact on changes in multiple change domains. It has implications for the ways in which professional learning for teachers is designed and has drawn attention to the important influence that participation of school leaders in such programs can have, not only on the leaders themselves but also on the environments in which teachers work and on the ways in which such opportunities allow teachers and leaders to work together as co-participants and co-contributors to one another's professional growth. One of the challenges in this project was encouraging the leaders to become involved in the program. Of course, school leaders have many demands on their time and for many, this was their key reason for not attending the workshops. Those leaders who did attend consistently were emphatic about the importance of attending and the positive influence that this had on their practices at school. Their attendance was also important from the teachers' perspectives because they felt valued and supported and they appreciated the time that their leaders took to attend with them. The ongoing collaboration between leaders and teachers has the potential to ensure sustainability of professional development programs beyond the life of the programs themselves and thereby have an impact in the longer term. Further research might investigate flexible ways of delivering professional development so as to facilitate leaders' attendance. It might also focus on whether co-participation of school leaders in professional development does indeed lead to sustainability of professional learning and the factors that influence such sustainability.

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Acknowledgements

Appendix 1: Sample Survey and Interview Questions

Sample Survey Questions

Personal Domain:

- In what ways has your knowledge of proportional reasoning concepts changed over the course of the project? (in your own life and in classroom contexts)
- In what ways has your knowledge of teaching strategies associated with proportional reasoning changed?
- In terms of the curriculum, how has your knowledge changed?

Domain of Practice:

- What proportional reasoning activities have you used (perhaps activities that you developed yourself or found elsewhere)?
- Has your planning changed – do you integrate proportional reasoning or does it come up incidentally – or both?

- What aspects of your practice would you say have changed as a result of the workshops?

External Domain:

- What do you consider to be the most valuable things you gain(ed) from the PD sessions?
- How would you say the PD sessions have influenced your knowledge or practice?
- Which aspects of the PD model (e.g., cluster members from other schools and year levels, multiple workshops, admin participation) have enhanced your learning? Why/how?

Domain of Consequence:

- How have the students responded to the activities focusing on proportional reasoning?
- Have you noticed any changes / what have been the outcomes for your students as a result of what you've done?

Change Environment:

- Please describe any aspects of the school context that support or hinder your implementation of your ideas around proportional reasoning
- What else would help you to engage more with / make more use of the ideas and strategies presented at the workshop?

Sample Semi-structured Interview Questions

Personal Domain:

- How do you think your knowledge has changed this year?

Domain of Practice:

- What have you tried with your students (teachers) this year?
- What would you think you will do differently or the same next year?

External Domain:

- How has the professional develop program influenced your decisions or practice back at school?

Domain of Consequence:

- How have the students (staff) responded to these changes?
- What do you see as the benefits for your students (teachers) as a result of your participation in the project?

Change Environment:

- Are there aspects of the school context that afford or hinder your implementation of your ideas or those of your staff?