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

[1]Sam Ramaila and [2]Umesh Ramnarain

[1]Department of Applied Physics and Engineering Mathematics, University of Johannesburg, P.O. Box 17011, Doornfontein, 2025, Johannesburg, South Africa

[2]Department of Science and Technology Education, University of Johannesburg. P.O. Box 524, Auckland Park, 2006, Johannesburg, South Africa

E-mail: samr@uj.ac.za

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 a means by which a teacher facing challenges in teaching Physical Sciences in secondary schools in South Africa could be support 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 receives support from 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]. Suffice to indicate that CHAT has extensively been utilized as a key framework in computer science for analysing human computer interfaces [25,26]. 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 [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.

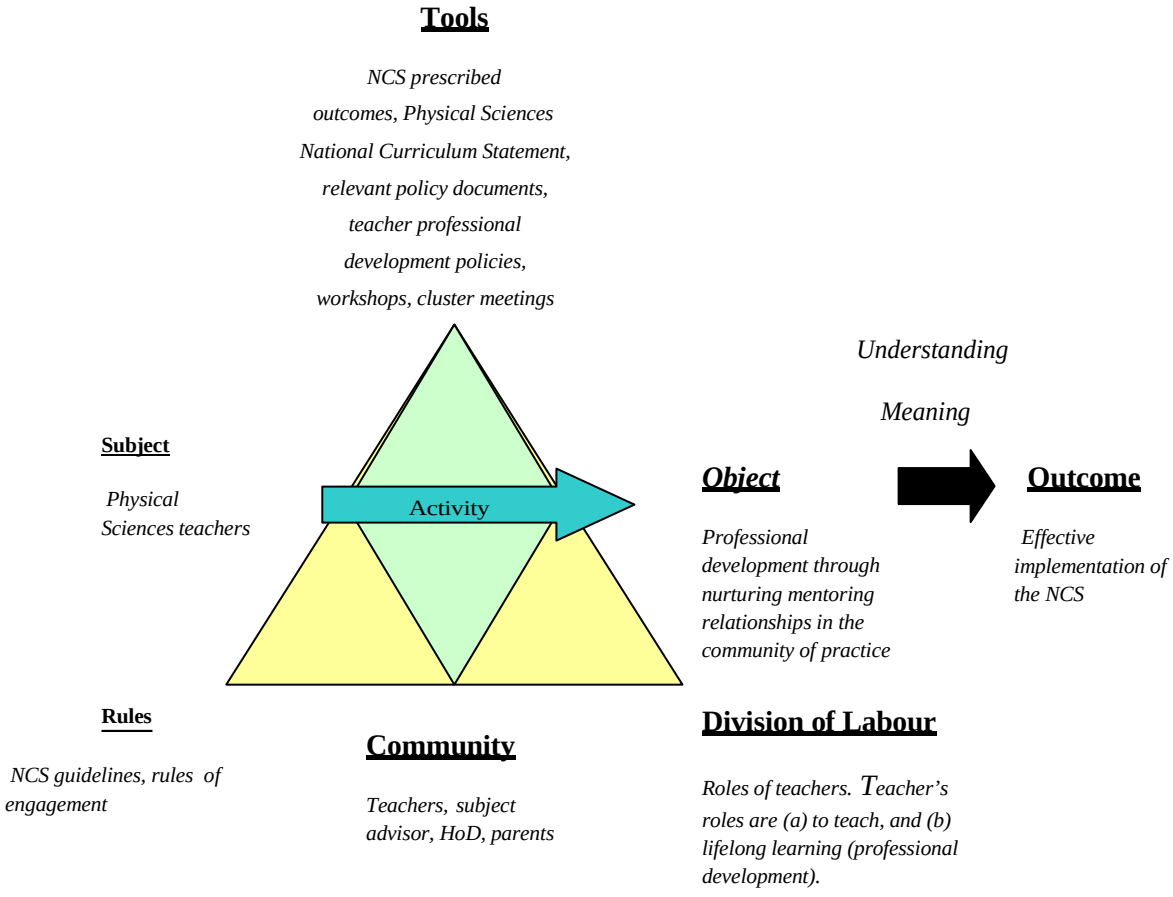

Figure 1: An activity system adapted for the research study

3. Research design and methodology

The research adopted a case study design that was used to gain an in-depth understanding of the situation. 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. 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. Discussion of findings

Insights into the nature of the mentoring relationship between Physical Sciences teachers in this inquiry revealed distinctive tensions and contradictions in terms of the activity system. In the 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 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 considerable extent. The critical tension that emerged in this regard is that crucial elements such as workshops and cluster meetings were largely not responsive to the effective implementation of the National Curriculum Statement. In essence, workshops and cluster meetings as vital tools served a minimal purpose in providing meaningful professional development opportunities for teachers in order to enhance their practice. The concomitant consequence was that teachers' creativity was essentially stifled thus limiting their capacity to become reflective practitioners in their profession.

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. 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. This unharnessed potential ought to be brought to full fruition through critical understanding and interpretation of complex dynamic activity systems affecting meaningful professional development of teachers guided by firmly established and coherent analytical frameworks.

5. 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 mentoring relationship 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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