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Features of a Developing Mathematics Professional Learning Community and Affordances for Teacher Learning Opportunities

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Abstrak

Komunitas pembelajaran profesional umumnya sebagai model yang layak untuk pembelajaran guru yang berkelanjutan dan produktif. Namun beberapa penelitian telah menyelidiki bagaimana komunitas tersebut berkembang menjadi komunitas belajar yang berfungsi penuh dan berkelanjutan. Studi ini menyelidiki fitur dari komunitas pembelajaran profesional guru yang berkembang dan peluang untuk belajar. Lima guru matematika di satu sekolah dasar kota di Afrika Selatan dan dua penulis makalah ini merupakan komunitas pembelajaran profesional. Transkrip pertemuan yang direkam secara audio merupakan data yang dianalisis dalam makalah ini. Analisis data dilakukan dengan menggunakan pendekatan kejadian kritis. Temuan menunjukkan bahwa guru bergeser dari pasif menjadi peserta yang lebih aktif. Mereka secara bertahap menganggap diri mereka sebagai sebuah komunitas, berbagi pemikiran dan bersama-sama menciptakan makna baru secara kolaboratif. Peran fasilitator secara bertahap bergeser dari memimpin dan mengintervensi dan menyelidiki. Peluang untuk belajar diciptakan sehubungan dengan pengetahuan tentang kebutuhan pemecahan masalah peserta didik, dan praktik instruksional khusus untuk memenuhi kebutuhan tersebut. Temuan menunjukkan bahwa pengembangan komunitas pembelajaran profesional yang efektif dan berkelanjutan adalah proses bertahap yang membutuhkan waktu, dan melibatkan pergeseran peran oleh fasilitator dan guru.

***Kata kunci*:** *Komunitas Pembelajaran Profesional, Peluang Belajar Guru*

Abstract

Professional learning communities are commonly as a viable model for on-going and productive teacher learning. However few studies have investigated how such communities develop to become fully functional and sustainable learning communities. This study investigated features of a developing teacher professional learning community and opportunities for learning. Five mathematics teachers in one township primary school in South Africa and the two authors of this paper constituted the professional learning community. Transcripts of the audio-recorded meetings constituted the data analysed in this paper. Data analysis was done using the critical incidence approach. The findings indicate that the teachers shifted from passive to more active participants. They gradually perceived themselves as a community, sharing thinking and co-creating new meanings collaboratively. The facilitators' roles gradually shifted from leading and intervening and probing. Opportunities for learning were created with respect to knowledge of learners' problem solving needs, and specific instructional practices to address those needs. The findings indicate that the development of effective and sustainable professional learning communities is a gradual process that takes time, and involves shifts in roles by both facilitators and teachers.

Keywords: Professional Learning Community, Teacher Learning Opportunities

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1. INTRODUCTION

Currently there is no universally accepted model of in-service teacher professional development that produces impactful teacher learning. Contemporary thinking is that long-term, and evidence-based teacher professional development can have significant impact on teachers' knowledge and teaching practices (Koellner and Jacobs 2015; Chauraya and Brodie 2017). Three key features of effective professional development models that are highlighted in the literature are: adapting the professional development to support local goals and interests; developing teachers' mathematical knowledge for teaching; and fostering a professional learning community (Koellner, Jacobs, and Borko 2011). A key mechanism for

learning in such models are the on-going conversations which support reflection on understandings and challenge teachers' assumptions and knowledge about teaching and learning (Katz, Earl, and Jaafar 2009; Kuh 2015; Horn 2010). However, there has been little research on features that support initiation and sustaining professional learning communities. The study reported in this paper involved a newly established, school-based professional learning community consisting of five mathematics teachers and two university-based facilitators. This paper analyses features that supported the growth in the teachers' participation and confidence in the community. The paper also examines the learning opportunities that were created in the activities of the professional learning community.

Research on teacher professional development shows that various models have been developed and implemented with the hope of influencing teachers' knowledge and practice. (Koellner and Jacobs, 2015) depict models of professional development as existing on a continuum that runs from highly adaptive models to highly specified models. Highly adaptive models are "designed to be readily responsive or adapted to the goals, resources and circumstances of the local professional development context" (Koellner and Jacobs 2015, 51). These are professional development models that have general guidelines that evolve according to the needs and goals of particular contexts. Normally in such models the content of what teachers' learn is determined by what learners' need to learn in classroom situations (Timperley 2010; Chauraya and Brodie 2018). On the other extreme end of the continuum are the highly specified professional development approaches "where goals, content resources, and facilitation materials are provided to ensure a particular, predetermined PD experience" (Koellner and Jacobs 2015, 51). Examples of such professional development approaches are the traditional workshops to which teachers are invited to listen to a presenter on a predetermined topic. According to the (Koellner and Jacobs, 2015), the rest of the professional development models exist somewhere along the continuum depending on their levels of adaptivity or specialisation.

This study was located within the highly adaptive models of professional development in that the teachers' learning needs evolved from learners' learning needs in relation to problem solving in mathematics. A word problem mathematics test was administered to learners. From the responses it was observed that learners struggled with understanding and answering word problems. Thus, the focus of the professional learning conversations reported in this paper was the teaching of mathematics word problems.

A commonly used definition of a professional learning community is that of "a group of teachers sharing and critically interrogating their practice in an on-going, reflective, collaborative, inclusive, learning-oriented, growth-promoting way" (Stoll and Louis 2007, 2). This definition indicates that professional learning communities are about teachers collaboratively inquiring into their problems of practice, and developing new understandings that can lead to changed practices (Katz, Earl, and Jaafar 2009). As a process, learning in a professional learning community involves: challenging practice, focused professional learning conversations, deepening understanding, proposing and testing solutions, and improving the quality of classroom instruction (Katz, Earl, and Jaafar 2009). However, it needs to be noted that the success of learning is dependent on the extent to which the participating teachers can engage and participate in the learning activities of the professional learning community. In professional learning communities which are in their early stages of establishment, the teachers may tend to rely more on the facilitators in each activity.

In South Africa research on teacher learning in professional learning communities has been going on in the last two decades. Such research has been initiated at university level, and involved creating and working with teacher professional learning communities in selected schools (Shalem and Brodie 2007; Graven 2002; Walton 2016; Liebenberg 2016; Botha 2012; Chauraya 2013). Results from these studies have indicated the power of

professional learning communities to support teacher learning in various aspects of their practice (Brodie, 2013). Significant teacher learning has been reported in knowledge of subject content, pedagogical content knowledge, using evidence from classroom situations for transforming teaching practices, and analysing learners' thinking in particular situations (Liebenberg 2016; Chauraya and Brodie 2017). Features of professional learning communities that have been found to support learning include: collegial relations in the community (Smith 2016); confidence (Graven 2002); group cohesion; a challenging learning focus; rigorous collaborative inquiry; and joint sense making (Brodie, 2013). Research on professional learning communities in South Africa has mostly been done in poorly performing public schools, especially township schools. The motivation has been to determine how professional learning communities could support teacher learning, which could lead to improved instruction and learners' learning and performance in such schools. The research reported in this paper was conducted in this context.

In the study the learning focus was on word problems in mathematics. Word problems can be defined as "linguistically presented problems requiring arithmetic solutions" and involve "translating linguistic statements into internal representations, and applying mathematical operations for reaching a solution" (Zhu 2015, 1). In South Africa word problems are very common in most mathematics topics. They also feature in most school-based and national examinations. Research shows that solving word problems is more challenging than other mathematical tasks (Zhu 2015; Bernardo 1999). Learners' challenges with word problems have been attributed to a number of factors that include inadequate text comprehension, and incorrect problem representation (Kyle and Yanzhen, 2013).

Results from the mathematics word problem test which was administered to primary school learners in this study showed that learners had challenges in translating word problems into correct mathematical statements, hence they tended to answer the problems in unsystematic and unpredictable ways. In the professional learning community the conversations focussed on developing the teachers' understanding of problem solving and how to teach word problems.

2. METHODS

The research reported in this paper was conducted as a post-doctoral research under a university in South Africa. A qualitative approach was adopted for the study. The study was carried out in one poorly resourced township primary school in Johannesburg. The school had large class sizes, and learners' performance in mathematics was generally low. The school was conveniently selected for having a Department of Science and Mathematics which had quite a large number of mathematics teachers. Ethical clearance for the research was given by the university. Access into the school was granted by the Gauteng Department of Education and the School Principal. Informed consent was obtained from the participating teachers and learners. Five Intermediate Phase (Grades 4-6) mathematics teachers agreed to participate in the study. The five teachers and the two university-based facilitators constituted the professional learning community in this study.

The research began by testing learners using a teacher-designed word-problem test. Evidence from the test results showed that the majority of learners showed lack of comprehension of the word problems in their solution attempts. This information was used as the learning focus in the professional learning community activities. The activities involved: analyzing the specific learner challenges in solving word problems and identifying what needed to be done to improve the learners' problem solving abilities; jointly planning lessons for dealing with the observed learner challenges; video-recording the lessons; and joint reflection these lessons. Altogether seven, one-hour long meetings were held by the

professional learning community over a period of eight months. The article analyses some of these conversations for features that supported gradual teacher engagement and participation, as well as the opportunities for learning that were created.

The data for this paper consisted of transcripts of the audio-recorded conversations of the professional learning community, as well as transcripts of a focus group interview conducted with the teachers at the end of the study. The data was transcribed for analysis, and in this paper we present some excerpts of the conversations that illustrate features of the developing professional learning community and opportunities for learning that were created. Pseudonyms were used to refer to the teachers for purposes of anonymity.

Data analysis was done using the critical incidents analysis approach (Angelides, 2001). The approach regards a critical incident as a common-place event that occurs in the everyday life but is justified as critical on the basis of its significance to the goals of the activity and the researcher's interpretation of the event (Angelides, 2001). The approach was adopted in the analyses at two levels. The first level involved defining critical incidents. A critical incident was defined as a series of conversation turns that that showed an opportunity for the teachers to learn about a particular aspect of problem solving in mathematics. Using this approach three critical episodes were identified that are presented below. At the second level critical conversation turns within each episode were identified for analyses. A conversation turn was classified as critical if the utterance or remark was contributing to the theme or goal of the talk in the episode. Such classification enabled the elimination of those turns that were not contributing or relevant to the theme in the episode. The critical turns were then categorized according to what was being said and the purpose of the turn. This categorisation enabled the analyses of the developmental features of the professional learning community that supported or constrained the teachers' contributions and ways of participating in the community activities. Data presentation in this article consists of tables that summarize the conversation turns in each episode, showing the nature and frequency of particular categories of conversation turns, including examples of such turns.

3. RESULTS AND DISCUSSION

Results

The conversation episodes presented below illustrate opportunities for teacher learning in three aspects of problem solving, namely: learners' challenges in solving word problems; strategies for teaching word problems; and espoused learning by the teachers.

Episode 1: Learners' challenges with word problems in mathematics

The first episode shows how the professional learning community analysed learners' challenges in solving word problems. The table below summarises the key features of the conversation, according to the data analysis framework described above. Table 1 includes the frequencies of each type of utterance to illustrate the nature of utterances that dominated the conversation, and the different levels of participation.

The episode was part of the initial meetings of the professional learning community in which the focus was on making sense of the observed learner errors in the test. It shows that the facilitators took a greater initiative, and a more leading role in the conversation. The teachers' participation was mainly limited to responding to the facilitators' questions, although a few clarification questions were asked, and some sharing of teaching practice was observed. In these initial meetings the teachers were clearly looking up to the facilitators for guidance, which could be a perception of the facilitators as being more knowledgeable, and as sources of information. However, in their contributions the facilitators limited themselves to asking questions, probing for explanations, elaborating the teachers' responses, and summarising the interim ideas emerging from the conversations. In a way, the facilitators

were making an effort to engage teachers in collaborative participation targeted at joint sense making of the learners' challenges in word problems. The fact that this was a newly established community could account for the observed pattern of participation by the teachers in this episode. The teachers could have been trying to understand their roles and ways of relating to the facilitators in the conversations.

Table 1. Summary of Conversation Turns or Utterances in Episode 1

Category of utterance	Purpose	Example	Number of Turns
Facilitator questions	Initiating	"If you look at four b, why did we think it would be easy for the learners?" (T1)	3
	Probing for further explanation/clarification	So what is peculiar about this question that could have caused the learner difficulties? (T35)	21
Facilitator comments	Elaborating a teacher's remark	"In other words you are saying that they have to draw on different knowledge, they have to know that for the forty six point three eight, the forty six is the rands and the thirty eight is the cents, …" (T37)	21
	Summarising key points	"Okay just to draw on what everybody was saying, I think there is, maybe two difficulties that learners have with word problems. One is to get the right information, and two is being able to do the mathematics." (T140)	9
Teacher questions	Seeking clarification	"So why is it important for us to know that the cashier did not have any one-cent or two-cent coins?" (T77)	9
Teacher comments	Expressing opinion	"If I look at this question I think it is difficult for the learners" (T2)	9
	Stating learners' challenge	"The question is easy but the problem is our learners have a language problem …" (T16) "I think there are other issues here, it's the fractions, in all honesty, it's the understanding of one eighth, or two eighths, of six thousand, and the issue here is working with fractions" (T22)	19
	Elaborating learner challenges	"They see twenty and ten but suddenly they have to give the answer in a fraction form, so that to them it will be difficult" (T118)	8
	Justifying learners' challenge	"Yes, rounding down, that down will be difficult for them because we didn't teach them how to round it down" (T60)	3
	Stating possible solution strategy	"I explain in their language, and then ask them, which operation are you going to use to solve this problem?" (T166)	8
	Acknowledgement of learning	"I honestly wasn't aware that it was this severe, the word problem issue, I honestly thought it ended at the language barrier level, … I didn't know that there were other underlying issues" (T191)	5

In terms of opportunities for learning, the teachers' utterances, show that they were beginning to make sense of, and account for their learners' challenges with word problems in mathematics. The episode was an opportunity for the teachers to deepen their understanding of learners' challenges with word problems, and the possible sources of those challenges.

Episode 2: Strategies for teaching word problems in mathematics

The two meetings which followed focussed on discussing teaching strategies that could help to address the learners' challenges identified in the previous meeting. The focus of the conversations was on how to develop learners' word problem solving capabilities through the teachers' teaching, a process of using learners' learning needs to initiate teacher learning about their practice. The episode was spilt according to two sub-themes, which are presented and analysed separately.

Teachers' suggested strategies for teaching word problems in mathematics

In this meeting the teachers were asked to describe what they thought were possible strategies for teaching word problems, drawing from the earlier conversations. The format of the conversation differed from earlier conversations in that the teachers did most of the talking in describing and justifying their suggested strategies. The facilitators limited themselves to probing and seeking for justification. For expediency Table 2 focused on the teachers' suggested strategies and how these were articulated. Conversation turns that show how the conversation was conducted were deliberately omitted.

Table 2. Suggested Problem Solving Teaching Strategies

Pedagogical Strategy	Examples of teachers' suggestions
Identifying, underlining and explaining key words in a problem	***Alfred:*** "… something that I have been thinking about, as you said we must go and think about it. Eh one of the ways was just an extension of explaining key words in the problem, to say if we explain those words and we underline them, what then happens when we change their format from the paragraph and get them into these bullets or some points of some sort. And we have them underlined, extract those key words and put them in a format maybe learners can see …" (T7)
Making learners read the problem several times	***Vivian:*** "To me what I do always in class if it comes to problem solving using the sentences, … first I make them read twice or thrice the same question … then I ask, I ask if there is anyone who can interpret then I, I, I ask them the numbers, then I start writing on the board, then I ask them what operation are we going to use, then after that I show them how to solve, then after that I give them another, another problem like, like, like which one we have solved, … it's how I do it in my class" (T11)
Representing problems using diagrams	***Linda:*** "I think learners they learn and they understand when they see representations like drawings, maybe on charts, unlike when it's in words" (T13)

The conversation turns show some changes in the teachers' engagement and confidence. The teachers suggested and explained teaching strategies for dealing with learners' challenges in solving word problems. The teachers were more confident in expressing their ideas, showing that they were more comfortable with participating in the community. They were also making substantive contributions to the theme of the conversation, and shared their thoughts and experiences freely, an indication of growing trust

in the community. Regular and consistent participation in the meetings of the professional learning community seemed to have fostered growth in the teachers' confidence and trust in the community. The teachers were beginning to realise their role as not limited to answering facilitator questions, but to also share and justify ideas linked to the theme of the conversation. The episode also shows that the teachers were developing knowledge of teaching word problems in such a way that learners would approach such problems systematically. The suggested strategies highlighted the need for learners to understand a word problem before attempting to solve it. The episode created an opportunity for the teachers to collectively deepen their knowledge of teaching word problems in ways that could help learners in solving such problems.

Designing mathematics lessons for teaching problem solving

The theme of this meeting was how to design lessons for teaching learners how to solve word problems, and what constituted a problem solving lesson. In preparation for the meeting the teachers had been asked to plan a draft lesson plan, in pairs, using the ideas discussed in the previous meetings on problem solving pedagogy. The meeting started with one of the teachers presenting a description of the lesson plan which they had planned, as shown in the following excerpt:

Thandiwe's description of a lesson:

Okay, this is based on capacity and volume, right? The teacher will show the learners two bottles, two litre bottle of coke, one litre and five hundred millilitres. And the leaners will observe, they will look at those bottles and then the learner, the teacher will ask the learner 'What is the difference between the bottles?' And the learners will answer that 'There is a bigger one which is two litre, one litre and five hundred millilitres.' They will measure these millilitres, litres and... Oh and then the teacher will demonstrate and pour five hundred millilitres of water in the bottle, there is five hundred millilitres using the measuring beaker. And explain when the bottle was empty, its total was capacity. And when they pour water into the bottle that is a volume of the water, of the bottle, volume, right. And give the learners exercise to do on page so and so. So here the lesson is based on the difference between capacity and volume. After this description, the facilitators asked the teachers if the lesson described was a problem solving lesson. Table 3 show some of the teachers' comments.

Table 3. Some Conversation Turns on Joint Lesson Planning

Speaker	Utterance
Vivian	Here is just a demonstration, where you, it will show the learners the difference between the millimetres and the litres. There's no problem in the lesson. There is no problem solving here
Facilitator 1	Okay so your observation is that it seems not to be about problem solving?
Vivian	Yes
Facilitator 2	So this is the start, the basis for which we can build. I think Vivian's point is right, that at the moment it's not clear where the problem solving is. So how could we very simply maybe change this a little bit, so that there's more problem solving?
Thandiwe	I think we need to put the exercise as it is here, you put it, or you do an example using that exercise which I think there is problem solving in it.
Facilitator 2	Okay. What else could we do to make it more of a problem solving lesson? … How can we change it so there's more problem solving?
Thandiwe	You have to put the problem solving here … there is no problem solving here, they were just pouring water and comparing, that's it.

Speaker	Utterance
Facilitator 1	So I think we can agree that this lesson plan is not about word problems … Can you locate a word problem in there? *(referring to Thandiwe who had a textbook)*
Thandiwe	*Reading from the textbook* "Cara has two bottles of juice, each bottle holds two litre. She also has four cups of juice; each cup holds two hundred and fifty millilitres of juice. How much juice does Cara have, write your answer in millilitres. Cara wants to pour the juice into glasses that can each hold two hundred millilitres, how many glasses will Cara need?"
Facilitator 2	How can we build a lesson just around that problem?

In the rest of the conversation the community discussed how the identified problem could be used to design a problem solving lesson in which learners would begin by reading and understanding the problem before attempting to solve it. The conversation culminated in the teacher who had originally presented a description of the lesson describing how she would teach the lesson using this problem as shown in the following excerpt.

Thandiwe's description after the community's comments:

As we were saying you have to just put the problem there. So I'll have to put the problem and ask them to read, and they will read and read and I'll ask them to explain what they understand about that problem on the board. And then I'll ask them to give me the key words, the words that they think they are important in that problem and then we underline them. And then I'll ask them to explain in isiZulu so that they can understand better. … And then when they understand better I'll ask them to solve the problem. After solving the problem I'll see if they need help in sorting out, check if they got it correct. If they didn't get it correct I'll try and explain more to them so that they can be able to do it.

The extracts in this conversation show some significant shifts in the teachers' participation. As in the previous episode, the teachers showed more confidence in expressing their ideas about their lesson plans. They also participated more strongly in challenging each other's ideas as evidenced by the way in which they challenged the initially proposed lesson. Features of teacher learning that were evident in this episode were, sharing thinking, challenging each other's thinking, and progressive convergence on meanings, in line with ideas discussed earlier. The episode shows progressive understanding of the teachers' roles in the professional learning community. They were now participating collaboratively and equally in joint meaning making and developing new understandings.

In terms of the substance or content of the conversations in the episode, there was an opportunity for the teachers to develop their knowledge of lesson planning for teaching word problems in mathematics. The teachers began to see the importance of learners engaging with word problems in a systematic manner that begins with understanding the problem, and planning strategies for solving the problem. There was an appreciation of how such an approach would enhance the learners' chances of successfully solving such problems.

Episode 3: Espoused benefits of participating in the professional learning community

The final meeting for the professional learning community was a reflections focus group interview. In this meeting each teacher was asked to say what they had learnt from their participation in the project. Table 4 presents some of the teachers' comments.

Table 4. Some of the Teachers' Comments on Their Perceived Learning

Teacher	Comment(s)
Alfred	"Ah, yah, I learnt quite a number of methodologies, ah I learnt that … one of the ways is that you can put learners into groups so that they can work around it as a group. Number two is that we can try to represent the problem solving in graphic forms, that is using pictures so that it may be easier for grade four, five learners to understand. … I also learnt that you can also translate it, the English in there to the mother tongue of the particular class."
Linda	"Eh to me problem solving was a challenge, I was even ah, I didn't spend a lot of time with the learners on the word problems in my teaching, but now as we explain what is involved I can see some light, … that's what I have learnt"
Vivian	"I understand what we are saying, sometimes *(laughs)* I just skip these questions … Sometimes I skip them to numbers, but sometimes I work, but now, I am now alright … I have learnt how to go step by step with problem solving and it's helpful to the learners to understand these things"
Thandiwe	"I think we need to work as a team, we sit together, we explain, we look at the questions and try to come up with the way on how to teach these word problems … and work as a team so that we can begin to help the learners"
	"The good thing is we have learnt a lot from this project if I can put it. Eh I have the method how to deal with problem solving. The first thing that I have learnt is that you are not supposed to tell the learners what they must do …they have to do it for themselves and then understand the problem and then solve the problem. *Mina* (me) I was doing it the other way round. I was reading for them and explaining to them for them to be able to do, to solve the problem. But now I know I have to just put the problem for them there on the board. They have to read and explain together, and explain to me, I don't have to explain to them, and they highlight the important bits, and then they answer."

Table 4 shows some of the teachers' expressed learning gains in the professional learning community. A critical feature of their utterances was the use of 'we' when referring to the community. This was an indication that the teachers were now perceiving themselves as a community, rather than as individuals.

Discussion

The findings presented above indicate that, in the initial meetings, the teachers' participation was limited to responding to the facilitators' questions. There was strong facilitator guidance and intervention in the learning activities. The teachers showed little confidence in their participation, and seemed to regard the facilitators as more knowledgeable. The teachers also seemed to be not sure about their roles in the professional learning community. Such features of teacher participation can constrain learning in professional learning communities. However, this is understandable, given that this was a newly established professional learning community, and the teachers were not used to such a professional development approach. As the meetings continued on the planned learning activities, there was evidence of developing confidence and trust in the professional learning community by the teachers (Graven, 2004).

The teachers progressively participated in more substantive ways, making significant contributions to the theme of each conversation. They also began to assume a more participatory role, sharing their ideas and explanations more freely. They also began to perceive themselves as a community, developing new meanings together. The findings indicate that the on-going meetings of the professional learning community engendered the development of features that support collaborative and sustainable learning and cohesion. The features were also supported by having structured and developmental learning activities. The roles of the facilitators also shifted from being more guiding to more facilitating of the conversations. The conversations created significant learning opportunities about learners' word problem solving difficulties and how to improve the teaching of such problems.

A sense of belonging in community with others supports collaborative engagement and participation in the activities of the community (Wenger, 1998). Most of the teachers began by acknowledging their own limited understandings about the teaching of word problems prior to engaging in the activities of this community. Acknowledging the limitations of prior knowledge and practices is fundamental for being receptive to new ideas that are collectively developed in a professional learning community (Katz et al., 2008). The teachers' remarks about their espoused learning show that they were beginning to see themselves as a learning community from which they developed new understandings of how to teach word problems in mathematics. Such features were a result of the extended and developmental activities in which the teachers participated.

The findings of this study contribute to knowledge about the initiation and development of sustainable and productive professional learning communities. Such communities initially require strong guidance and intervention by facilitators. The teachers need to be afforded the opportunity to gradually learn and accept their roles as collaborative inquirers into issues related to their practice. They also need to gradually perceive their participation as the source of new understandings related to their practice. These findings are significant for the South African context where professional learning communities have been adopted as a systemic teacher professional development approach (Department of Basic Education 2015). Knowledge about how to initiate and sustain such communities is of significance in such a context.

4. CONCLUSION

In conclusion, the findings indicate that developing professional learning communities is a process that can be supported by structured, developmental and on-going learning activities. In the initial stages, strong facilitator intervention in the form of initiating and probing questions may be necessary. The participating teachers need to be afforded opportunities for gradually taking more participatory roles in which they develop the agency to share, explain and justify their thinking with confidence. Facilitators need to gradually assume the roles of asking guiding and probing questions without dominating and taking leading roles. Such conditions may lead to the development of professional learning communities which have the basic features of effective and sustainable learning contexts for teachers.

5. REFERENCES

Angelides, P. (2001). The development of an efficient technique for collecting and analyzing qualitative data: The analysis of critical incidents. *International Journal of Qualitative Studies in Education, 14*(3), 429-442. https://doi.org/10.1080/09518390110029058.

Bernardo, A. B. (1999). Overcoming obstacles to understanding and solving word problems in mathematics. *Educational Psychology*, *19*(2), 149-163. https://doi.org/10.1080/0144341990190203.

Botha, E. M. (2012). Turning the tide: creating Professional Learning Communities (PLC) to improve teaching practice and learning in South African public schools. *Africa Education Review*, *9*(2), 395-411. https://doi.org/10.1080/18146627.2012.722405.

Brodie, K. (2013). The power of professional learning communities. *Education as change*, *17*(1), 5-18. https://doi.org/10.1080/16823206.2013.773929.

Chauraya, M. (2013). *Mathematics teacher change and identity in a professional learning community* (Doctoral dissertation, University of the Witwatersrand, Faculty of Humanities, School of Education).

Chauraya, M., & Brodie, K. (2017). Learning in professional learning communities: Shifts in mathematics teachers' practices. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(3), 223-233. https://doi.org/10.1080/0035919X.2017.1350531.

Leendertz, V., Blignaut, A. S., Ellis, S., & Nieuwoud, H. D. (2015). The development, validation and standardisation of a questionnaire for ICT professional development of mathematics teachers. *pythagoras*, *36*(2), 1-11. https://journals.co.za/doi/abs/10.4102/pythagoras.v36i2.297.

Department of Basic Education. (2015). *Professional Learning Communities - A guideline for South African Schools*. Department of Basic Education.

Graven, M. (2002). *Mathematics teacher learning, communities of practice and the centrality of confidence*. Mathematics Education, University of the Witwatersrand, Johannesburg.

Graven, M. (2004). Investigating mathematics teacher learning within an in-service community of practice: The centrality of confidence. *Educational studies in mathematics*, *57*(2), 177-211. https://doi.org/10.1023/B:EDUC.0000049277.40453.4b.

Horn, I. S. (2010). Teaching replays, teaching rehearsals, and re-visions of practice: Learning from colleagues in a mathematics teacher community. *Teachers College Record*, *112*(1), 225-259. https://doi.org/10.1177%2F016146811011200109.

Katz, S., Earl, L. M., & Jaafar, S. B. (Eds.). (2009). *Building and connecting learning communities: The power of networks for school improvement*. Corwin Press.

Katz, S., Earl, L., Ben Jaafar, S., Elgie, S., Foster, L., Halbert, J., & Kaser, L. (2008). Learning networks of schools: The key enablers of successful knowledge communities. *McGill Journal of Education/Revue des sciences de l'éducation de McGill*, *43*(2), 111-137. https://doi.org/10.7202/019578ar.

Koellner, K., & Jacobs, J. (2015). Distinguishing models of professional development: The case of an adaptive model's impact on teachers' knowledge, instruction, and student achievement. *Journal of teacher education*, *66*(1), 51-67. https://doi.org/10.1177%2F0022487114549599.

Koellner, K., Jacobs, J., & Borko, H. (2011). Mathematics professional development: critical features for developing leadership skills and building teachers' capacity. *Mathematics teacher education and development*, *13*(1), 115-136. https://eric.ed.gov/?id=EJ960952.

Kuh, L. P. (2016). Teachers talking about teaching and school: collaboration and reflective practice via Critical Friends Groups. *Teachers and Teaching*, *22*(3), 293-314. https://doi.org/10.1080/13540602.2015.1058589.

Morton, K., & Qu, Y. (2013). A novel framework for math word problem solving. *International Journal of Information and Education Technology*, *3*(1), 88. http://www.ijiet.org/papers/240-T0031.pdf.

Liebenberg, R. (2016). Teachers' critical inquiry into cognitive and social dimensions of learners' mathematical errors in a professional learning community. *Professional learning communifies in South African schools and teacher educafion programmes*, 57-78.

Shalem, Y., & Brodie, K. (2007). Data-Informed Practice Improvement Project (DIPIP) Draft 1 (pp. 1-17). *Wits University, Johannesburg: School of Education Curriculum Division*.

Smith, R. (2016). "Building sustainable professional learning communities: Relational affordances." In *Professional Learning Communities in South African Schools and Teacher Education Programmes*. HSRC Press.

Stoll, L., and K. Louis. (2007). *Professional Learning Communities: elaborating new approaches*. Open University Press.

Timperley, H. (2010). Using Evidence in the Classroom for Professional Learning. In *Ontario Education Research Symposium*. Canada.

Walton, E. (2016). "Developing professional learning communities for inclusive education: A university community engagement opportunity." In *Professional Learning Communities in South African Schools and Teacher Education Programmes*. HSRC Press.

Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press.

Zhu, N. (2015). Cognitive strategy instruction for mathematical word problem-solving of students with mathematics disabilities in China. *International Journal of Disability, Development and Education*, *62*(6), 608-627. https://doi.org/10.1080/1034912X.2015.1077935.