A Model to Direct Online Continuous Professional Development Opportunities for Mathematics Teachers in the South African Context of Disparities

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Abstract
In a previous paper we reported on several personal and situational tensions which influence the use and value of a mathematics-friendly online discussion forum environment in pursuit of the Continuous Professional Development (CPD) of previously disadvantaged and advantaged mathematics teachers in the South African context of disparities. This paper builds on the preliminary contributions reported there by offering a strategic model that can be used by a Subject Advisor to firstly anticipate and secondly discover tensions that point at teachers’ real forum needs, thereby ensuring an online CPD strategy that is concomitant to the community for which the online forum is offered. The model is explained by way of a narrative walkthrough which also illustrates the practical usefulness thereof. Implications for existing theory are also offered. In a rapidly expanding and increasingly accessible technological environment, this paper provides a timeous foundation, benchmarks and pointers for future implementations of online forum discussion environments aimed at the CPD of not only mathematics teachers, but teachers in general.

Keywords: South African mathematics teachers, advantaged, disadvantaged, online Continuous Professional Development model, forums, personal tensions, situational tensions.

Introduction
The continual poor performance of South African pupils in the International Mathematics and Science Studies (TIMSS) has led to several significant policy changes in the last decade. Mathematical Literacy, for example, was introduced as recently as 2006 in the Further Education and Training Phase (DoE, 2003). Despite such policy changes, the South African government is first to admit that there is little evidence of any improvement in educational outcomes (DoE, 2006). Statistics from 2007 shows inequalities of outcome to continue to exist in the higher
Besides poor pupil performance, the TIMMS studies also highlighted the importance of mathematics teacher preparation, especially where it concerns teachers from previously disadvantaged communities. According to the TIMMS report, nearly half of the teachers surveyed reported they feel ill prepared to teach the content of the mathematics curriculum, while few teachers had significant experience. A lack of adequate preparation in terms of content knowledge has also left these teachers feeling poorly prepared to teach their pupils (TIMMS 1995). A recently released report on Grade 6 Mathematics lessons in Gauteng (Carnoy & Chisholm, 2008) reinforces these TIMMS findings with accurate figures and statistics. According to this report, in 2004, more than 50,000 teachers were considered under-qualified. Since the majority of teachers were trained in the now-disbanded teacher education colleges in a dispensation that did not equip them to teach the new curriculum introduced in 2005, only 5.4% of teachers were considered adequately prepared in their teacher training.

For these teachers, and given persistent policy changes, Continuing Professional Development (CPD) is a necessity. CPD is also known as further professional development, professional growth, in-service training, staff development and on-the-job training. Collectively these terms refer to an enduring process of professional development that occurs throughout a qualified teacher’s career (Webb, Montello & Norton, 1994). According to Knight (2002), CPD is needed because initial teacher education cannot contain all the proportional knowledge that is needed when a syllabus is altered or when positioning oneself for promotion or new responsibilities. The ultimate goal of CPD is to improve student learning outcomes (Guskey, 2003). With evidence surfacing that fewer new teachers are being trained (Carnoy & Chisholm, 2008), CPD opportunities are of great importance if the imbalances noted are to be addressed.

While the South African mathematics education research community has grown markedly since 1995 (see Vithal, Adler & Keitel (2005) for a reflection on the theoretical and ideological work that has been done in recent years), in-service initiatives to advance the status and teaching of mathematics in South Africa through CPD are largely limited to workshops and cluster meetings offered by the various Departments of Education. However, the usefulness of workshops or event-delivery models is debated by many authors such as Clark (2003), Guskey (2003) and Knight (2002). As Wiske, Sick & Wirsig (2001) summarizes, workshops are inclined to focus on general topics, are inattentive of teachers’ individual interests, are disconnected from specific classroom practices and are isolated from ongoing support. Other pertinent limitations identified by Becher (1999) are costs (rural teachers, in particular, are geographically dispersed) and variability in the quality and level of CPD provision. There is also evidence that cluster meetings are not popular, possibly as a result of the greater demands it places on teachers and Subject Advisors (Venter, 2003).

For these and other teachers, the sudden, rapid and dramatic advent of the World Wide Web (WWW) and its communication conduit, the Internet, with its multimedia capabilities, interactive tools and telecommunication facilities, seems full of potential as a catalyst for significant and sustained CPD activities. Accordingly, one very popular research route has focussed on the use of online discussion forums in an attempt to create ‘virtual’ communities of practice wherein CPD can occur (e.g. Carboni, 1999; Henderson, 2007; Shih, 2002).

A search of the literature has revealed that there exists a need for localized research that considers personal and situational factors (or ‘tensions’) as it impacts on the use and value of an online
discussion forum as a reflective tool for the CPD of mathematics teachers in the South African context of disparities. In a previous paper we have identified several such personal and situational tensions that points at teachers’ real (and thus forum) needs, and have offered some preliminary contributions (van der Merwe & van der Merwe, 2008).

Objectives of the paper
In this paper, we build on these preliminary contributions by directing our focus to the role of the Subject Advisor in online endeavours. In view of government’s commitment to provide all teachers with access to the Internet (Republic of South Africa Government Gazette, 2004), our specific objective is to propose a model that can be used by a Subject Advisor to firstly anticipate and secondly discover teacher tensions that may impact on online CPD strategies, thereby ensuring online CPD strategies are concomitant to the community for which the online forum is offered.

The rest of this paper is organized as follows. In the next section, building towards our model, we provide a concise background to the base study as it relates to our current objective. We also provide a list of the personal and situational tensions as discovered in the base study. For a clearer understanding of the tensions and how they contributed to and influenced our model, we direct the reader to the base paper. Thereafter, and based on our preliminary contributions, we present our strategic model for the online CPD of mathematical teachers, to be followed by a narrative, hypothetical walkthrough of the model. Before concluding this paper, we highlight the implications of our findings for existing theory.

Background to the base study and tensions discovered
Smiley and Conyers (1991), in reconceptualising CPD for teachers, called for a paradigm shift from learning separately and learning through replication (static learning) to learning together and practicing reflection (interactive learning). Barnett (1998) argues that teachers are often isolated from one another and there is a need for them to engage in inquiry and reflection, a viewpoint supported by Clandinin and Connely (1995) and Stein, Smith and Silver (1999). Reflection, communication with colleagues and the exchange of knowledge and ideas is the conceptual backbone of this paradigm shift. In supporting this viewpoint, the Norms and Standards for Educators (Republic of South Africa Government Gazette, 2000) state that reflective competence is one of three strands of competence required of all teachers. Such activities are, on face value, particularly suited to an on-line discussion forum environment.

Whereas much international research are done on sustainable and scalable online communities of education professionals, Schagler and Fusco (2003) note that for the most part those communities were created in isolation from the existing local professional communities within which the teachers practice. Hence professional development should be treated as a socio-organizational system. They furthermore argue there are socio-cultural preconditions that need to be considered to prevent “us from putting the cart before the horse” when developing online communities. Barab (2003) supports their viewpoint by arguing that a “virtual community” must evolve with a group, around their particular needs, and for purposes that they value as meaningful. While there has been much debate about what a ‘community’ is or is not (Grossman, Wineburg and Woolworth, 2000) we align ourselves firstly to Barab and Duffy’s (2000) description of a significant history, a shared cosmology, social interdependence, a common cultural and historical heritage, and a reproduction cycle; and secondly to Lave and Wenger (1991), who speaks of a ‘community of practice’ where participants share an understanding of what they are doing and what that means in their lives and for their communities.
The literature base reveals that there is a long way to go in understanding methods of effective practice with respect to the various impacts of such activities on teaching and learning (Lawless & Pellegrino, 2007). By providing a mathematics-friendly on-line forum environment to teachers where they can interactively reflect on their ‘community of practice’, our aim was to contribute to the literature base on technology professional development for teachers. By mathematics-friendly we mean the capacity to include expressions, should it be required, in forum posts. Our main purpose was to discover personal and situational tensions that impact on the use and value of such a forum as a reflective tool for the CPD of advantaged and disadvantaged teachers in South Africa context of disparities.

We provide a brief summary of the qualitative research approach and methodology employed to avoid ambiguity. Two groups of Grades 5-7 teachers, one from a historically disadvantaged and one from a historically advantaged background and environment, were separately provided with Internet-ready computers and Internet access from home and tasked to reflect on their practice in the forum, thereby providing opportunities for collegial interaction and growth through a bottoms-up approach to community formation and participation in pursuit of CPD.

Small subject pools (see Table 1) forced a descriptive case study approach. For data analysis we employed selected techniques from Grounded- and Activity-Theory that focused on the decomposition and interpretation of data collected from semi-structured interviews, server logs, teacher- and our own research-diaries kept throughout the study, the nature of the posts made to the forum, and a focus questionnaire to confirm certain themes that arose from the data. Triangulation across various techniques of data collection provided multiple perspectives (data views), supplied more information on emerging concepts, allowed for cross-checking, and yielded stronger substantiation of constructs (Orlikowski, 1993).

In analysing the data we firstly used Grounded Theory techniques to code and open the data in order to identify emerging concepts within each case. These concepts were then grouped together in categories of best-fit. The relevant categories that emerged were then used to identify sub-cases or ‘Activity Systems’ within each case. Activity Theory (Engeström, 1987) is particularly suited as a theoretical framework to follow when context is acknowledged. This study was underpinned by the philosophy that participation in social organizations (e.g. families, communities, institutions or other informal collectives) provides for a complex set of interactions from which we cannot extricate ourselves, were we are simultaneously affected by our social environments while, at the same time, we participate in their creation (Little, Allistair and Preiebe, 1991). These Activity Systems were ‘decomposed’ separately within its framework of subjects, rules, community, division of labour and the objects and goals by way of a chronological report in rich narrative format. An attempt was made to interpret the decomposed data by identifying and describing the Activity System’s components and possible tensions that existed in and between components. Thirdly, connections between categories, its concepts and Activity Systems were integrated as part of the interpretation phase – bringing meaning and coherence to the categories, developing linkages between tensions identified and making sense of data collected. In this endeavour lied additional purposes of confirming existing or indentifying other tensions that may resolve or exaggerate the tensions already identified.

The advantage Activity Theory brought to the study lies in the generalizability of the results. As Miles and Huberman (1994) points out, a case study is not necessarily singularly monolithic. A single case may have many sub-cases embedded within them, which may offer an even deeper understanding of processes and outcomes of cases and a good picture of locally grounded
causality. Our use of the Activity Theory framework was aimed at identifying such sub-cases in context.

Several tensions were identified in various Activity Systems discovered amongst the two groups. Using Riel and Levin’s (1990) schematic framework for describing network communities, Table 1 tabulates the group profiles, features and tensions associated with the two cases.

**Table 1:** Profiles, features and tensions associated with the disadvantaged and advantaged groups

<table>
<thead>
<tr>
<th>Structure</th>
<th>Disadvantaged Group</th>
<th>Advantaged Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization of Network</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of groups</td>
<td>9 teachers, 8 active participants</td>
<td>7 teachers, 5 active participants</td>
</tr>
<tr>
<td>Physical location of active teachers</td>
<td>7 teachers from Mamelodi Township (middle to lower class community) 1 teacher from Laudium, an Indian community (higher to middle class community) 1 teacher from Pretoria Central (middle to lower class community)</td>
<td>2 from Pretoria East (higher class community) 2 from Pretoria North (higher to middle class community) 1 from Pretoria Southwest (higher to middle class community)</td>
</tr>
<tr>
<td><strong>Level of Education</strong></td>
<td>7 Diplomas, 1 Degree</td>
<td>1 Diploma, 4 Degrees</td>
</tr>
<tr>
<td>Common experience</td>
<td>All active Cluster Meetings participants Grade 7-9 phase mathematics teachers</td>
<td>All active Cluster Meetings participants Grade 7-9 phase mathematics teachers</td>
</tr>
<tr>
<td><strong>Level of PC/Internet Literacy</strong></td>
<td>1 literate, 7 illiterate</td>
<td>5 literate, 1 illiterate</td>
</tr>
<tr>
<td>Professional relationship to one another</td>
<td>Reflect, exchange information, share ideas</td>
<td>Reflect, exchange information, share ideas</td>
</tr>
<tr>
<td>(vertical or horizontal)</td>
<td></td>
<td>Horizontal</td>
</tr>
<tr>
<td><strong>Tensions associated with Network Task Organization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>DAS2: What to Post (P,F)</td>
<td>T1</td>
</tr>
<tr>
<td><strong>Tensions associated with Response Opportunities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>DAS1: Creating Internet Accounts (S,F)</td>
<td>T3</td>
</tr>
<tr>
<td>T6</td>
<td>DAS2: A busy life (P,NF)</td>
<td>T4</td>
</tr>
<tr>
<td>T2</td>
<td>DAS1: Connection Problems (S,F)</td>
<td>T3</td>
</tr>
<tr>
<td>T3</td>
<td>DAS1: Lack of Suitable Support Structures (S,F)</td>
<td>T2</td>
</tr>
<tr>
<td>T5</td>
<td>DAS2: Financial Factors (Sh,NF)</td>
<td>T7</td>
</tr>
<tr>
<td>T7</td>
<td>DAS2: School/Township Related Issues (S,NF)</td>
<td>T11</td>
</tr>
<tr>
<td><strong>Tensions associated with Response Obligations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T8</td>
<td>DAS2: Quality of Participation (P,F)</td>
<td>T5</td>
</tr>
<tr>
<td>T10</td>
<td>DAS2: Lack of Motivation (P,F)</td>
<td>T7</td>
</tr>
<tr>
<td>T3</td>
<td>DAS2: Lack of Fervour (P,F)</td>
<td>T9</td>
</tr>
<tr>
<td><strong>Tensions associated with Coordination and evaluation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T12</td>
<td>DAS2: Leader Required (S,F)</td>
<td>T6</td>
</tr>
</tbody>
</table>

**Key:** T1|DAS1: Name of Tension (e.g. first tension (T1) identified from Disadvantaged Activity System 1 (DAS1)) P=Personal tension, S=Situational tension, Sh=Shared (Personal and situational tension), F=Forum-related tension and NF=Non-Forum-related tension.

An in-depth review of these tensions led us to the following preliminary contributions as it relates to our current objective:

1. Participation by mathematics teachers in an online forum in pursuit of the CPD is influenced by several forum- and non-forum-related tensions, the sources thereof either
personal or situational with some sharing both sources. Situational tensions result in many of the personal tensions found. The impact of these tensions has the ability to destabilize an online forum and may prevent CPD goals (such as reflective practices) from being reached.

2. Disadvantaged teachers generally face more tensions than advantaged teachers. Although some tensions were shared (e.g. the tensions “quality of participation” and “a busy life”), they had different sources and impacted at different levels. For example, where disadvantaged teachers were reliant on time-consuming public transport to get to and from cluster meetings, all advantaged teachers owned faster private vehicles. Therefore the rules, the object, and the goal of the forum should be specific to communities.

3. Forum tensions are closely associated with the real (and thus forum) needs of teachers, which are different for homogenous communities. If these needs are not resolved, tensions result. These needs must therefore be discovered.

4. Given the nature of the tensions that exists, a Subject Advisor is best positioned to fulfil these forum needs by selecting an appropriate online CPD strategy.

Note the assumption is that all teachers have access to the Internet. In the next section, which provide the focus of this paper, we build on these preliminary contributions by offering and explaining a model that can be used by a Subject Advisor to firstly anticipate and secondly discover tensions that point at teachers’ real forum needs, thereby ensuring an online CPD strategy that is concomitant to the community for which the online forum is offered.

A model for successful online CPD of teachers in the South African context of disparities

The model we offer here is based on our interpretation of the tensions identified. While our focus has been on mathematics teachers, the nature of the tensions identified suggests that the model is equally valid for teachers in general, although more research is required to confirm this. As suggested by the nature of the tensions, there is one important proviso to the use of this model: an online forum environment in pursuit of CPD cannot be shared between heterogeneous communities, except if the object is interaction between such communities. ‘Heterogeneous’ is defined along diversity rather than advantageousness, with diversity referring to factors such as rural or urban, level of education, level of PC-literacy, training requirements and ease of access to the Internet. Combined, these factors may incidentally reflect the level of advantageousness, which is contextual.

Key flow processes of the model

The preliminary contributions identified in the base study suggested several key flow processes that guided the development of the model. These processes are:

1. A preliminary object and goal is defined. It is considered preliminary since the object and goal themselves may also contribute to tensions, given a particular subject and community profile.

2. A subject and community profile is drawn in order to anticipate tensions that will impact on teachers forum needs. This profile is drawn by answering several questions related to the setting of the group (urban or rural), the socio-economic class of the area wherein teachers practice, the teachers’ level of education, their general level of PC-literacy, their training requirements and whether they have ease of access to the Internet. Other sources are dependent on what is available to the Subject Advisor. For example, his/her experiences from cluster meetings, year reports from headmasters, past teacher evaluations and relevant research reports may offer more insight into the profile. The
‘tensions’ discovered in this manner provide insight into teachers’ anticipated forum needs.

3. These anticipated forum needs may well require a redefinition of the initial object and goal. Since the ensuing object and goal may result in further tensions, a first ‘inner’ cycle is run in order to ensure a fit between the ensuing object and goal, the subject and community, the (latest) anticipated tensions and teachers’ (latest) anticipated forum needs. This cycle is repeated until the Subject Advisor is comfortable with the balance of elements of this first inner cycle.

4. Based on the result of this first inner cycle of anticipated needs, a set of rules, division of labour and tools is created, which presents the growing CPD strategy.

5. Once implemented, the growth of the online community is evaluated. Here we suggest a combination of elements of success in professional development programs as identified by King (2002) and elements of a model proposed by Grossman, Wineberg and Woolworth (2000) that aims to provide schematic markers of community formation, i.e. whether a community is in a beginning, evolving or mature phase. These elements provide a useful starting point to evaluate the current level of community formation and to discover additional tensions. These elements are not fixed, and our current suggestions for evaluation elements to be considered are the group identity, the norms for interaction that arises from participation, the depth of interaction and dialogue that takes place, the trust, responsiveness and insight shown by teachers, and the use of the (appropriate) technology employed.

6. The real forum needs discovered may once again force a redefinition of the object and goal. A second inner cycle is initiated where the ensuing object and goal is firstly redefined, which starts a new cycle that aims to discover teachers’ real (or current) forum needs.

These key flow processes are contained in our model which is presented in Figure 1.

The model is cyclic in nature, allowing a Subject Advisor to initiate the process but also allowing space for a bottom-up approach to community formation where teachers’ real needs ultimately dictate the appropriate CPD strategy to follow. This does not imply that teachers force the CPD strategy. Rather, the model recognizes that a chosen CPD strategy may not suit the immediate needs of teachers, which give rise to tensions. If these needs are not met, the chosen CPD strategy is bound to fail. For this reason, the model refers to a “growing CPD strategy”.

Since context is complex, there is considerable disagreement in the literature on what constitutes a successful online community. Determining the level of growth that occurs within a community over a period of time, as the model proposes, provides a more robust and reliable benchmark of the success of that online community since such evaluation is based on the community’s specific and contextual needs.

To practically explain and illustrate the usefulness of the model, we provide a narrative walkthrough in the next section.

Figure 1: A model for successful online Continuous Professional Development of teachers in the South African context of disparities

- Urban or rural
- Middle, lower, high class area
- Level of education
- PC-literacy
- Training requirements

Consider the subjects and their community
A narrative walkthrough of the model

Assume the Subject Advisor (SA) for mathematics wishes to make use of the forum environment to stimulate discussion and reflection about Outcomes-Based Education (OBE) in the Senior Phase. This presents the preliminary object of the forum, the goal being for teachers to become more confident with the OBE approach.

The SA’s target community is Grades 7-9 mathematics teachers from disadvantaged schools in the Gauteng North area. In drawing up a subject and community profile, the SA relies on his/her experience from working with these teachers and schools, and also decides to review current research that has been done on OBE in South Africa.

For example, the SA considers the following issues as identified in a recent research project by Velupillai (2006) who did an investigation into how South African mathematics educators teach the outcomes-based curriculum:

- Teaching materials were either non-existent or insufficient for addressing specific outcomes;
- A lack of textbooks and resources;
- No calculators or mathematical instruments are available;
- May classrooms do not have enough desks and benches, which may hinder the achievement of the outcomes;
- Regarding the teaching resources, in most of the classes very little has changed after introduction of Curriculum 2005;
- The actual planning of lessons show little improvement;
- There are gaps in the educators’ content knowledge with some teachers not confident in their subject matter.
From experience the SA also knows that:

- The majority of schools are located in or close to urban areas;
- The general socio-economic statuses of the areas teachers teach in are lower to middle class;
- The level of education of teachers is low, with few holding degrees;
- The classrooms are overcrowded;
- PC-literacy levels are low, while only about 50% of the schools in the areas have functioning computer laboratories.

All these issues present potential sources for tensions. The SA anticipates the following plausible tensions:

- Not all teachers will have access to the forum, and those that do probably have a low level of PC-literacy;
- The general lack of resources, textbooks, teaching material and mathematical instruments presents a major source of tensions that will probably dominate discussions;
- Teachers’ lack of content knowledge will detract from the value of the discussions;

The SA realizes that many other tensions possibly exist, but unsure what these are, he/she anticipate teachers’ forums needs to centre around training in using the forum, a need for OBE material and guidance, OBE approaches fitted to the urban character of schools, and active leadership by herself.

Given these anticipated needs, he/she realizes that the goal should probably change from “teachers being confident with OBE approaches” to “fitted OBE approaches”. Reconsidering the subjects, the community and the anticipated tensions that result from his new goal, he/she comes to the conclusion that a best fit is achieved given what he/she knows and understands.

Based on the anticipated forum needs, he/she needs to define the rules, division of labour and the tools required. He/she considers the following:

- Teachers that have access to the forum will require exact guidelines and a basic PC-literacy workshop focusing on the use of the forum;
- Headmasters of schools with computer laboratories will have to buy into the strategy to ensure support for teachers wishing to make use of these facilities;
- A blended approach is required. He/she will make use of the forum and printed material to reach all teachers. In particular, he/she will distribute a monthly manual with content, guidelines and exercises for teachers that focus on the urban and socio-economic character of the schools. He/she tailors an initial learning programme that makes use of examples which both teachers and pupils can identify with, and which in subsequent issues takes into consideration the forum discussions generated by teachers. These manuals are posted to all schools, meaning that teachers who do not have access to the forum can share in these discussions. He/she also collects inputs from these teachers, which is posted on the forum by her assistant for other teachers to respond to.
- Given the general lack of teaching materials, textbooks, mathematical instruments and over-crowded classrooms, he/she decides to focus on group work techniques in OBE;
- He/she asks teachers to make use of the exercises provided in the first manual, and to provide specific feedback on what works and what does not work.

The SA now defines the rules, division and labour and tools, which present his/her CPD-strategy:
• **Rules:**
  o Teachers: attend workshops, work through material, report back on forum or written report; group work focus.

• **Division of labour:**
  o Subject Advisor: Prepare OBE material, run workshops, leadership in forum;
  o Teachers: As above in rules;
  o Headmasters: Ensure laboratory access;
  o An appointed Subject Advisor assistant: Manage written reports.

• **Tools:**
  o Workshops, OBE material, forums, written reports.

The SA implements this strategy, initiating workshops in preparation for the launch of the forum environment, where teachers with Internet access receive training in the forum environment. He/she also uses the workshops to relay the CPD strategy to teachers.

After two months of implementation, he/she evaluates the online community and recognizes that while teachers are actively involved, the depth of interaction and dialogue that takes place is relatively shallow. Discussions focuses largely on disciplinary problems in class, while a large number of posts and written reports contain questions about the exercises.

He/she discovers two additional tensions: group work leads to disciplinary problems and teachers demonstrate a lack of independent reasoning in applying the exercises, which is carried over to learners and possibly results in the disciplinary problems. It is apparent that teachers’ current needs are leadership on how to handle disciplinary problems, and how to reason independently. Knowing teachers’ real needs, he/she changes the object to discussions on group work, disciplinary problems and independent reasoning. The goal is better classroom practice wherein OBE can occur. In this process, a new cycle is initiated, which may very well create a different set of tensions, needs and an adapted CPD strategy.

The value of such an approach is seen in the implications this model holds for existing theory.

**Implications for existing theory**

With specific reference to mathematics teachers, the proposed model holds several implications for existing theory. Clarke (2003), after an intensive review of the research literate, listed several key principles that correlate with professional growth of mathematics teachers. These key principles (in italics) are embodied in the proposed model, as follows:

1. **Addressing issues of concern.** The model allows for a bottoms-up approach to community formation with context the driving force. Context largely dictates the online CPD-strategy that needs to be followed since it is the context that gives rise to tensions that determine teachers’ real forum needs. The results and model developed confirm this principle as seen in the requirement to determine teachers’ real needs.

2. **Groups of teachers and links to school administration and community.** Whereas the current study made use of cluster teachers, allowing for some form of community to exist before participation in the forum, the proposed model underscores the importance of homogenous groups of teachers participating in a forum as opposed to heterogeneous communities. There cannot be a single strategy for all communities since tensions and needs are remarkably similar within a specific community. Our previous study not only
confirmed the needs teachers had for links to administrative procedures, but is inherent in
the model which allows for links to school administration and community.

3. **Addressing impediments.** At the centre of the model is the recognition and addressing of
impediments to CPD (here impediments are the tensions identified).

4. **Modelling classroom practice.** Intended to mean “using teachers as participants in
classroom activities”, the model never removes classroom practices from its vision.
Rather, the model invites a consideration of classroom practice and needs by considering
the context of participating teachers.

5. **Soliciting commitment.** If teachers’ needs are addressed, then commitment is ensured. A
bottoms-up approach also invites commitment since teachers’ needs are addressed.

6. **Validating new approaches through classroom practice.** The model attempts to validate
new approaches through classroom practise, leading to the discovery of needs that not
only validate the approach, but adds to it.

7. **Time for planning, reflection and feedback.** These principles are built into the model. In
fact, it encapsulates most elements of the model. For example, a SA plans a new strategy,
implements it, reflects on the feedback received and replans if necessary.

8. **Ownership.** In following a bottoms-up approach, ownership is inherent in the model.

9. **Change is gradual and difficult.** The need for regular evaluation of the level of
community formation testifies an adoption of this truism. There are no quick-fit or quick-
fix solutions, hence the need for and value of cyclic model.

10. **Setting future goals.** Build into the model where goals are open to redefinition when
tensions arise and teachers’ real needs are discovered. The setting of goals is closely
linked to progress, that is, fewer tensions points at progress.

The current research and model thus not only confirms these key principles, but extends its
application from general CPD efforts to online efforts.

The model also adds to the theory on online CPD. As supported by the results, context plays an
important role when an online forum environment is offered to teachers. This context largely
dictates the online CPD-strategy that needs to be followed since the context gives rise to tensions
that determine teachers’ real forum needs. These tensions may lie within the forum environment
or outside the forum environment but cannot be separated because there is an order to tensions
that give rise to needs. Since these tensions differ for disadvantaged and advantaged
communities, it follows that an online CPD-strategy must be linked to a targeted community.
There cannot be a single strategy for all communities since tensions and needs are remarkably
similar within a specific community.

The presence of a facilitator as a key component in online interaction is recognised throughout
the literature (Ahern, Peck & Laycock, 1992; McMahon, 1997; Romiszowski & de Haas, 1989;
shift from traditional approaches to CPD occurs whereby data to inform CPD strategy is collected
within a naturalistic environment as opposed to controlled environments. Assessment is
conducted by a consideration of the context of users (subjects, community, rules, and division of
labour) and the tools employed. There is a shift away from knowledge storage to knowledge
construction, with users being active partners in the CPD process and the Subject Advisor
assumes the role of active manager with his/her main role to lie mainly in resolving many of the
tensions that arise when teachers’ needs are not addressed.

Casey (1994) and Spitzer & Wedding (1994) proposed that the nature of online discussion may
promote reflection. Our model proposes that reflective practises will only arise when teachers’
real (forum) needs have been satisfied. Unfulfilled needs result in a shift of focus away from reflective practises, suggesting that reflective practises should be considered a higher-order need that is only achieved when lower-order needs are fulfilled.

**Conclusion**

In a rapidly expanding and increasingly accessible technological age, the Internet will undoubtedly play an ever increasing role in CPD activities. The significant and continual increase in research efforts aimed at exploring the role and contribution of the WWW to all levels of education over the last two decades bears testimony to this certainty. Our series of research studies therefore provides a much needed foundation, benchmarks and pointers for future implementations of online environments aimed at the CPD of South African mathematics teachers.

Our research has established that teachers are subjected to personal and situational tensions that impact on the value and usefulness of online CPD efforts. The model we proposed not only assists a Subject Advisor in the identification such tensions in context, but guides his/her online CPD strategies.

The model holds several implications for existing theory, best summarized in the identification of a need for a bottoms-up approach to online-CPD. A secondary contribution of our research lies in the insight it offers into the challenges teachers from different communities experience at grass-roots level. It is not about what these tensions are - is about acknowledging and recognising that there are tensions, and that these tensions differ between communities. Should the evidence produced here be embraced by Departments of Education and Subject Advisors, concrete steps can be taken to support mathematics teachers in their important task as educators.

Finally, although we are confident that our model is grounded in our data, it is our intention to test and possibly refine the model by with a Subject Advisor and a larger group of teachers.

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