

LEARN 2.0 TECHNOLOGIES AND THE CONTINUING PROFESSIONAL DEVELOPMENT OF SECONDARY SCHOOL MATHEMATICS TEACHERS

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Abstract

The paper reports on a Learn 2.0 technology that was used to support the continuing professional development of mathematics teachers at a secondary school. Design Based Research methods were used within a Multiphase Mixed Methods research framework to create professional development opportunities that were subsequently monitored by Social Network Analysis techniques. We demonstrate that Learn 2.0 technologies can indeed support the continuing professional development of teachers and improve their performance, and also that Social Network Analysis is an effective method to describe, comprehend, clarify and transparently monitor teacher engagement during online professional development activities. We identify 'participation' as a key pre-determinant to success.

Keywords: Social Network Analysis, Learn 2.0 technologies, continuing professional development, professional development activities, personal development networks, development networks, Multiphase Mixed Methods research designs, Web 2.0 technologies

1. INTRODUCTION AND BACKGROUND

South African education is in crisis (DBEHET 2011). As teacher knowledge and skills are considered critical factors that impact on learner performance (Papastamatis et al. 2009), it is imperative that continuing teacher development should be prioritised by educational authorities. Continuing professional development refers to a process whereby teachers participate in formal and informal professional development activities in order to improve their own performance, and subsequently also the performance of their learners (DBEHET 2011; Department of Education 2001; Department of Education 2007). Therefore, the continuing professional development of teachers should be monitored.

To this end, the Integrated Quality Management System (IQMS) was implemented by educational authorities in 2004; it monitors the continuing professional development of South African teachers. This system has been crippled by the lack of an efficient method to monitor participation in professional development activities. We nevertheless argue that teachers are also not offered sufficient opportunities to engage in professional development activities to improve their knowledge and skills. Therefore, a gap in practice is created.

This gap can be overcome by the implementation of Web 2.0 technologies¹. In fact, it is recommended in several policy documents that teachers should be encouraged to experiment with new technologies to enhance their performance (DBEHET 2011; Department of Education 2001; Department of Education 2004; Department of Education 2007).

This paper reports on research that was undertaken on the continuing professional development of mathematics teachers at a secondary school in Gauteng (Van Staden 2012). It demonstrates how the use of Learn 2.0 technologies can enhance the performance of the teacher of the 21st century. It also demonstrates that Social Network Analysis can provide an effective method to monitor and enhance continuing professional development, as well as highlight the negative impact of nonparticipation on own work and the work of groups and communities. Therefore, we argue that commitment to a coordinated strategy that responds to teachers who do not perform adequately is also needed to avoid getting caught up in an education reform cycle.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

The research was rooted in perspectives on Social Network Analysis as a strategy to support the continuing professional development of teachers. Social Network Analysis includes concepts and information about the relationships that intertwine social units, and is therefore characterised by relationship-related theoretical concepts, relationship-relevant data and the use of critical tests to investigate the distribution of relationship characteristics to better understand the phenomenon under the spotlight (Wasserman & Faust 1999). According to Wasserman and Faust, the emphasis placed on individual behaviour in the social structure, and on the response of the structure to the individual, is useful to clarify individual behaviour.

Moreno (1934) is considered the architect of Social Network Analysis. He developed a pen-and-paper method to visualise the invisible, underlying social structures intertwining the subjects he studied, and referred to them as sociograms. Today, specialised software such as Krackplot and Ucinet are used to visually draw social networks. The concept social network was coined in 1954 when Barnes needed to refer to the set of social ties intertwining the inhabitants of a Norwegian island parish (Barnes 1954). Social Network Analysis developed over a period of 80 years into a powerful method in diverse research fields, such as political sciences, sociology, social psychology and mathematical sciences. It provides the knowledge, tools and techniques to understand, describe and predict human behaviour. Despite this, a literature review showed that Social Network Analysis only recently entered the educational research field (Van Staden 2012).

¹Social network environments similar to Facebook, Ning and Twitter, which allow its users to interact with one another.

According to Schlager et al. (2009) the interest in this approach was prompted by the absence of an efficient method to understand, explain and predict what happens in online networks. Currently, Social Network Analysis provides both a theoretical perspective on human interaction and a method to understand, predict and explain what happens in online networks (Schlager et al. 2009). Social Network Analysis furthermore offers a theoretical knowledge base for creating assumptions regarding a specific social phenomenon. These assumptions can be investigated by using the measures developed to analyse and interpret social networks.

Four assumptions underpin this research. The first assumption is that the personal development networks of teachers can be studied to understand and predict the effectiveness of their work. This assumption is based on research done by Sweitzer (2009), who identified a set of three social ties (expertise, support and leadership) that doctoral students rely on during their studies. She referred to them as development networks and found that the difference between their development networks predicted the completion of their studies. From a Social Network Analysis perspective, such a set of social ties can be referred to as a personal development network (Van Staden 2012). Teachers also rely on their personal development networks to enhance their performance, but theirs consist of a set of seven social ties, namely those used to get access to the knowledge, information (Cole 2008; Cross & Parker 2004), advice (Sweitzer 2009; Ryymin, Palonen & Hakkarainen 2008), leadership (Warfield 2009), support (Meister 2010; Duncan-Howell 2010; Sweitzer *ibid*; Fox & Wilson 2009; Pittinsky 2005), experience and concrete sources available in their working environments (Van Staden *ibid*). A literature review shows that a lack of one or more of these sources has a remarkable effect on the work of teachers (cf. Van Staden *ibid*).

The second assumption was that the social ties between people can be considered the building blocks of the social environment (Borko, Jacobs & Koellner 2010). Participation in professional development activities does not happen in isolation, therefore the personal development networks involve teachers in larger social networks. According to Wellman and Hampton (1999), social networks create opportunities and mobility to bridge the constraints of single networks to get access to sources needed. Therefore, many Social Network Analysis researchers believe the successes and failures of organisations to be determined by their internal structural patterns (Borko et al. *ibid*). According to Veugelers and Zijlstra (2002), the networks in schools provide opportunities to be part of a larger school community. We refer to such a learning environment (social network) as a development network. The development networks hold the key to monitoring the continuing professional development of teachers since the activities and attitudes of the teachers can be best explained in terms of their positions in their development networks (Van Staden 2012).

The third assumption is that Web 2.0 technologies², such as social network environments, can be regarded as social networks since they consist of a number of users (social units) and the techno-supported social ties between them. Firefly Global Qualitative Research found that the interest in social network sites is sparked by a need to belong, to be connected, to be entertained and to create own content, as well as a need for variety (MillwardBrown 2010). Redecker, Ala-Mutka and Punie (2010) coined the concept Learn 2.0 technologies to refer to learning opportunities made possible by the use of Web 2.0 technologies to enhance learning, education and training. They reasoned that Learn 2.0 technologies could support lifelong learning. According to Redecker et al. (ibid), Web 2.0 technologies develop into Learn 2.0 technologies if they provide users with opportunities to create their own content, to get access to content, to collaborate and to connect to one another. We reason that these four dimensions of Learn 2.0 technologies can support the building of personal development networks, and vice versa, and therefore they are regarded as criteria for evaluating the effectiveness of Learn 2.0 technologies.

Finally, Social Network Analysis offers an effective method to monitor the continuing professional development of teachers. The right connections in well managed social networks have a visible impact on performance, learning and innovation (Cross & Parker 2004). According to Schlager et al. (2009), social networks are defined by their structure (evolving social ties between members and sub-groups) and the activities of the members (using tools and technologies to reach a goal). Therefore, the context of the teacher – or the social ties between the teachers – forms the basic unit of analysis. The intuitive premise here is that the patterns formed by the social ties display important aspects in the lives of the individuals (Freeman 1996). Social Network Analysis provides a powerful method to monitor the continuing professional development of the teachers and makes available the knowledge, tools and techniques needed to analyse and interpret these patterns. An analysis of the development network at a specific point in time can provide teacher leaders with information to understand and predict the performance of teachers. This future-oriented perspective enables timely provision of sufficient professional development activities to enhance the performance of teachers. However, the development network evolves as soon as new social ties are formed or old ones disintegrate. Therefore, consecutive Social Network Analysis studies can supply relevant, reliable information to monitor the continuing professional development of teachers in a transparent manner (Van Staden 2012).

This paper now reports on the design and development of a Learn 2.0 technology to enhance and the monitor the continuing professional development of a group of teachers in a transparent manner.

²Web 2.0 technologies that can be used to support networking.

3. A MULTIPHASE MIXED METHODS DESIGN

The primary aim of the research was to monitor the continuing professional development of the teachers and reaching this aim depended on relevant and reliable information. Therefore, a secondary aim was set, namely to provide teachers with sufficient opportunities to participate in professional development activities. The following questions were formulated to guide the research:

- 1) *How can teachers be provided with sufficient opportunities to participate in professional development activities?*
- 2) *How can participation in the continuing professional development activities be monitored?*

The first question could have been addressed by a Learn 2.0 technology, but the available social network environments in 2010, such as Facebook and Twitter were not adequate for this purpose since they did not allow the sharing of documents. This barrier was addressed by the application of Ning³, a social network platform allowing designers to design and develop their own, personalised social network environments. Social Network Analysis provided the knowledge, techniques and tools to address the second question. Our pragmatic worldview was complemented by a Multiphase Mixed Methods framework, which allowed for the integration of various methods to focus on the central purpose of the research.

Multiphase Mixed Methods helped the researchers to address a set of research questions to focus on the central purpose of the research (Creswell & Plano-Clark 2011). We integrated Design-based Research methods during the various phases of an overarching Multiphase Mixed Methods framework to provide the teachers with sufficient opportunities to participate in professional development activities, while Social Network Analysis techniques were integrated during the planning and monitoring phases to monitor the continuing professional development of the teachers (see Figure 1). This framework allowed the integration of qualitative, quantitative and network data⁴ to facilitate the development of a Learn 2.0 technology, as well as the monitoring process.

³A social network platform for creating own social network platforms.

⁴Network data are data about the presence and absence of social ties between pairs (relationship-related) and might be quantitative or qualitative. Thereafter the data are quantified to be read into special software to analyse the data.

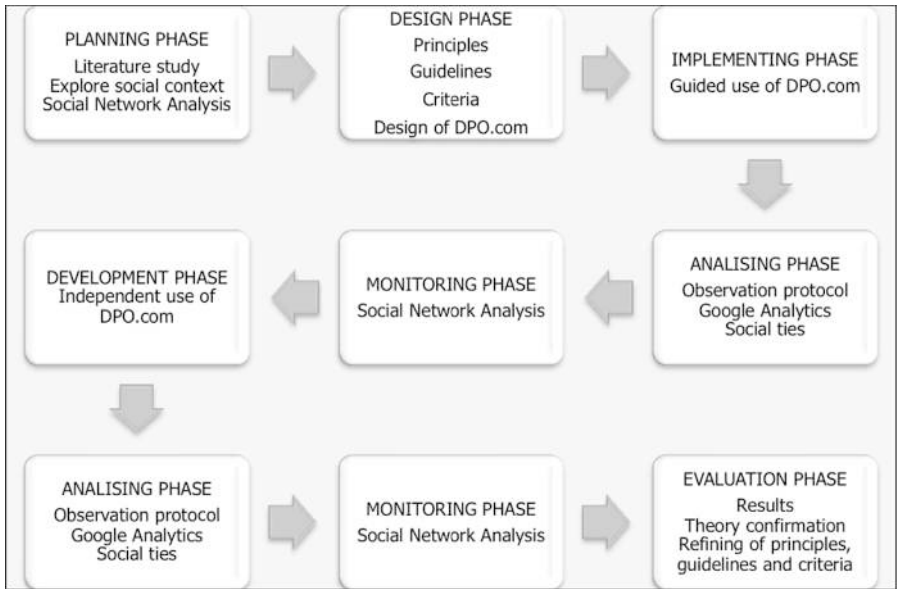


Figure 1. Multiphase Mixed Methods Framework

Twelve mathematics teachers at a secondary school in Gauteng were identified through purposeful sampling; they participated voluntarily. We argued that the development of the Learn 2.0 technology was dependent on the computer skills of the participants, their willingness to embrace technology to enhance learning and their access to the internet. The participants used technology in their classrooms and internet access was provided by the school. The research report was written in Afrikaans, therefore it was convenient that the participants were all Afrikaans mother tongue speakers. They were well qualified (see Figure 2A) and heterogeneous with regard to experience as mathematics teachers in this specific department (see Figure 2B). In this paper, we refer to each of the participants by a pseudonym.

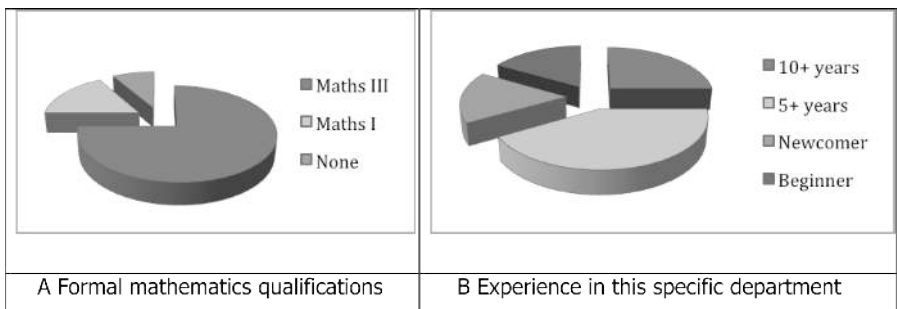


Figure 2A and B Qualifications and experience of the participants (2010)

They met weekly to monitor their progress. Tanja, who was the head of department, was frustrated because some of the teachers seldom attended meetings due to other responsibilities. She envisioned the weekly meetings as learning opportunities, but this did not happen. As social network environments can support both synchronous and asynchronous collaboration, we proposed the use of a Web 2.0 technology to replace the weekly meetings. Tanja indicated that she would use the meetings to invite outsiders and colleagues to share knowledge and expertise and the minutes would be shared online.

During the planning phase, the teachers were requested to respond to three questions and rate themselves on a scale of 1 to 5, where 1 represented low or no response, and 5 represented a high or positive response (see Figure 3).

- My knowledge of social network sites. [knowledge]
- Can a social network site enhance my performance? [attitude]
- I am using social network sites to enhance my performance. [usage]

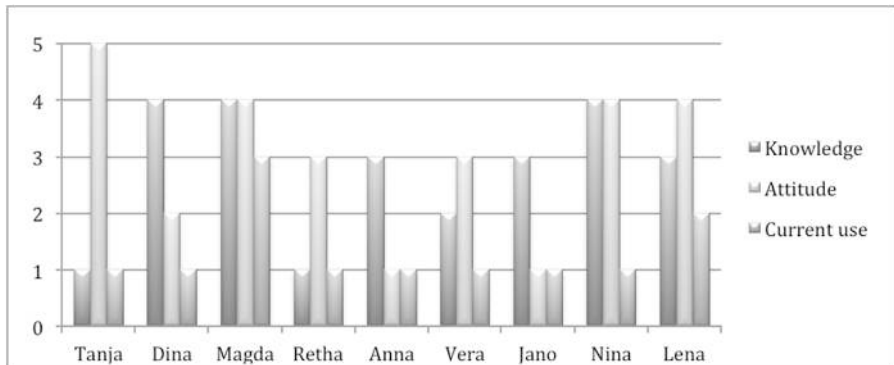


Figure 3 Knowledge, attitude and usage of social network sites (before 21/03/2010)

The figure shows that only two respondents (Tanja and Retha) had no knowledge of social network environments, and that only one teacher (Lena) had used it once for professional development. The majority of the respondents indicated that they believed that social network environments could improve their practice (Wilma, Freek and Steyn did not return their questionnaires).

The results of the Designed-based Research and the Social Network Analysis will now be described separately (see paragraphs 4 and 5).

4. DESIGN AND DEVELOPMENT OF DPO.COM⁵

The secondary aim of the research has been to provide opportunities for teachers to participate in professional development activities. The teachers participated in the development of the Learn 2.0 technology, referred to in this paper as DPO.com. The guidelines, criteria and principles for the development of DPO.com were identified during the planning phase (Van Staden, 2012) and are now described.

4.1 Design, implementation and development of DPO.com

The design and development of DPO.com was guided by design principles generated by using Design Based Research methods and integrated during consecutive phases of the overarching Multiphase Mixed Methods framework. Thereafter the social networking tool Ning was used to design DPO.com.

DPO.com was implemented at the end of the first term of 2010. The participants were instructed to use it once a week to create their own content, to get access to content, to collaborate and to connect to one another to enhance their performance. They were also instructed to use DPO.com to create proof of their purposeful intentions to access the information, knowledge, support, leadership, advice, experience and concrete resources needed to enhance their performance. They were allowed to invite important others, such as their facilitator, to use DPO.com. Various tools were made available in DPO.com to be used to participate in the professional development activities identified by IQMS. These tools included a blog, a journal, a message tool and video, image and document uploading functions. The Google Analytics tool was used to track and record the data about the usage of DPO.com. It was therefore easy to determine, for example, the number of page visits, the time spent on each page and the time of day that pages were visited. This data were used to evaluate the development of DPO.com.

4.2 Evaluation of DPO.com

During the evaluation phase, the dimensions of Learn 2.0 technologies, as identified by Redecker et al. (2010), served as criteria to determine if DPO.com developed in a Learn 2.0 technology, namely whether DPO.com provided opportunities to:

- create own content
- access shared content
- collaborate
- connect to one another.

⁵Pseudonym of the technology to protect the identity of the participants.

DPO.com met the first criterium of a Learn 2.0 technology. Five of the participants used DPO.com to create content to enhance their own performance and the performance of their colleagues. According to one of the teachers (Magda), DPO.com was effective, because she could return to these shared sources to enhance her performance. The number of pages created or accessed during the research is shown in Figure 4.

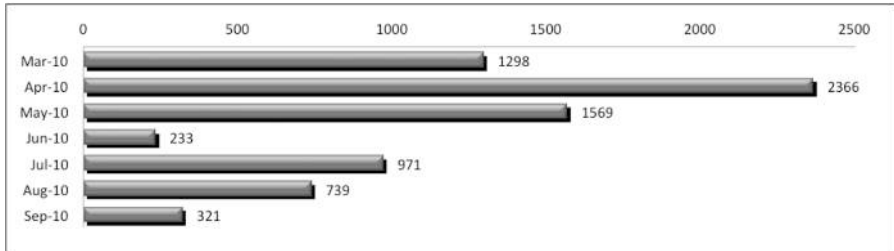


Figure 4. Number of pages accessed/created during research

The teachers were guided in the use of the technology during the implementation cycle (March – June 2010). Thereafter they used DPO.com independently. It is important to note that they created and accessed content during school holidays (April, June and September) as well. Figure 5 (below) shows that the highest usage was recorded during weeks 19 and 21 (development cycle) when they used DPO.com independently.

The second criterium of a Learn 2.0 technology was also met. Although face-to-face interaction happened at school, the usage of this tool demonstrated a need to access content in a centralised place (see Figure 5).

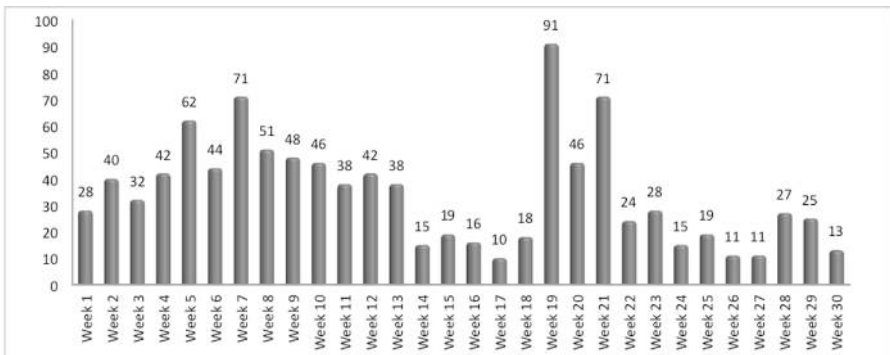


Figure 5. Weekly access to DPO.com (data provided by Google Analytics)

The teachers were required to use DPO.com once a week, but they used it up to 91 times per week, including during school holidays (weeks 1, 14–17 and 30) and the 2010 teacher strike (week 15), averaging more than seven times per week (see Figure 5).

The participants used DPO.com to collaborate with others, thereby meeting the third criterium of Learn 2.0 technologies. They worked together to achieve a collective purpose, which is in contrast to what happens in many schools where teachers continue to work in isolation (DuFour 2004). SNA provided an effective method to identify problems in terms of collaboration. Despite the head of department sharing information online with all of the teachers, after which collaboration ensued, two teachers did not collaborate online at all. This resulted in one of these teachers underperforming, for which she was reprimanded. She blamed the head of department for not sharing the information. However, the data that were generated with date and time stamps confirmed that the information had been shared well in advance. Since ten of the teachers (83,3%) used DPO.com to collaborate with one another, this criterium was met as well.

Finally, the participants used DPO.com to connect to others in order to enhance their performance. In this regard, see the sociograms of the development network establishment during the implementing phase (Figure 6A) and development phase (Figure 6B).

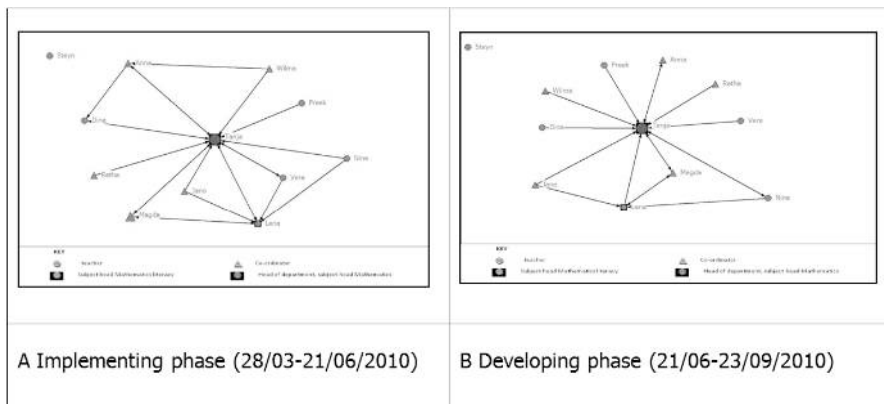


Figure 6 A & B. The connectedness of the teachers in DPO.com (Van Staden 2012)

Only one of the teachers (Steyn) did not use DPO.com to connect to his colleagues. It is nevertheless clear that DPO.com met the final criterium as well, thus it can be regarded as a Learn 2.0 technology. The teachers took ownership of and used DPO.com until the end of 2010, well after the completion of this research. Within six months all of the teachers, except for Steyn, learned to use the Learn 2.0 technology to enhance their performance - a clear indication of their strive to develop professionally. The connectedness of the teachers provided the data for the monitoring process.

5. MONITORING OF CONTINUING PROFESSIONAL DEVELOPMENT

As stated in paragraph 3 the primary aim of the research was to monitor the continuing professional development of the teachers. DPO.com provided opportunities for participating in professional development activities, but the question remained whether this participation was indeed effective.

5.1 Using Social Network Analysis for monitoring continuing professional development

The network data for the planning phase were collected by using a questionnaire tool. The participants generated the names of colleagues on whom they relied to get access to information, knowledge, advice, leadership, support, experience and concrete sources to perform their work. Questionnaires were not regarded reliable, since participants might not identify all the social ties, therefore they were instructed to provide the names of the colleagues who relied on them as well. The reliability of the network data was improved during the research since evidence of the interactions was stored electronically.

The social ties that formed during the implementing and development phases were identified and read into Krackplot, a software tool to facilitate the visual representations (sociograms). Traditional measures, such as degree, network position and direction of social ties, were applied to monitor the continuing professional development of the teachers (see Van Staden 2012). These measures were used to analyse and interpret the existing development network (01/01/2010-21/03/2010), as reported by the teachers on 21 March 2010 (see Figure 1).

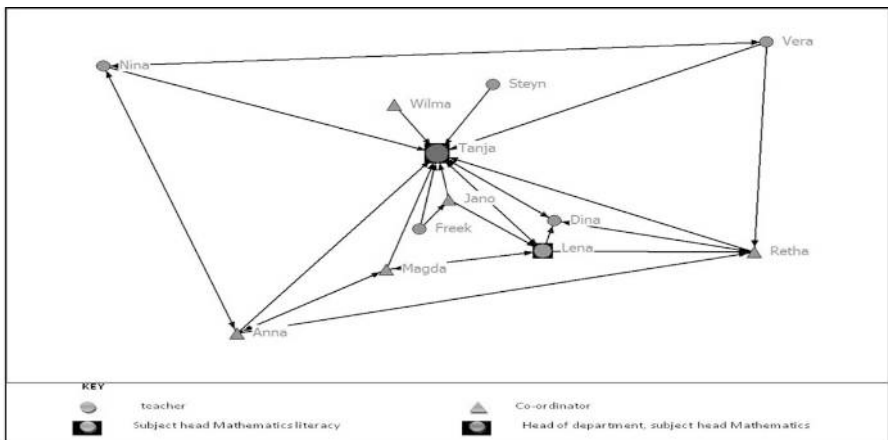


Figure 7. Reported development network (between 1 Jan and 21 March 2010)

However, these measures were not sufficient to understand and predict the effectiveness of the continuing professional development of the teachers. It allowed a simultaneous study of the individual teachers, groups (teachers responsible for a grade) and the community (mathematics department), but this information was not sufficient to monitor continuing professional development in a transparent manner.

Tanja was identified as the star of the network, as all 11 teachers reported that they relied on her to enhance their performance. This finding could indicate that she was overloaded and deprived of sufficient time to focus on her own work. The personal development networks of Wilma and Steyn consisted of only one social tie, but the inference could not be made that their personal networks were not effective. Although the flow of information could be traced, it was not possible to predict the effectiveness of the work of the teachers based on this information. Therefore, a new perspective had to be introduced.

The 2010 hierarchical structure was therefore regarded as an essential development network⁶ (see Figure 8) and served as baseline to monitor effectiveness of the continuing professional development of the teachers.

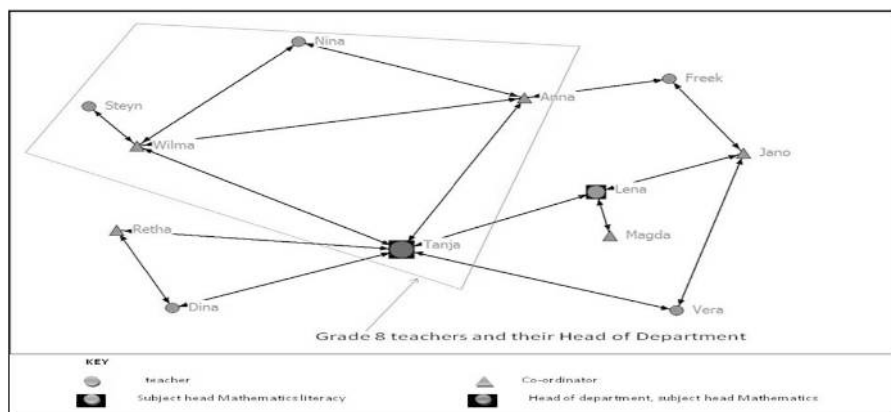


Figure 8. Essential development network for 2010

The sociograms of the development network (Figures 6A, 6B & 7) were compared to the essential development network to identify the barriers and affordances that could impede or enhance the performance of the individual teachers, their groups and community. A few examples will be discussed.

5.2 Monitoring on group and community level

Some of the groups used DPO.com effectively to improve their work, for example Lena and Magda, who were responsible for teaching grade 11 and 12 mathematical literacy (see Figures 6A & 6B).

⁶Concept coined to refer to the ideal development network based on the hierarchical structure that consists of the teachers and the social ties envisioned by management.

However, some did not, with a negative impact on their own work and that of their colleagues, for example the grade 8 group (Wilma, Nina, Anna and Steyn).

Wilma (coordinator) had to set tests and examinations, draw up the work schedules and monitor the performance of her group. Therefore, the following essential ties were expected: Wilma<->Nina, Wilma<->Anna, Wilma<->Steyn and Tanja<->Wilma. The essential ties between Anna (grade 9 coordinator) and Nina (who taught grade 9's as well), and Anna and Tanja (see Figure 8) could also enhance the performance of Anna and Nina.

Wilma did not attend all the face-to-face meetings. She also did not use DPO.com to create or participate in activities created by Tanja. Only one essential tie (one-directional) existed between her and Tanja, indicating that sources did not flow from her to Tanja, and that might have impeded Tanja's work. None of the essential ties between her and her group existed before the study commenced (see Figure 7). A one-directional essential tie developed between her and Anna (Figure 6A), but disintegrated again (see Figure 6B). The lack of essential ties could impede the performance of the grade 8 teachers, therefore Tanja created professional development activities to enhance collaboration, but Wilma did not participate. We expected that the performance of the grade 8 teachers would be impeded, but only Wilma was reprimanded for work being late. The reason for this was also provided by Social Network Analysis. Nina, Anna and Steyn overcame the barriers presented by the hierarchical structure (Cross & Parker 2004) by building additional ties with Tanja.⁷ The essential tie between Anna and Nina could also have enhanced Nina's performance. Although the additional ties enhanced the performance of Nina, Anna and Steyn, Tanja was overloaded in the process. It was clear that Wilma's reluctance to participate had a negative impact on her work and the work of her colleagues. However, no systems were in place to enforce participation.

5.3 Monitoring on individual level

Tanja was head of department, subject head mathematics and coordinator for grade 11 and 12 mathematics. More than one of the coordinators did not take responsibility for their group of teachers. Tanja allowed the teachers to bridge the structural holes (gaps) created by her coordinators by building additional ties with her to enhance the performance of her department. Although these additional ties enhanced their performance (e.g. Tanja<->Nina; Tanja<->Steyn), Tanja was deprived of time to perform her own duties. She addressed this issue by sharing the information digitally. She drove the development of the Learn 2.0 technology to enhance her own performance, as well as that of her department. Tanja created opportunities for groups of teachers to build essential ties, but some of them did not participate.

⁷Additional ties formed to enhance performance.

The work overload did not improve and Tanja resigned by the end of that year to create time for her first love, as she stated it, namely the teaching of mathematics.

According to Pittinsky (2005), 50% of all beginner teachers leave practice due to a lack of support networks. Nina could have resigned as well, due to the lack of support from her direct superior. However, she succeeded from the first day at the school to build additional (Vera, Tanja and Lena) and essential (Anna) ties for access to the support, knowledge and advice she needed to enhance her performance (see Figures 6A, 6B & 7). The additional ties with Lena and Vera (both in mathematical literacy) allowed her to cross the barriers of a single network to get access to sources, which gave indirect access to several other teachers. The reciprocal additional tie that developed between her and Tanja (see Figure 6B) indicated her professional development: Tanja regarded her as knowledgeable.

6. CONCLUSION

We have demonstrated that DPO.com provided the teachers with sufficient opportunities to participate in professional development activities. This finding was later substantiated by Goggins, Laffey and Gallagher (2011), who stated that social network environments can provide opportunities for participation in professional development activities. All four dimensions of Learn 2.0 technologies developed as DPO.com was used to create own content, get access to sources, collaborate and connect to one another. We also demonstrated that Social Network Analysis provided an effective method to identify the barriers that might impede the performance of individual teachers. This information was used to create professional development activities to enhance the work of the teachers. Although we could predict the negative impact of nonparticipation on the performance of individual teachers, their groups and the community, there were no systems in place to enforce participation. The Continuing Professional Development System was developed to address this gap in the education system, but it has not yet been implemented.

7. THE WAY FORWARD

The Department of Basic Education and the Department of Higher Education and Training developed the Integrated Strategic Planning Framework for Teacher Training and Development to enhance the performance of South African teachers. This Plan requires⁸ that professional learning communities should be widely established by 2017 (DBEHET 2011:11). Due to financial constraints, only some of the District Development Centres, which should serve as meeting places, will be ready by 2023 (DBEHET *ibid*:14).

⁸Shortened name of the framework.

This discrepancy between policy and implementation might impact negatively on the establishment of professional learning communities and might even doom the professional learning community model to be caught up in the infamous education reform cycle.

DuFour (2004) described the challenges of the educational reform cycle: initial enthusiasm gives way to confusion, followed by inevitable implementation problems, failed results, and eventually the abandonment of the reform.

The reform cycle can be avoided if teacher managers were aware of the incongruity between their commitment to enhance the performance of teachers and the lack of a coordinated strategy to respond when a teacher does not perform adequately.

The effectiveness of a professional learning community model can be impeded by the lack of meeting places. We demonstrated that Learn 2.0 technologies, by their very nature, can accommodate the needs of teachers associated with professional development. They can serve as virtual meeting places where information, knowledge, experience, leadership, support and advice can be shared. They can also serve as repositories of the resources teachers might use to enhance their performance. Participation is a key determinant for success. We demonstrated that Social Network Analysis can identify the barriers and affordances that impact the work of individual teachers, and the work of their groups and community. Therefore, we argue for commitment to a coordinated strategy that responds to teachers who do not perform adequately to ensure that the professional learning community model does not fall prey to the educational reform cycle.

8. ACKNOWLEDGEMENTS

We want to thank J.L. van der Walt⁹ for his valuable inputs as critical reader.

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⁹J.L. van der Walt was the presenter of an academic writing school hosted by North-West University that the first author attended in June 2013.

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