

A CHAT perspective on the tensions and dynamics in the professional development of Physical Sciences teachers in a mentoring relationship

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Abstract. This research explored mentoring in terms of the dynamics and tensions associated with the interaction between a ‘keystone species’ and a novice teacher within communities of practice using a case study method underpinned by the Cultural Historical Activity Theory (CHAT). A primary constraint in the implementation of curriculum reform has been the lack of professional development for teachers. Insights into the nature of the mentoring relationship between Physical Sciences teachers revealed distinctive tensions and contradictions in terms of the activity system. The benefits of mentoring relationship suggest that teacher professional development could receive a major boost if the Department of Basic Education more overtly encouraged mentorship relationships between teachers.

1. Introduction

Large-scale research in South Africa reveals that despite significant reform in science education in this country there is little to suggest that the quality of science education has improved. For instance, the Trends in International Mathematics and Science Studies (TIMSS) repeated over the years revealed that the performance of South African learners in mathematics and science was very poor compared to other developing countries [1,2,3,4,5]. A primary constraint in the implementation of the National Curriculum Statement (NCS) has arguably been the lack of professional development for teachers [6] in response to curriculum reforms. Teachers in South Africa feel overwhelmed by the challenges presented by the reforms in the Physical Sciences curriculum. Research has pointed to teachers lacking confidence in teaching topics in the new curriculum [7,8,9] and teachers lacking in competence in implementing meaningful learner-centred scientific investigations [10,11]. Furthermore, teachers’ lack of pedagogical content knowledge (PCK) may limit their ability to facilitate meaningful learning [12,13].

It is against this background that our study sought to explore how mentoring can be exploited as means by which a teacher facing challenges in teaching Physical Sciences in secondary schools in South Africa could be supported from a skilled and experienced colleague (“keystone species”). Mentoring has increased in popularity as a way by which a teacher experiencing some weakness in his/her practice can be supported by a skilled and experienced colleague [14]. A review of literature on mentoring in the field of teacher education reveals that it involves complex personal interactions conducted under different circumstances in different schools in which it cannot be rigidly defined [15]. In this research we invoked the theoretical lens of Cultural-Historical Activity Theory (CHAT) in trying to unpack the tensions and

dynamics in the experiences of two physical sciences teachers involved in a mentor-mentee relationship.

2. CHAT as a theoretical framework

Activity Theory is a socio-cultural and historical lens through which human activity systems can be holistically analyzed [16,17]. Activity Theory is thus a framework for understanding the totality of human activity in context [18]. This theory invokes premises of Vygotskian socio-cultural theory [19,20,21], namely, that learning takes place in a social and cognitive space known in Vygotskian parlance as the “zone of proximal development.” Such a perspective sees learning as a mediated process in which not only subject content is learned, but in which the relationships of mediation are crucial [22,23,24]. We use this theory to explore the social dynamics and tensions of teachers engaged in a mentoring relationship within a community of practice. Accordingly, the following research question was formulated:

How can CHAT reveal the tensions and dynamics of the mentoring experiences of physical sciences teachers within a school educational setting?

The basic elements of an activity include subject, object, tools, community, rules, and division of labor [25,26,27]. All of the elements influence the others and are influenced by social, cultural, and historical factors, such as background knowledge, personal bias, availability of tools, and other factors. **Tools** in this research included the national curriculum policy document, namely the National Curriculum Statement (NCS). The policies of a district (cluster) and the relevant school on professional development are also tools since the activity system in this research study focuses on professional development through mentoring. The **subject** is the Physical Sciences teacher and the concomitant professional development. The **object** refers to the effective development of the teacher by means of mentoring support within the community of practice.

Rules refer to the guidelines of the NCS, but also the rules of the school in which the teacher operates. In particular the rules can be the “rules of engagement” of teachers with their line managers (subject heads or HODs). The **community** refers to the school (or ecology of practice) in which the teacher works, and the symbiosis between teachers, learners, parents and institutions. **Division of labour** in the context of this study refers to the roles of the teachers who participate in this study. Figure 1 below shows an activity system adapted for this research study.

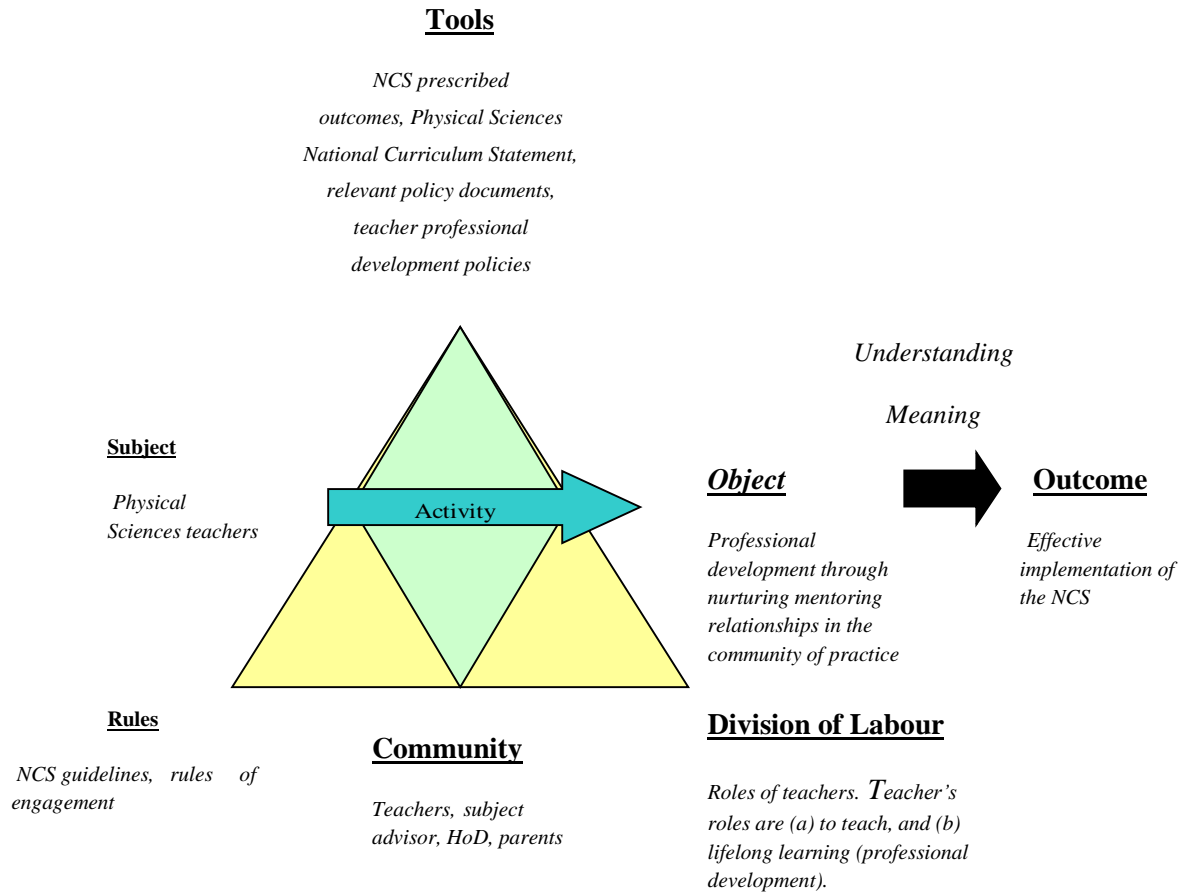


Figure 1: An activity system adapted for the research study

3. Research design and methodology

The research adopted a case study design that was used to gain an in-depth understanding of the situation [28]. The research was conducted at a city school. The school was purposefully selected as it depicted a case where Physical Sciences teachers were involved in a mentoring relationship. The location of the school was convenient as it was accessible to us in terms of travelling distance. The research extended over a period of three months. Data collected from the interviews and classroom observations were analysed qualitatively. The interviews with teachers were transcribed verbatim. Written notes were also taken for lessons observed. The other data for qualitative analysis were the comments made by teachers on the questionnaires. Data were coded using the Atlas.ti computer programme. A code is a word or short phrase that symbolically assigns a summative, salient, essence-capturing name for a portion of language-based or visual data [29]. The process of coding is guided by the analytical lens chosen [29]. With regard to this study, we were particularly guided in this process by the Cultural Historical Activity Theory grounded in the Vygotskian tradition as the underlying theoretical framework. The related codes were then grouped into categories. The ensuing categories were then named inductively using the data as a guide in deciding what a category should be called. The patterns within the categories then led to the formulation of themes. These themes were then related to the elements within the activity system.

We sought to establish reliability in this process of coding and grouping codes into families by conferring with two researchers in science education. Due to the large volume of interview transcripts it was not feasible to ask them to go through the entire process as I had done so. I therefore randomly chose a transcription of one interview, which was analyzed using the same software. There was an 82% agreement amongst the three of us in this process of data analysis.

3.1 The school

Whale High School is a city school that is located in central Johannesburg, South Africa, and is described as a former model C school. In the Apartheid education system a model C school was designated for white children. The school is now racially integrated, with many Black children travelling from a neighbouring Black township. The school now has approximately 80% Black learners with the rest of the school population comprised of Coloured, White and Indian children. The school is adequately resourced for science with two laboratories that are being used. The school has 995 students. The pass rate for the Grade 12 national exit examination in the previous year was 83%. The school fee was R5000, with a 65% collection rate. The teachers were all employed by the state. The average class size is 35.

3.2 The teachers

Mr Ndlovu has 15 years' experience teaching Physical Sciences. He is very well qualified and has a Bachelor of Science degree with mathematics and physics as his majors. He also has a Higher Diploma in Education. He is the subject head in Physical Sciences at the school. He teaches grade 11 and grade 12 Physical Sciences. The principal of the school described him as "a master educator who is an inspiration to all teachers". Mr Ndlovu appears to hold a social constructivist view of learning as he believes that "learners develop their knowledge by working socially with the teacher guiding them". The learners in his class have consistently produced excellent results. In the previous matric examination, five learners had a distinction in Physical Sciences, and all learners had achieved a mark in excess of 50%. His expertise in the subject has also been recognised by his subject advisor who has asked him to act as an examiner for a district examination in Physical Sciences. He stated that despite the enormous challenges posed by the new curriculum he had adapted to it with ease. He explained that he had always subscribed to a teaching approach where learners were "centre stage" and he would design his activities around them. Mr Ndlovu therefore has all the credentials to be considered a "keystone species" in his profession. Mr Ndlovu acted as a mentor to a novice teacher, Mr Ngidi. Mr Ngidi had graduated the previous year from a university with a Bachelor of Education degree. His specialist teaching subjects are Physical Sciences and Mathematics. He teaches grade 9 Natural Sciences and grade 10 Physical Sciences.

4. Findings

The findings on the mentoring relationship are now presented in terms of CHAT. Figure 2 below describes the elements of the activity system in terms of the case.

Tools

NCS prescribed outcomes, Physical Sciences National Curriculum Statement, relevant policy documents, textbooks, workshops, cluster meetings, mentoring discussions/ scaffolding

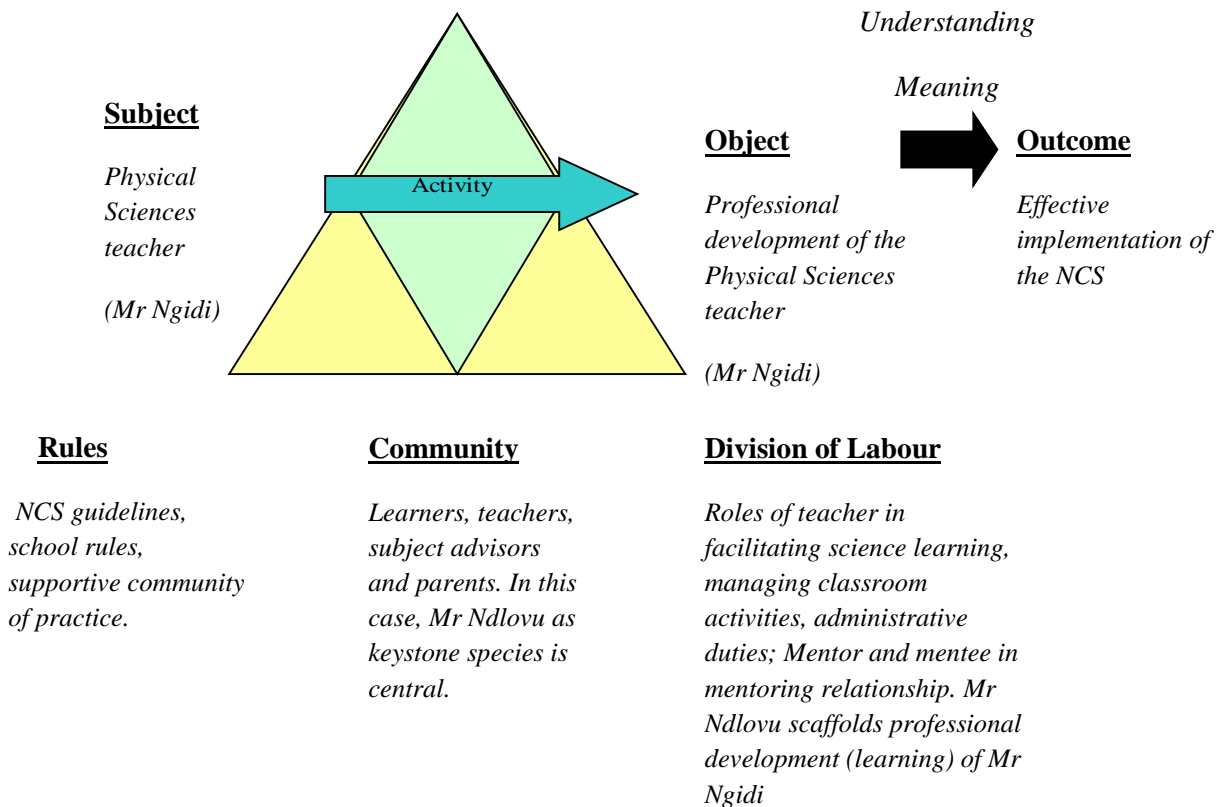


Figure 2: An activity system of professional development within a mentor-mentee relationship

4.1 Tools

The cluster meetings were perceived to be counter-productive as they did not adequately address the critical needs of teachers. The cluster meetings focus on addressing administrative matters in teaching the subject rather than issues relating to the professional development of the teachers. There is therefore a tension in the activity system between the cluster meetings which do not appear to facilitate the object, namely the professional development of the novice teacher. Also, Mr Ngidi indicated that he does not receive support from his subject advisor.

In a similar vein, the workshops attended by the novice teacher were deemed to be ineffective as they did not address the professional development needs of the teacher. To a large extent the novice teacher subscribed to the principles of new curriculum but due to his lack of experience and to a certain extent a lack of expertise encountered difficulty in infusing these principles in

his teaching. Mr Ngidi's content knowledge was sound. In planning his lessons he consulted a number of textbooks and found the content in these textbooks easy to understand. However, due to his lack of pedagogical content knowledge (PCK) he was unable to transform this knowledge so that his learners were able to access it. This was a limitation in his professional competence, which the textbook as a tool could not address. While Mr Ndlovu (keystone species) rendered excellent professional service in mentoring Mr Ngidi (novice teacher), teacher professional development would receive a major boost if the Department of Basic Education can start to encourage mentorship relationships between teachers. This might in the long term lead to optimum utilisation of available tools at schools and this is the contradiction that should be resolved for smooth functioning of schools to occur.

4.2 Subject

The *subject* is the Physical Sciences teacher and the concomitant professional development. Mr Ngidi is the novice teacher who strives for professional development in the teaching of Physical Sciences. The professional development needs of Mr Ngidi as the novice teacher in the activity system relate to content, pedagogy and contextual knowledge. He has identified certain shortcomings in his teaching practice as a result of the introduction of new topics into the curriculum. He is eager to develop himself into an effective Physical Sciences teacher. While the novice teacher is eager to enhance his professional development, he is not receiving the necessary support from the subject advisor.

4.3 The rules

Rules refer to the guidelines of the NCS and the rules of the school. The curriculum is outcomes-based and the three learning outcomes in Physical Sciences, the critical and developmental outcomes form the focus of lesson planning. Physical Sciences teachers design activities so that the three learning outcomes are addressed. Assessment tasks are designed to establish the extent to which these outcomes have been achieved. A work schedule that is prescribed by the department of education specifies the scope of content coverage as well as the time that is to be allocated to each of the topics. At the school where Mr Ndlovu and Mr Ngidi teach, learners write control tests in the first and third terms and a half yearly examination and final examination at the end of the year. The two control tests are set by the subject advisor and written by all school within the district. Teacher, therefore, needs to ensure that all topics to be covered in these tests have been completed. Apart from these summative assessments, learners need to do other tasks for assessment purposes such as projects and case studies. While the emphasis is placed on assessment policy during cluster group meetings in terms of the rules of engagement, teachers are yearning for professional development opportunities to develop their PCK.

4.4 The community

The *community* encompasses the school community in which the teachers teach as well as the extended community involving parents and teachers from other schools. The community of practice at Whale High School included Mr Ndlovu and Mr Ngidi. The relationship with other science teachers was amicable but these teachers tended to work independently and there was little evidence of collaboration. The management of the school was supportive of the professional development of Mr Ngidi. Whenever workshops were arranged by the department of education he was encouraged to attend these workshops.

Furthermore, given the fact that it was his first year of teaching, he was given a reduced teaching load compared to other teachers at his level of employment. Mr Ngidi also interacted with teachers from other schools at cluster meetings that were chaired by a subject advisor. However, he stated that these meetings did not contribute to his professional development as a Physical Sciences teacher as they did not address any of his needs that he had identified. The meetings were heavily dominated by administrative issues and he did not see any benefit in terms of his professional development. The community also includes his subject advisor. Mr Ngidi was disillusioned by the lack of support and guidance he had received from his subject advisor. To a large extent it can be inferred that the community of practice that has contributed to Mr Ngidi's professional development is confined to his school and involved his mentoring by Mr Ndlovu.

4.5 Division of labour

As a novice teacher Mr Ngidi was introduced to a number of roles he had to play. Despite some challenges he readily embraced the role of Physical Sciences teacher with a strong sense of commitment and dedication. To a large extent this state of affairs can be largely ascribed to the support and encouragement he received in his mentoring by Mr Ndlovu. In this mentoring relationship where he was being developed professionally he assumed the role of mentee with Mr Ndlovu as the mentor. In his role of a Physical Sciences teacher he started to define himself as one who facilitates learning rather than a transmitter of scientific knowledge. The management difficulties that he encountered in organising learner-centred activities such as practical investigations were negotiated through his collaboration with his mentor. Furthermore, he facilitated the understanding of science concepts by his learners by transforming the concepts into forms that were more accessible to them. The role of Mr Ngidi being an administrator in the sense of maintaining records such as lesson plans was a source of much frustration and anxiety. He maintained he did not see any value in writing up a lesson plan and found this to be burdensome. However, through his interaction with Mr Ndlovu he came to realize the real value of lesson planning. He was shown a lesson that Mr Ndlovu had developed over the years and found this to be very useful.

4.6 The object

The *object* of this activity system is the professional development of the Physical Sciences teacher so that the NCS can be effectively implemented. The new Physical Sciences curriculum has presented teachers with challenges which can only be addressed through professional development. Both Mr Ndlovu and Mr Ngidi are fully supportive of the changes to Physical Sciences curriculum. Mr Ngidi probably due to his lack of experience in teaching the subject was challenged in managing learner-centred activities and making scientific knowledge more accessible to learners. He looked to the Department of Basic Education to provide him with professional support in order to address these challenges. However, this was not forthcoming. His relationship with Mr Ndlovu who acted as his mentor enabled him to develop professionally so that he was able to overcome these challenges in his teaching. The scaffolding provided by Mr Ndlovu enabled Mr Ngidi in developing a better understanding of the nature of science and to become a more constructivist teacher. This was accomplished by sharing insights into curriculum documents based on the new Physical Sciences curriculum and putting more emphasis on the use of the constructivist approach to teaching. However, inadequate pedagogical content knowledge on the part of the novice teacher made professional development a lofty goal to achieve.

4.7 The outcome

The outcome refers to effective implementation of the NCS by the novice teacher. He was able to achieve this as a result of mentoring by a colleague who is considered to be a “keystone species” in his profession. Through his interaction with his mentor the novice teacher grew professionally and was able to teach his lessons effectively. His mentor acknowledged this and believed that Mr Ngidi had a great future as a Physical Sciences teacher. Proper induction programs for novice teachers supported by the Department of Basic Education can go a long way towards enhancing professional development. In our view, these induction programs may serve to facilitate the effective implementation of the NCS in the long term.

5. Discussion of findings

Insights into the nature of the mentoring relationship between Physical Sciences teachers revealed distinctive tensions and contradictions in terms of the activity systems which characterise the two cases. In activity system the object is the professional development of the novice teacher and the subject is the vastly experienced teacher providing mentorship. The achievement of the outcome, which is the effective implementation of the National Curriculum Statement, was complicated by several factors which can be described in terms of the elements of the related activity system. Workshops and cluster meetings organised by the Department of Basic Education were largely ineffective in addressing the professional development needs of the novice teacher. However, the mentor provided much needed scaffolding which benefited the novice teacher to a great extent.

The absence of the subject advisor in the professional life of the novice teacher appeared to be detrimental to his professional development aspirations. The subject advisor appeared to be the weak or missing link in this professional development process and this renders the existing community, a pseudo-community of practice [30]. This is a key area of concern that must be addressed by the Department of Basic Education in order to facilitate meaningful professional development of novice Physical Sciences teachers in particular. This crucial step has the potential to eventually engender dynamic, innovative and well-functioning communities of practice. The onus is on the Department of Basic Education to provide meaningful professional development opportunities through subject facilitators. The study also recognised the potential of CHAT in affording a holistic and analytical description of the mentor-mentee relationship in the professional development of teachers.

6. Conclusion

The significant reforms associated with the implementation of the South African Physical Sciences curriculum frustrated teachers’ efforts in implementing the curriculum effectively. The two critical areas of reform have been in the content of the curriculum and an investigative approach to practical work. Teachers largely endorsed these reforms but their efforts at implementing such reforms have been compromised due to their lack of competence and experience in this regard. Clearly, the expectations of teachers have grown more complex and demanding. The In Service Educational Training (INSET) from the department of education by way of the one-shot workshops has been ineffective in developing teachers. The two cases explored in this inquiry showed that mentoring does hold promise as a form of professional support for developing teachers by keystone species in the profession.

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