

# A LEAP TOO FAR: AN EVALUATION OF LIFE SCIENCES TEACHERS' LEARNING DURING A THREE DAY SHORT LEARNING PROGRAMME IN INDIGENOUS KNOWLEDGE

Lounell White<sup>1</sup> & Josef de Beer<sup>2</sup>

North-West University

[Lounell.White@nwu.ac.za](mailto:Lounell.White@nwu.ac.za)<sup>1</sup>, [Josef.debeer@nwu.ac.za](mailto:Josef.debeer@nwu.ac.za)<sup>2</sup>

**ABSTRACT** – In this paper the authors reflect on the value of a short learning programme in terms of teacher professional development. Life Sciences teachers (n = 71) who attended a three-day short learning programme on infusing indigenous knowledge into their teaching of curriculum themes, had to submit evidence-based portfolios within three months after attending the course. During the short course the teachers were exposed to teaching and learning strategies such as cooperative learning, problem-based learning and reflective practices. In the portfolios the teachers had to provide lesson plans in which they incorporated these strategies and foci. In this qualitative study data were collected through the analysis of these portfolios, as well as through individual interviews with six teachers, and the analysis of the Views of the Nature of Indigenous Knowledge questionnaire. The findings show that, after the course many teachers were still unable to apply these strategies effectively in their lessons. Although the teachers were more familiar with these strategies, the data showed that many of them did not have nuanced understandings of the principles underpinning such strategies. Teachers, although they were more aware of the affordances of including indigenous knowledge in their lessons, provided very little evidence of mastering such epistemological border-crossing. In this paper recommendations are made on how such interventions could be revised in order to have a bigger impact, amongst others by establishing on-line communities of practice to further support teacher professional development.

**Keywords:** Teacher professional development; Cooperative learning; Indigenous knowledge; Epistemological border-crossing; Problem based learning; Communities of Practice; Portfolios.

## 1. INTRODUCTION

The curriculum and assessment policy statement (CAPS) for Life Sciences (DBE, 2011) states that indigenous knowledge systems should be cherished in the classroom, in order to make learners aware of the rich cultural diversity and indigenous knowledge of the people of South Africa. However, the curriculum does not provide definite guidelines on how teachers should incorporate indigenous knowledge into the curriculum (Hewson, 2015). To infuse indigenous knowledge into the classroom teachers must firstly have a good understanding of the tenets of indigenous knowledge (Cronje, De Beer & Ankiewicz, 2015), in order to be able to teach indigenous knowledge in relation to the content of the existing curricula. Teachers should also adapt their teaching strategies accordingly (George, 1999). Ogunniyi (2007), Cronje (2015) and De Beer (2016) state that teachers are still uncertain what is required from them and how to incorporate indigenous knowledge (IK) in their classrooms. Furthermore South Africa has a rich cultural diversity which makes it difficult to decide *which* indigenous knowledge to infuse into the curriculum (George, 1999; Cronje, 2015). The result is that teachers tend to marginalize indigenous knowledge when teaching or ignore it completely (De Beer, 2015).

To address this problem and to empower teachers to include indigenous knowledge in their teaching a short three day learning programme (SLP) was developed by the North-West University. This SLP emphasizes science processes (and emphasizing the tenets of science) and how it

corresponds to the tenets of indigenous knowledge. Literature indicates that to be successful short courses should include both knowledge and pedagogical approaches, and that it should furthermore emphasize critical reflection (VeLure Roholt & Fischer, 2013). The SLP therefore focused on the nature of indigenous knowledge (and the epistemological and ontological similarities and differences between indigenous knowledge and the natural sciences), and on infusing indigenous knowledge into classrooms by using cooperative learning (CL) and problem based learning (PBL) approaches. Although Bernstein (2011) cautions against the use of short courses for teacher professional development (emphasizing that more systemic, longitudinal interventions are needed, and that teacher professional development can best be scaffolded within well-functioning communities of practice), other research indicates that short courses do have merit (Van der Mark, 2013).

The research question that guided this research was: What role does a three-day short learning programme play in assisting Life Sciences teachers in their professional development, specifically in terms of infusing indigenous knowledge in their teaching approaches?

## 2. THEORETICAL AND CONCEPTUAL FRAMEWORKS

This research was anchored in social constructivism as theoretical framework. The third generation cultural historical activity theory (CHAT) (Engeström, 1987) was used as a lens for this research as it explains learning from a social interaction perspective (Ogawa, Crain, Loomis and Ball, 2008). CHAT has its roots in Vygotsky’s (1978) theory which proposes that higher cognitive development and functions can be attained through mediation by using cultural tools, signs and artifacts during the processes of social interaction (Veresov, 2009). Built into the activity theory is Vygotsky’s theory of the zone of proximal development (ZPD). In this research we specifically focus on the zone of proximal teacher development (ZPTD) (Warford, 2011), and how teacher learning could be scaffolded during the SLP. The zone of proximal development in the context of this study, refers to the epistemological border-crossing in infusing indigenous knowledge in the teaching of Life Sciences curriculum themes. Figure 1 below conceptualizes how IK can be infused into the school education system.

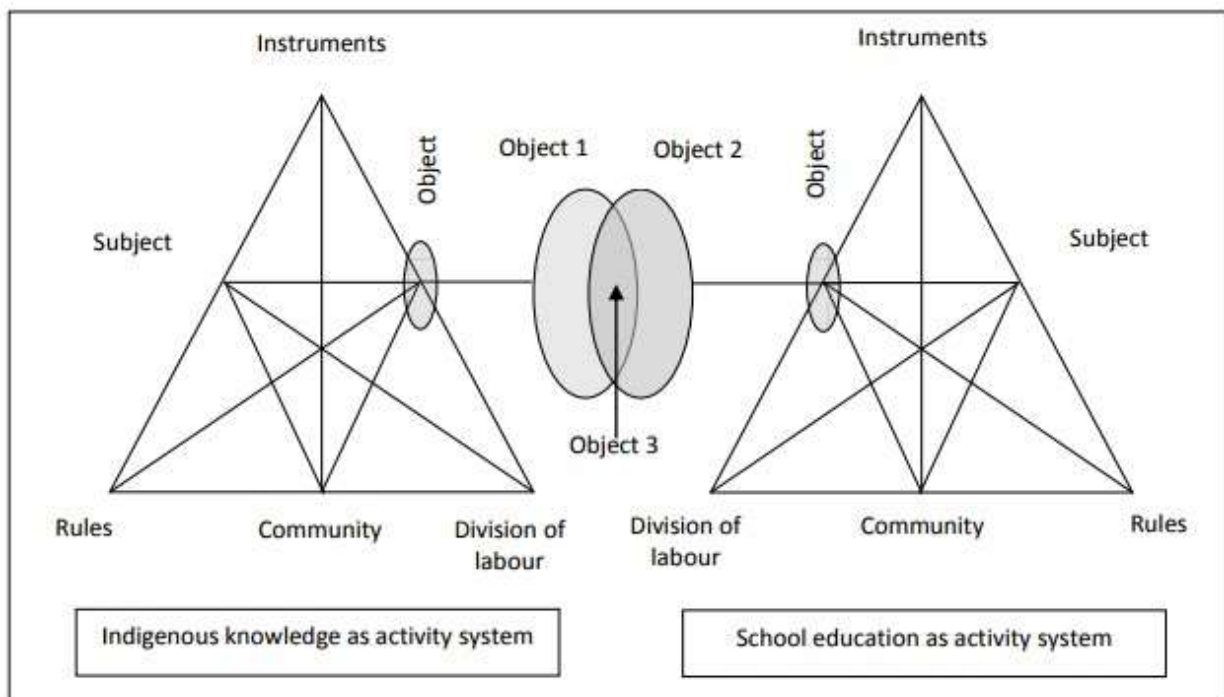


Fig. 1 Indigenous knowledge and school education as two interacting activity systems adapted from Engeström (1987) (based on De Beer & Mentz, 2016)

Two activity systems are depicted here, namely school education as activity system which is based on a western approach (on the right-hand side) versus an indigenous knowledge system where education is a more holistic experience (on the left-hand side). Rogoff (1995) states that CHAT can be used on three planes, namely the personal, the interpersonal, and the institutional or community plane, and in this example we use CHAT in the former way, but we also emphasize the reciprocal relationship between teacher and learner in the classroom. In these activity systems the subject refers to Life Sciences learners, and how their learning could be scaffolded. De Beer and Mentz (2016) show that learning embedded in cultural contexts (e.g. where learners are taught about indigenous ways by the elders or informed members of the community), often has a strong focus on cooperative learning and problem-based learning. Jautse, Thambe and De Beer (2016) show how cooperative learning is often embedded in cultural groups, e.g. among the Bakgatla-ba-Kgafela. The learning is also contextualized and needs-driven. For instance, traditionally learners in rural areas in the Hantam learn about edible and medicinal plants in order to address the basic need for food and medicine (De Beer and Mentz, 2017). The school classroom (activity system on the right) is often characterized by transmission-mode approaches, where learners are prepared for the examination (De Beer and Ramnarain, 2012). Learning is also often not well contextualized, and the learners are provided with answers to questions that they never asked. De Beer and Mentz (2016) claim that the activity system on the left far better achieve the object (outcome) to provide learners with a more nuanced view of the nature of science, and the nature of indigenous knowledge. De Beer and Mentz (2016) therefore claim that formal education could learn a lot from informal traditional education. The short course has therefore been conceptualized to show teachers how to do such epistemological border-crossing, to infuse IK into their teaching of CAPS topics, and emphasizing good contextualization, problem-based approaches and cooperative learning. Instruments (or mediating artifacts/ tools) include indigenous knowledge artifacts such as stories, processes and customs. During the short course, Life Sciences teachers for instance engage in an adapted Kirby- Bauer technique (De Villers, De Beer & Golightly, 2016) in order to test the anti-microbial properties of muthi plants. This provide the teachers with a more nuanced understanding of the nature (tenets) of both science and indigenous knowledge.

The community refers to Life Sciences teachers who attended the SLP, NWU staff who offered the SLP as well as holders of IK which supported and participated in the short course. Rules indicate the aims and objectives of the Curriculum and Assessment Policy Statements (CAPS) (DBE, 2011) which teachers have to adhere to in teaching Life Sciences, as well as the tenets of science (e.g. that science is empirical, tentative, inferential, etc), and the tenets of indigenous knowledge (e.g. that it is also empirical, tentative and inferential, but unlike the natural sciences it is also holistic, with elements of the metaphysical) (Cronje, 2015). Rules would also refer to the basic principles underpinning problem-based learning and cooperative learning. Division of labour indicates the different roles of the teacher namely a lifelong learner where the teacher should become familiar with IK principals and processes, the teacher as facilitator who incorporate IK into their teaching methodology, and the teacher as critical reflective practitioner (of which evidence should be provided in the portfolios).

As we have shown above, the object refers to Life Sciences learners developing a more nuanced understanding of the tenets of natural sciences and indigenous knowledge systems. However, the object could also refer to teacher professional development (which includes development of subject content knowledge, teaching methodology as well as pedagogical content knowledge of the teachers), would we consider the teacher in these activity systems as the subject. Object 2 indicates

the Life Sciences content which the teacher is familiar with when teaching Life Sciences which is informed by the CAPS document. Object 1 introduces aspects from the IK activity system. The intention of the SLP is that teachers should strive to infuse IK into their teaching methodology of Life Sciences which is depicted by Object 3- an integration of indigenous knowledge with CAPS themes. The SLP has therefore been developed to assist the teacher in such epistemological border-crossing between the 'western' CAPS curriculum, and indigenous knowledge (with its inherent methodologies).

### **3. METHODOLOGY**

This qualitative research followed a basic interpretive research design. A purposive sampling strategy was used to select participants in this study. Data were collected through the Views of the Nature of Indigenous Knowledge (VNOIK) questionnaire, which was developed by Cronje (2015). The VNOIK instrument consists of 10 open-ended questions aimed to probe respondents' views on the nature of indigenous knowledge. This instrument was completed by 71 teachers teaching Life Sciences in the Limpopo and North-West provinces in a pre- and post-intervention setting. Additional data were collected from 29 teachers who submitted evidence-based portfolios after the SLP. Teachers were expected to, in the portfolios, provide three lesson plans, a comprehensive reflection report as well as a laboratory report on the anti-microbial (Kirby Bauer) work done during the SLP. The lesson plans had to deal with problem-based learning, cooperative learning and infusing indigenous knowledge into the lesson.

Individual interviews were also conducted with six teachers. The transcripts of the interviews were analyzed and the data were organized into themes through coding methods described by Saldaña (2013). (Codes were clustered into categories, and from the categories, emerging themes were distilled). The VNOIK questionnaire was analysed by using the technique described by Cronje, De Beer and Ankiewicz (2015). Responses from the teachers to each of the questions were coded as an informed view, a partially informed view, or an uninformed view. To obtain the predominant category for each teacher, the average was calculated and rounded off.

Ethical clearance was obtained from the Education Sciences Ethics Committee (NWU-00271-16-A2) and all ethical guidelines followed in this research.

#### **Validity**

To ensure the validity of the VNOIK questionnaire, a panel of experts examined the instrument (Cronje, De Beer & Ankiewicz, 2015). Member checking (Creswell, 2007) was also used, and the generated findings were taken back to the participants in order to obtain feedback on whether it accurately reflect reality. This study is framed within a design-based research paradigm, and the replicability of the study is high, as the participants, intervention and instruments are well described.

### **4. FINDINGS**

The three major themes that emerged from the data are discussed below as well as the tensions observed within the activity system. We first want to point out the disappointing fact that only 29 of the 71 teachers submitted portfolios. Of these 29 teachers, only 20 obtained a pass mark- some of them only after resubmitting the portfolios, after an initial fail. Although teachers indicated that they did learn new strategies which they will be able to incorporate into their teaching, evidence collected from the interviews and especially the portfolios indicated that this was not necessarily so.

**4.1. A lack of a nuanced understanding of cooperative learning and problem-based approaches** Many teachers showed a lack of understanding of cooperative learning (CL) and problem-based learning (PBL) approaches. This was evident from the portfolios that teachers submitted, as well as

from the interviews. Many teachers did not previously use CL and PBL approaches in the classroom. This was clear from the responses from teachers: “I learned new strategies that I saw are effective and will use,” whilst another teacher indicated “I always considered cooperative learning in a huge class as a challenge but now I am more open to such approaches.”

The role of the teacher in PBL approaches were not clear to all teachers: “Yes learners become critically thinkers and the teacher does not have to work hard”. This was also evident in CL approaches where a teacher commented, “I will group learners according to their performance in class so that the most intelligent learners can help me teach the low achieving learners.” Teachers showed, despite the fact that it was dealt with in the SLP, a lack of understanding of the principles underpinning CL, such as positive interdependence and individual accountability (Johnson and Johnson, 2014).

Evidence from the portfolios indicated that many teachers were unable to use the six characteristics of PBL to develop their lesson plans although it did form part of their learning material and was discussed during the SLP. A teacher-centered approach was still followed in the majority of lesson plans, as indicated in a lesson plan where a teacher wrote “Learners listen and take notes”. There were a number of attempts to follow more heuristic and inquiry-learning approaches, but at best these were “recipe-like” experiments, where the learners were expected to follow detailed instructions, and where conclusions could easily be derived from the textbook.

This also occurred when planning lessons which included CL approaches. Here teachers did not address the five basic principles of CL (as formulated by Johnson and Johnson, 2014), but only referred to group work when addressing CL strategies in their lesson plans: “Learners discuss in groups the characteristics of gymnosperms,” and “Learners discuss in groups the main difference between indigenous, exotic species and endemic species”. Teachers could not distinguish between teacher-centred approaches and learner-centred approaches, e.g. “They were listening attentively as a polish tin and wire were used as wheel and axle and this shows that learners can learn from themselves and cooperate”. Teachers were definitely more aware of including practical activities in their lessons after the SLP, but unfortunately these were mostly demonstrations by the teacher, and there was very little evidence of active engagement (and inquiry) by the learners.

Teachers felt the need for more training in both CL and PBL approaches. This is illustrated by the following comments by teachers (reflections in the portfolios): “as educators we need more training in order to implement the approach thoroughly” and another “we need to acquire the skills to solve problems.”

#### **4.2. Insufficient knowledge and skills to teach indigenous knowledge in the Life Sciences classroom**

Although the short learning programme made teachers more aware of the affordances of IK in the classroom they still lacked sufficient knowledge and the necessary skills to implement the new approaches in the classroom. The VNOIK instrument clearly showed that many teachers still held only partially informed views of indigenous knowledge after the SLP. Although the majority of teachers who were interviewed indicated that they were able to integrate IK in their lessons, very little evidence was provided in the portfolios. Some teachers clearly showed a lack of understanding of the tenets of indigenous knowledge, as can be seen in the following comment: “IK is minds-on and hands-on learning, so in order to teach this, I will take learners out of the classroom and under the shade, especially with that chapter of environmental studies”. However, the lesson plan provided no information on how indigenous knowledge would be infused in this ecology lesson (in the shade). Most of the lesson plans referred to medicinal plants that will be mentioned in the

lesson, e.g. the cancer bush (*Sutherlandia frutescens*) or *Hoodia*, but there was only one lesson plan in one of the portfolios, where learners engaged in a laboratory exercise, in which they had to extract alkaloids from a medicinal plant.

Teachers could in general not apply the strategies of PBL in their classroom and they were unable to infuse IK knowledge with the strategy, "I will use a problem for example give learners different kinds of leaves, red, blue, green and ask them to identify the one with chlorophyll and why that colour of the leaf". This comment indicated that the teacher still followed a western approach and were unable to think of a suitable example where IK could be infused into the classroom. They were unable to think of appropriate examples of infusing IK using CL approaches as this example indicates, "teaching of biosphere and the levels, learners should be arranged in groups and discuss all the levels before teaching the topic". This example showed that the teacher were unaware of the different principles of CL and were unable to think of a suitable example of IK to use within the teaching strategy.

Evidence from the (limited number submitted) portfolios indicated that most of the teachers were unable to include IK into their lesson plans and reverted back to western approaches which they were more familiar with. The post-VNOIK responses indicated that there was a slight positive shift in teachers' understanding of the nature of indigenous knowledge, yet very little evidence of such more nuanced understandings were evident in the portfolios.

#### **4.3. Many teachers provided very little evidence of being critical reflective practitioners**

Most of the teachers provided very little evidence in the portfolios that they are critical reflective practitioners. The majority of teachers were unable to use the principles of reflection to reflect on their own knowledge and pedagogies, and to set goals for their own pedagogical content knowledge development. Many teachers did not submit their reflections at all.

Teachers were generally unable to identify problems and propose strategies to enhance their future lessons, "It was little bit challenging to link the topic with the IK. I was not sure that the strategy that I am going to use will be effective when I was planning my lesson. The playing of IK took a lot time and I was starting to panic as time was running without introducing the lesson. Too much time was consumed on arranging the IK". They were also unable to use reflection in practice where they could make amendments in the lesson itself, "I thus, had no idea of whether I should let learners discuss the issues (which result in the emotional class mood) or cut the discussion".

It is evident from the portfolios that many teachers are unable to adapt their lesson to suit the context of the learners as they feel unequipped to do so, "I was under the impression that I will be able to identify misconceptions during class planning that learners may have about a particular topic. Although I can identify some misconceptions, I realized that I overlook some because I do not come from the same context as the learners".

The data obtained through the analysis of the portfolios indicated that although some teachers are able to identify problems that learners experience with the lesson content, they are often unsure or unable to use the different steps of the reflection process to address these problems.

#### **4.4. Looking at the data from a CHAT perspective: Tensions within the activity system**

Engeström (1987) distinguished four levels of conflict affecting individuals within the activity system. We saw manifested tensions especially on primary and secondary level in this research.

On level one or primary contradictions tensions develops within each constituent component in the central activity identified and here it occurred within the teacher herself. One teacher indicated, “I lack confidence...”, and another teacher stated that “I was never trained in teaching in a laboratory set-up, and I was very nervous when we did the tests on the *muthi* plants, because I did not know how to use the equipment correctly”. It became clear from the data that many teachers lack the knowledge and skills to effectively facilitate inquiry lessons in the laboratory.

Secondary or level two contradictions appear between the constituents of the central activity. Here it was evident between the teacher and the rules, “This is because in most cases as I tried to make it part of my lesson it turns out that the information were irrelevant and as it was not covered in the curriculum”. Teachers were unable to use suitable examples of IK in their teaching practices. They also found it very hard to pay justice to the tenets of natural sciences and indigenous knowledge in their classrooms. Another such tension identified, is that the teacher often do not emerge as a critical reflective practitioner (division of labour in Figure 1).

## 5. RECOMMENDATIONS

The findings suggest that teachers benefited from the SLP as they were exposed to new strategies and the infusion of IK practices into their teaching methodology. The VNOIK instrument also indicated that teachers developed a slightly better understanding of indigenous knowledge. However teachers indicated that they need more training and some of the teachers were unable to complete their portfolios to show their competency of infusing IK into CAPS topics. It is therefore suggested that there should be additional support structures after a SLP to sustain new content and skills developed during the short course. Communities of practice as proposed by Wenger (2000) might provide the much needed mentoring and longitudinal support to scaffold teacher professional development. If teachers form part of such a community of practice they can support one another on different levels (peer mentoring). Research has shown that well-functioning communities of practice can act as a support structure to enhance teachers' professional development (White, 2016). Wenger also suggests that these communities can be online communities of practice (Farnsworth, Kleanthous and Wenger-Trayner, 2016) which means that teachers can support one another in an online environment (e.g. using a Blackboard platform). This sentiment is echoed by Bernstein (2011:22, 23) who states that “...the piecemeal, workshop type professional development currently prevalent in South Africa is not effective... Teachers learn best through interactions with other teachers and with experts acting as ‘critical friends’ in professional learning communities”.

### Acknowledgement

The authors acknowledge funding from the National Research Foundation. Views expressed are not necessarily that of the NRF.

## 6. REFERENCES

- Bernstein, A. (2011). Value in the classroom: The quantity and quality of South Africa’s teachers. *Centre for Development and Enterprise. Informing South African Policy*. Johannesburg: Centre for Development and Enterprise.
- Creswell, J.W. (2007). *Qualitative inquiry and research design. Choosing among five approaches*. Thousand Oaks, California: SAGE Publications.
- Cronje, A. (2015). Epistemological border-crossing between western science and indigenous knowledge and its implications for teacher professional development. University of Johannesburg: Unpublished PhD thesis.
- Cronje, A., De Beer, J. & Ankiewicz, P. (2015). The development and use of an instrument to investigate science teachers’ views on indigenous knowledge. *African Journal of Research in Mathematics, Science and Technology Education*, 19(3), 319 – 332.



- De Beer, J.J. (2015). Die insluiting van inheemse kennis in die wetenskapklaskamer: 'n Betoog vanuit die kultuurhistories aktiwiteits teorie. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie*. 34(1) Art.#1344 6 pages <http://dx.doi.org/10.4102/satnt.v34i1.1344>
- De Beer, J. (2016). Re-imagining science education in South Africa: the affordances of indigenous knowledge for self-directed learning in the school curriculum. *New Generation Sciences* 14(3), 34 – 53.
- De Beer, J. & Mentz, E. (2016). Self-directed learning: Lessons from indigenous knowledge holders for school science education. In: Proceedings of the ISTE Conference on Mathematics, Science and Technology Education, October 2016, pp 543 – 553.
- De Beer, J. & Mentz, E. (2017). 'n Kultuurhistoriese aktiwiteitsteoretiese blik op die houers van inheemse kennis as selfgerigte leerders: Lesse vir onderwys in Suid-Afrikaanse skole. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 36(1).
- De Beer, J. & Ramnarain, U. (2012). The implementation of the Physical- and Life Sciences curricula: Opportunities and challenges. Research report prepared for the Department of Basic Education.
- Department of Basic Education. (2011). National Curriculum Statement Grades R-12. Pretoria: Government Printing Works.
- De Villiers, L., De Beer, J. & Golightly, A. (2016). Problem-based and self-directed learning during an indigenous knowledge intervention for Life Sciences Teachers. In: Proceedings of the ISTE Conference on Mathematics, Science and Technology Education, October 2016, pp 502 – 512.
- Engeström, Y. (1987). Learning by expanding: An activity-theoretical approach to developmental research. Helsinki: Orienta-Konsultit.
- Farnsworth, V., Kleanthous, I. and Wenger-Trayner, E. (2016). Communities of practice as a social theory of learning: a conversation with Etienne Wenger. *British Journal of Educational Studies*. 64(2), 139-160.
- George, J.M. (1999). Indigenous knowledge as a component of the school curriculum. In Ladislaus, L.M. Semali and Kincheloe, J.L. (Eds.) What is indigenous knowledge? Voices from the academy. London: Falmer Press.
- Hewson, M.G. (2015). Embracing indigenous knowledge in science and medical teaching. Dodrecht:Springer Science and Business Media.
- Jautse, P.P., Thambe, N. & De Beer, J. (2016). A day at the museum: A case study of how museums could partner with universities in teacher education. In: Proceedings of the ISTE Conference on Mathematics, Science and Technology Education, October 2016, pp 438 – 445.
- Johnson, D.W. & Johnson, R.T. (2014). Joining together: Group theory and group skills. London: Pearson Education Limited.
- Ogawa, R.T., Crain, R., Loomis, M. and Ball, T. (2008). CHAT-IT: Toward conceptualizing learning in the context of formal organizations. *Educational Researcher*, 37 (2), 83-95.
- Ogunniyi, M. (2007). Teachers' stances and practical arguments regarding a science-indigenous knowledge curriculum. *International Journal of Science Education*. 29(8): 963 –985.
- Rogoff, B. (1995). Apprenticeship in thinking: development in social context. Cambridge: Harvard University Press.
- Saldaña, J., (2013) The coding manual for qualitative researchers. SAGE Publications: London.
- Van der Mark, M. (2013). The use of narratives and concept cartoons in the professional development of teachers to achieve higher-order thinking skills and deep learning about the evolution of life and geological time. University of Johannesburg: Unpublished PhD thesis.
- VeLure Roholt, R & Fisher, C. (2013). Expect the unexpected: International short-term study course pedagogies and practices. *Journal of social work education*. 49:48-65.
- Veresov, N. (2009). Forgotten methodology. Vygotsky's case. In A. Toomela and J. Valsiner (Eds.), *Methodological thinking in Psychology: 60 years gone astray?* Charlotte: Information Age Publishing, INC. Vygotsky, L.S. (1978). Mind in society. London: Harvard University Press.
- Warford, M.K. (2011). The zone of proximal teacher development. *Teaching and Teacher Education*, 27(2), 252– 258.
- Wenger, E. (2000). Communities of practice and social learning systems. *Organization*, 7, 225-246.



White, L. (2016). Re-imagining the professional development of Life Sciences teachers through professional learning groups. *Journal of New Generation Sciences*. 14(3), 126-143.