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MATHEMATICS LEARNING COMMUNITIES: ROLES OF TEACHERS NETWORK, CLUSTER AND ZONAL ACTIVITIES IN SINGAPORE

CHUA, Puay Huat < puayhuat.chua@nie.edu.sg >

National Institute of Education, Nanyang Technological University, Singapore

ABSTRACT

The purpose of this paper is to unravel the roles of Teachers Network (TN), the school clusters and zones in promoting mathematics learning among teachers in Singapore. Specifically, the author draws from the concept of Learning Communities to discuss teachers' continuing learning in mathematics in these communities. The case study on TN in particular looks at how, at the national level, teachers are trained to create an environment for mathematics sharing and learning through the practice of the Learning Circles (LC) methodology in their schools. At the zonal level, the author describes the work of the Mathematics Centre of Excellence (COE) in their creation of scaffoldings for collaborative learning and sharing of mathematics for schools in the East Zone. Through their activities and programmes, both the TN and the COE spawn learning communities within schools. Issues challenging the roles of TN and of COE in teachers' continuing professional development and the implications of these issues for policy makers are also discussed.

TEACHER EDUCATION

In Singapore, formal mathematics teacher training starts with the pre-service PGDE (Post Graduate Diploma in Education) courses. In the course of their teaching career, teachers attend in-service courses to keep abreast of the changes in the mathematics curriculum and to upgrade their mathematics and pedagogical content knowledge. These pre and in-service courses are largely provided by the National Institute of Education (NIE), an institute of the Nanyang Technological University (NTU) in Singapore. Some schools also engage external vendors to provide mathematical enrichment courses for their teachers to enhance their knowledge so that they can translate this learning to improve their classroom teaching. Teachers in schools also go through some informal collegial learning. For example, teachers may participate in the sharing of pedagogies within their mathematics departments. Others may be engaged in sharing of their best practices at TN and at activities organized by the school clusters and zones. Such on-going interactions and sharing plays an important role in promoting the professional growth of teachers. They provide a social milieu for inquiry into teachers' practices in a non-formal environment. Besides, these episodes of learning also provide opportunities for mathematics teachers to cross-pollinate their localized knowledge of their practices across schools which otherwise would remain insulated within their departments. This is what Cochran-Smith and Lytle (1999) termed the "knowledge-of-practice" (learning through working within "contexts of inquiry communities") in their conception of teacher learning. Elsewhere, Llinares and Krainer (2006) use the term "mathematics teachers as learners" to emphasize the importance of inquiry in the professional growth of practicing teachers. Shulman (2004) took the view that teachers must be in "communities where they can actively and passionately investigate their own teaching" so that they can build a knowledge base that goes beyond what they would have in isolation in their departments. Wong (1999) and Shanmugaratnam (2004) have separately emphasized

this need for teachers to network and to interact for professional sharing and learning and this has been recognized by the Ministry of Education. It is in alignment with Teo's (2001) "Learning Organisation" framework advocated by the Ministry for all schools and is congruent to Goh's (1997) Ministry's vision of TSLN ("Thinking Schools, Learning Nation"). In that vision, teachers play a pivotal role in transforming their schools into thinking communities through their active engagement in reflective practices and continuous learning. The purpose of this chapter is to explicate the roles of the TN and the COE in contributing to this non formal aspect of teacher development through their spawning of learning communities in schools.

LEARNING COMMUNITIES

Increasingly there has been recognition that the professional learning community plays an important role in teacher development (Day & Sachs, 2004, Toole & Louis, 2002, Beck, 1999; Stein, Silver & Smith, 1998). The term learning community is not new in the research literature in education. It is used variously to mean different things. On the one hand, there are teacher communities of practice where members come together to solve problems of practice, share knowledge and learn from each other. Such a community is characterized by having a shared purpose, having evidence of broad networking, sharing of craft knowledge and having an enquiring collaborative culture. Martin-Kniep (2004) describes such communities as being versatile in terms of their sizes and in terms of their structures. Their sizes can vary and their setups can vary from loose informal groupings to those with fixed formal structures. On the other hand, there are also university learning communities. Among universities in America, a learning community comprises a small group of students from different faculties enrolling in two or more courses together with the intention to build academic as well as social connections between what "otherwise would be discrete academic and social experiences" (Tinto, 2002). It also requires faculty and staff members to

collaborate so that the learning experience provides for an academic coherence that is interdisciplinary in nature. In addition to other qualities, such a community (where membership is voluntary) typically focuses on shared learning, shared leadership and the valuing of diversity of perspectives among its members. This type of structure promotes a holistic learning experience by emphasizing student to student and teacher to student interaction and the interdisciplinary linkage of courses. Yet there are also virtual learning communities where Lewis and Allan (2005) characterize them as having discussions and learning taking place through active on-line collaboration. In drawing a suitable framework for discussions of how the TN and the COE promote learning communities, references are made on the commonalities across these various conceptions of learning communities. In this chapter, a learning community is conceived to be one that is characterized by voluntary membership, a leadership that is facilitative, a sense of a shared purpose to solve a problem or to resolve an issue, a spirit of collaboration and the valuing of diversity of views. The roles of TN and the COE in bringing about the growth of learning communities will be discussed in terms of their organizational structures, the nature of their programmes and activities and their impact on teachers professional learning.

TEACHERS NETWORK

i. Organisational Structure

Teachers Network (1998) was launched by the Ministry on 30 April 1998. Its setup is in alignment with the TSLN vision of producing teachers who are thinking and who are continuously learning and seeking new and better ways to improve their practices. With TN's formal infrastructure and clear agenda (<http://sam11.moe.gov.sg/tn/abouttn.html>), it is envisaged that networking among teachers can achieve the full potential of professional sharing. Whilst TN has in place structures and programmes to promote the professional and general well-being of teachers, the focus in this chapter will be on a study of its Learning

Circle (LC) methodology where teachers are trained to facilitate their own group learning using tools of reflection and dialogue. Such a focus will help to unravel the role of TN in mathematics teachers learning. LC, which is recognized by the Ministry as one of the three innovation tools that schools could use for their work improvement, promotes collaboration, reflection, sharing and learning among the teaching fraternity. This is in line with TN's vision "to build a fraternity of reflective teachers dedicated to excellent practice through a network of support, professional exchange and learning." TN therefore aims to be a catalyst to spawn teacher collaboration and learning. TN operates on an invitational mode by publicizing its LC methodology and activities through its website. It also uses the Ministry's Training and Development Division platform in reaching out to schools.

TN is supported by an administrative team and a team of 12 PDOs (Professional Development Officers) who serve schools in the four zones. Each PDO is a LC activist who champions and propagates LC methodology to schools which have indicated their interest to embark on the LC journey. When invited, a PDO team from TN will give teachers an introductory workshop on the skills of LC reflection and dialogue. A PDO then follows through with the LC with an action plan. A typical LC comprises four to eight teachers. It has a lifespan of six to nine months. Members of a LC may come from the same school or they may come from different schools. A LC is formed to serve a specific purpose of looking at teaching and learning issues like mathematics teaching and students learning. A LC is facilitated by a member who is trained and is partnered closely throughout the LC process by a PDO. Each PDO is a 'critical friend' to the LC in terms of guiding the group in its methodology by being a professional critic, being a sounding board and by lending emotional support to the team. The PDO facilitates the processes during which teachers explicate their practices and create new knowledge. The PDO then helps to record, publish and disseminate

such learning so that knowledge of practice can be replicated elsewhere in schools. If necessary, a PDO may also get expert help in a specific area.

ii. Nature of Programmes and Activities

TN's core beliefs about personal mastery, shared vision, mental models, team learning and systems thinking are drawn from Senge et. al. (2000)'s five inter-related disciplines about a Learning Organisation (LO). In a LO, members continually expand their learning capacities through learning together, freeing their collective aspiration and through nurturing "new and expansive patterns of thinking" (Infed, 2006). TN's five core beliefs form the working principles under girding the working of a LC. The concept of the LC closely mirrors Action Research (AR) which incorporates reflection, journal writing, dialogue, collaboration and the 5 step RPAOR cycle (R: initial reflection, P: plan, A: act, O: observe, R: critical reflection). For example, teachers may use the LC as a scaffolding to surface their mental model of students' picture of a mathematical concept, to challenge their practices about teaching that particular concept and to draw an action plan to improve those practices that can translate to better students learning. Ball (1996) took the view that such approach of contextualizing their teaching practices and reflection through the on-going interactions with colleagues is an effective professional development model for teacher learning.

Unlike learning from some mathematics in-service courses, a LC does not serve as a disseminator of specific content knowledge. It draws heavily on the members' sense of inquisitiveness into the group's practices. It fosters an attitude of self-critique and of drawing upon contextual knowledge to resolve a workplace issue. In this sense, the theory behind a LC is also linked to constructivism (knowledge creation) and to andragogy (adult learning). A LC also has a shared and facilitative leadership where the leader leads without dominating and behaves in a way that enhances the collective ability of the group to adapt, solve problems and to improve performance.

iii. Impact on Teachers' Learning

Much of the learning outcomes of LCs are captured through personal journals, group reflective journals, TN publications, TN teacher-led workshops and TN conferences. For example, a mathematics LC in St Andrews Junior School, reflected in their group reflective journal that “being part of the LC has enabled us to become more conscious of the needs of our pupils” and that “too often, we have made sweeping assumptions about why our pupils are not able to learn.” In another group’s reflective journal, the team from Haig Girls School shared about how Primary 4 students can be helped to improve on their problem solving skills in mathematics by supplementing the demonstration of problem solving strategies with affective actions like encouragement and extension of questions (posing new questions based on the original question). They reflected that they had become more empathetic towards their students and more focused, patient and reflective in their teaching. This reflection on teaching and student learning as an interactive and consultative process was also shared by the LC from Bukit Merah Secondary School. In their project on helping students strengthen their memory of mathematics, they were surprised to find when asked to come up with strategies for remembering, students were able to come up with innovative ideas of remembering formulae in the topic on mensuration. For example, students suggested $V = \frac{1}{3}Ah$ (“One-third Ah ”) for remembering the formula for volume of a pyramid and $A = \pi rl$ (“the π is ready to be loved”) for helping them to recall the surface area of a cone. The team also reflected that the high level of cooperation, openness and a tolerance of diverse views were key factors to the success of their LC.

As an example of the outcome of the LC methodology, TN has published two handbooks for mathematics teachers (one for primary teachers and the other for secondary teachers). In these publications, teachers share their successful practices and useful strategies and innovative ideas for more effective classroom teaching. For example, there is a sharing of

common errors made by students in upper secondary Elementary Mathematics and strategies to help students in this area from the mathematics LC team of Woodlands Secondary School. Another team from Swiss Cottage Secondary School looked into the motivating and monitoring strategies in Additional Mathematics. In another publication, “Challenging Maths Problems Made Easy” authored by Ammiel Wan Chee Hong from Catholic High School, teachers, for example, are able to get resources on how to bridge students learning of the Primary 6 Mathematics on the model method of Problem Solving to the algebraic approach used in Lower Secondary Mathematics.

TN teacher-led workshops and TN conferences are the other platforms which serve to promote communities of learning in schools. In TN teacher-led workshops which incorporate LC methodology, classroom teachers share their teaching ideas to fellow practitioners. The contents of such workshops are therefore contextualized to be directly relevant to the local classroom. For example, there were workshops on “Designing Effective Student Centred Tablet PC Lessons” by Sim Puay Hoon and Liu Gong Kai from Nan Hua High School and on “Eureka Maths” (problem solving for non-routine questions) by Low Yew Fai from Rulang Primary School. Teachers’ feedback was largely positive for such workshops with most participants reflecting that they had benefited in terms of picking up good ideas. Although such workshops do bring about the professional development of the presenters when they shared their implicit knowledge of their practice, not much is known about the follow-through learning in terms of how participants actually translate these into practices and how such knowledge influences their professional views of a topic.

Teachers also share their learning on the TN website. Tripp (2004) in his study of TN describes this website as an important repository and an archive of teacher knowledge. TN website archives contain links like the TN Workshop, TN Conference, LC method and the Reading Room (for resources on general reading and not mathematics specific topics). It also

has its online catalogue of resources at Read@TN link. Besides promoting professional growth of teachers through its LC methodology, TN also has in place a recognition structure to honour teachers who have contributed to developing the community of teachers as learners. For example, a teacher will be recognized as a “TN Associate” if he or she has either contributed more than 20 hours to TN or have written or edited at least three publications that are the direct outcomes of TN activities. Perhaps, this recognition structure has contributed to the teachers’ sense of professionalism across the fraternity. The number of LCs in schools has shown an increasing trend over the years (Table 1). But anecdotal evidence seems to suggest that LCs are more popular with primary schools. The number of new LCs in 2006 show that 84 of them are from primary schools, 35 from secondary schools and only three are from junior colleges. Besides the number of LCs focusing on issues arising from teaching and learning of mathematics (20 in 2005 and 23 in 2006) remains small relative to the total number of LCs across all schools.

Table 1

Number of LCs (2003 – 2005)

Year	Number of Schools Involved	Number of LCs
2003	42	196
2004	37	156
2005	63	220

Although the impact of LCs may not be fully quantified by the number of sessions offered at TN conferences, the number perhaps may be taken as a proxy indicator. Across the three TN Conferences (Table 2), the number of mathematics sharing sessions remains small. Perhaps it is an indication that the use of LC methodology for mathematics teachers is not as widespread as one would expect. Although the LC methodology fosters teacher learning, there have been concerns about its sustainability and viability in the further professional

development of teachers. With increasing demands on teachers to deliver results and to complete administrative tasks, membership to a LC may be construed as an add-on layer of work for teachers if the intent of the LC methodology is not properly communicated.

Table 2

Teachers Conferences (2001 – 2006)

	2001	2004	2006
Number of Sessions	105	93	48
Number of Maths Sessions	7	7	4
Percentage of Maths Sessions	6.7	7.5	8.3

The sustainability of a LC and the keeping of the intent of a LC therefore may present a challenge to school leaders. Teachers need to believe that the LC methodology is a viable and meaningful platform for them to develop professionally. There is also the danger that a LC may perpetuate familiar unsound practices just as easily as it can lead to meaningful change and innovation. Perhaps this can be addressed by the LC forging a partnership with NIE teaching staff to help in the facilitating of expert knowledge.

CENTRE OF EXCELLENCE [COE] FOR MATHEMATICS AT EAST ZONE

i. Organisational Structure

To set the context for describing the COE, it is useful to understand how schools are organized. Since 1998, schools in Singapore are grouped into clusters according to their geographical locations (*Cluster Schools and Its Challenges*, 1998). Several clusters are then grouped into a zone. There are four zones: North, South, East and West Zones. Each cluster is facilitated by a Cluster Superintendent. Cluster Superintendents help to establish networking, sharing and collaboration among schools within the zone in order to raise the capacity of the school leadership teams and the level of performance in each school. Within a cluster, there are special interest groups that serve particular needs. For example, there are

mathematics groups comprising Heads of Departments from different schools who organize enrichment activities like Mathematics Trail and Mathematics Camp for students within their cluster (*Cluster Teamwork x Maths Camp*, 1999; *Maths Trail*, 2001). There are also various mathematics workshops and discussion forums organized by mathematics cluster support groups to take care of teachers' learning needs in specific topics of common interest and to foster professional networking among the teachers. These learning communities serve the needs of schools within the clusters. At the zonal level, there are Centres of Excellence. The purpose of each Centre is to promote teacher professional development in a specific subject area. For example, there are Centres of Excellence for Arts and for Physical Education. Each Centre serves as a platform for active discussion and sharing of best practices among teachers within the zone. The focus of this chapter is to look at the East Zone Centre of Excellence (COE) for mathematics which was set up on 6 September 2003 and hosted at Tao Nan School (*A Synergy of Mathematical Minds*, 2003; *Towards Maths Excellence*, 2004). It is one of the more established mathematics COE among the four zones. It serves 45 primary schools, 40 secondary schools and four Junior Colleges.

Like the TN, COE is a formal grouping initiated by the Ministry's Schools Division. The primary purpose of the COE is to promote good mathematics classroom teaching and learning among schools in the East Zone so as to bring about higher standards of mathematics in these schools. From its Work Plan documents for 2006, the core business of COE is to "lead in the pursuit of excellence in the teaching and learning of mathematics." Its vision is to be the Centre of Excellence in mathematics pedagogy and practices in the East Zone. It does this by enhancing the capacity of its mathematics teachers and by leading the drive for innovation and creativity in the teaching and learning of mathematics. It actively promotes AR as one of the thinking tools for teachers. To engender a more sharing and learning culture, it organizes the annual EZ Mathematics Sharing Day for mathematics teachers in the

East Zone. Besides inviting NIE's MME staff and partners from other agencies to share their professional knowledge, the day is also a celebration of teachers' work and an occasion to showcase good teaching practices in the classrooms.

The COE has a recording studio (Maths Studio) which is designed as a classroom setting with video-taping and editing capability. It is used for recording good teaching practices and for teachers' evaluation of their own teaching. The COE also has a mathematics resource room known as MATELL (Mathematics Teaching and Learning Lab) which houses teaching resources from schools. The Centre has its own e-portal which is hosted at Tao Nan School (<http://www.eastzone-coemath.moe.edu.sg/default.asp>). E-portal accounts are given to all mathematics teachers in the zone. The e-portal serves as a one-stop resource that produces and promotes good teaching and learning ideas and resources for teachers. Besides functioning as a channel for communication between schools and the COE, it also serves as a repository of good lesson plans, a clearinghouse of successful classroom practices, learning ideas, resources and mathematics assessment papers from schools. Using its 'Matell' link, teachers can have access to pedagogical strategies that are posted by fellow practitioners. In its 'Event' link, schools can publicize their mathematics programmes and activities so that others may be able to link up to schools for collaboration. Likewise, from its 'Forum' link, teachers can engage in online discussions about specific topics in the mathematics curriculum.

The COE co-opts cluster representatives who are mainly Heads of Departments or Senior Teachers from the seven clusters within the East Zone. This administrative setup places the cluster groups in a complementary position within the COE. Each cluster representative acts as a spokesperson for schools within the cluster. Information dissemination about activities and initiatives from the COE and the ground feedback from schools and clusters about the COE's programmes are actively promoted. Having cluster representatives also facilitates 2

way communications between the COE and schools. It complements the COE's e-portal which is used as a platform to link schools to the COE. The Principal of Tao Nan chairs the COE Executive Committee. The Executive Committee comprises cluster representatives and three school Vice Principals who help in the running of the Centre. A panel of School Superintendents provides advice and guidance to the COE in its work. Much of the decision making within the Executive Committee are participatory in nature. The Principal leads in its strategic planning for the Centre every year. Before mapping up plans for the year, due attention is paid to the current issues on the educational horizon. In-depth discussions and considerations are made to align the Centre's work with the current Ministry's key initiatives for schools and the learning needs of mathematics teachers in schools. Partnerships with NIE's MME department and other external agencies are also made so as to add value to the work of the COE.

ii. Nature of Programmes and Activities

The COE functions as a decision making body that organises training and programmes to teachers to bring about learning. Its members being representatives from clusters are in a good position to understand the professional learning needs of the schools. The activities and initiatives taken by the COE serve as catalysts to promote learning communities within schools and clusters. Its AR initiative, its annual mathematics Sharing Day, its outreach through the e-portal and its workshops are targeted at fostering teachers' continuous learning and reflection.

Whilst TN champions the LC methodology, COE adopts AR as its strategy to promote teachers as reflective practitioners. Unlike the PDOs in TN that promote their LC methodology to schools, AR training is conducted by external agencies. Like TN, teachers' involvement in AR training is on a voluntary basis. Mathematics teachers are invited to attend such training if they are keen to use AR as one of the tools for their professional

reflection. Other than these external agencies, the COE does not have the capacity to provide its own follow-up continuous support to schools in their AR journey after the training. This is due in part to the nature of the COE setup where members are not full time staff.

The COE offers a spread of teacher-led sharing and training to cater for the different learning needs of its teachers. Teachers can learn about the varied classroom pedagogical practices from their fellow colleagues from different schools. This cross-pollination of ideas is actively promoted during the course of the sharing. There is also training on specific skills which are of interest to teachers. For example, a course on item calibration and item banking has been conducted by an external agency so that teachers can learn how to set quality Primary mathematics questions. Some courses are designed for the dissemination of pedagogical content knowledge. For example, teachers can learn specific knowledge through presentations by MME lecturers during the Sharing Day. But there is no active attempt to fully match schools' learning needs and the training that is organized during the Sharing Day. This difficulty is perhaps a natural consequence of COE's varied composition of schools within the East Zone and as such it is difficult to meet all their learning needs within a single platform.

iii. Impact on Teachers' Learning

In 2005, the COE engaged an external agency to conduct its AR training to 89 teachers from 23 primary schools and 21 secondary schools. As a follow up from the course, teachers implemented small scale projects relating to their areas of work. The completed projects which addressed specific issues in mathematics teaching and learning are housed in the COE e-portal. In a study of this training, Wong and Chua (2006) found that the participants had gained insights into the process of AR and most of the participants found that the AR training was useful and that they could apply it in their own schools to bring about work improvement. For example, a team from a primary school in teaching pie-charts did an AR

project on how to better engaged students in this topic. They used a mini survey activity with the students and asking them to compile data on their drinks preferences. The team found that students' interest and performance in this topic had improved as a result of this different approach to teaching the topic. The team members reflected that they had "gained insights into the thinking of their pupils" and that they had a closer bond with pupils (by engaging the passive students in lessons). This was a result of having a more relaxed classroom atmosphere because of the informal activities. Such an ownership of work problems and the capacity of teachers to reflect on their work issues are important learning outcomes which the COE is trying to propagate. There are also teams who reflected the value of working together as a team to solve a common problem. They also learnt to appreciate alternative views from members during the process of collaboration. These are essential attributes of learning communities which the COE hopes to create. To further increase the number of teachers initiated into AR, another workshop was organized in 2006 from March to September with 35 participants coming from six primary schools and 10 secondary schools.

Since 2003, COE has been organizing its annual Sharing Day. In each session, mathematics teachers from the East Zone are invited to share their best classroom practices. External partners such as NIE's MME department, AME (Association of Mathematics Educators) and the TN are also invited to give presentations on that day.

Table 3

Mathematics Sharing Day (2003 – 2006)

	Number of Teachers Attended	Number of Concurrent Sessions
2003	300	12
2004	439*	33*
2005	235	16
2006	210	22

* 2 sharings in 2004 because of the official opening of COE

Table 3 shows the number of participants and the extent of the sharing from 2003 to 2006. Although feedback from participants have always been positive, the extent of the follow up learning by teachers after these sessions have not been fully studied. A typical course evaluation form after each session only captures what the teachers had learned about the sharing at that point in time and the feedback about the presentation. But if learning is conceived as going beyond just picking up new techniques, then course evaluation may have to address questions like what exactly it is that they had learnt, what types of follow up that can be taken and to what extent had their conceptions of the topic changed after the learning. The subsequent reflection after the course is much left to the mathematics departments within their respective schools.

Although the e-portal is a platform for facilitating exchange of good teaching ideas and for serving as a springboard for innovation in classroom teaching, the number of teachers actively involved in online discussions in the 'Forum Board' link has not been significant given that COE serves 89 schools. This is reflected in the low number of online topics registering hits (only eight in 2006) at various levels. Perhaps this could indicate the teachers' reluctance to participate in such exchanges because of the lack of time due to other work commitments or that it is not a popular culture for teachers to engage in online mathematical discussions. Another possible reason (technical) is that the keying in of mathematical symbols and equations during an online discussion can be cumbersome and this may discourage teachers from contributing. Because of this lack of online collaboration, it is difficult to construe that the e-portal has spawned a virtual learning community for the zone. But this is not to be taken that teachers do not desire to share their teaching ideas. A total of 38 teaching resources have been uploaded in the Matell link within the e-portal and there has been at least 158 downloading of these resources by teachers. But it is difficult to describe the type of learning that takes place and the impact on classroom practice after a teacher has

downloaded a teaching resource. Like the AR workshop and the Sharing Day, there has been no comprehensive study on how the e-portal has impacted on teachers learning.

The COE also organizes workshops by teachers for sharing to a wider audience within the zone. In the 3 day workshop on Problem Solving and Fun Revision Strategies for Primary school teachers held on 24, 31 March and 7 April 2006, all participants reflected that they found the training useful and that they could apply the ideas gleaned for their teaching.

Similarly in another 2 day workshop on Assessment Strategies for Primary school teachers held on 12 and 19 April 2006, most teachers reflected that they could improve on their own scoring rubrics when setting their school assessment papers. But again, to what extent does such knowledge change teachers practice has not always been easy to fathom.

CONCLUDING REMARKS

Although there is no deliberate policy to create learning communities in mathematics education in Singapore, what can be inferred is that learning communities are growing as a result of a general policy towards teacher engagement in reflection and sharing. There is a move away from a centrally directed model of educational management towards one that encourages initiatives from the ground. Shanmugaratnam (2005) talked about the policy of a “bottoms-up approach with a top-down support” where teachers are encouraged to take ownership of workplace issues with support from the Ministry. Through this policy, a more thinking and learning culture can be encouraged and this is consistent with the TSLN vision. TN and COE are examples of groups created by the Ministry that help to fan such bottoms up engagement in workplace issues.

TN and COE by themselves are strictly not learning communities. They function more as activists of change for schools. They help to spawn learning communities within schools. TN has its LC methodology, its teacher-led workshop structure and its TN conferences. Its

activities touch across a range of subjects. It is not mathematics specific. Full time PDOs in TN serve as agents of championing the LC methodology. TN targets schools at the national level. It propagates its ideology of a LO approach towards teacher learning and development. The COE has its AR methodology, its annual Sharing Day programme, the e-portal framework, its support facilities and its teachers' workshops to meet the needs of schools in the East Zone. The COE targets specifically at fostering learning and innovation for mathematics teachers. Members of the COE are not full time staff. They are co-opted from schools and are representatives from different school clusters. Although significantly different in their setups, both TN and COE share some commonalities.

Participation in both TN and COE activities and programmes are on an invitational mode. They do not 'roll out' (make mandatory) their activities and programmes to schools. Instead schools are invited to join them in their journey to bring about teachers learning. Both endorse sharing across schools and actively encourage collaboration. TN's Teachers Conference and the COE's annual Sharing Day are examples. Both TN and COE recognize the need to archive good practices and they have taken steps in this direction. TN has its publications of teachers work and its e-portal repository. The COE has its e-portal archives of teaching ideas and the MATELL room which houses teaching artifacts contributed from schools. Above all, both share a passion towards promoting the non formal aspect of teacher training which is important because teacher learning is situated in communities. Besides self reflection, there is a need for teachers to have the desire to be part of a community of learners. It is important for teachers to extend the conversation about learning and collaboration beyond the close circle of their colleagues within the department. In partnering this aspect of teacher training, both the TN and the COE play important roles both as advocates of learning communities and as catalysts of change by giving teachers their different scaffoldings to build learning communities in schools. But how much of teacher

learning (and in particular, their learning in communities within their schools) is actually translated into improving or changing their classroom pedagogies so as to impact on students learning is not clear. However, it is clear that although training hours can be mandated, much of teacher learning is a complex and an individual experience and cannot be regulated. This is an area that would probably warrant further work.

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