THE PROFESSIONAL DEVELOPMENT OF TEACHERS IN TERMS OF THEIR UNDERSTANDING, EXPERIENCE AND APPLICATION OF INDIGENOUS KNOWLEDGE AND COOPERATIVE LEARNING IN LIFE SCIENCES EDUCATION

Sunet Jacobs
North-West University
South Africa
jacobs.sunet@gmail.com

Josef de Beer
North-West University
South Africa
Josef.debeer@nwu.ac.za

Neal Petersen
North-West University
South Africa
Neal.Petersen@nwu.ac.za

ABSTRACT The basic supposition of this research is that learners enter the classroom with socio-cultural indigenous knowledge. Tapping into the knowledge and being supported by pedagogies that promote cooperative learning will enhance learning and ensure that it becomes more self-directed. We attempted to broaden teachers' pedagogical content knowledge by incorporating cooperative learning strategies in the teaching of indigenous knowledge. It centres on interpretive, qualitative research which reports on indigenous knowledge short learning programmes with a group of non-probable purposive selected teachers. Data collection was conducted by means of questionnaires, individual interviews and observations. As a research lens we utilised Engeström's third-generation cultural-historical activity theory (CHAT) that highlighted 'tensions' in the activity system that were likely to inhibit cooperative learning and self-directed learning in the science classroom. The following four themes have emerged from the research, namely: (a) teachers have a naïve understanding of cooperative learning and many confuse it with groupwork; (b) the short course is effective in providing teachers with a more nuanced understanding of cooperative learning; (c) where appropriate pedagogies are demonstrated to teachers in short courses, teachers display positive attitudes toward such professional learning; and (d) the short course is effective in providing teachers with an enhanced pedagogical content knowledge. In the questionnaire 59.6% of Life Sciences teachers (n = 62) indicated that the course played a major role in changing, in a profoundly positive manner, their views of cooperative learning in the classroom; and a further 37% indicated that the course made a significant difference in how they came to view cooperative learning.

Keywords: Cooperative learning (CL); indigenous knowledge systems (IKS); indigenous knowledge (IK); pedagogical content knowledge (PCK); self-directed learning (SDL); teacher professional development (TPD).

INTRODUCTION

To support learners during the development of more complex and analytical skills in the 21st century it is essential for teachers to be trained to stimulate the learners' higher-order thinking and to further develop it (Darling-Hammond & Richardson, 2009). Although the South African Curriculum and Assessment Policy Statement (CAPS) serves as a guideline for mastering objectives, teachers themselves have to take the initiative of implementing suitable teaching-learning activities (Jacobs, Vakalisa & Gawe, 2004). The teaching-learning activities can be based on the integration principle that was used during the curriculum development. This principle enables teachers to create a more inclusive and equitable learning environment through the negotiation of the curriculum differentiation and the increase in the rate of the subject matter being taught (Brough, 2007:8). The article focuses on two main aspects that can be integrated into the Life Sciences curriculum to enhance learning: cooperative learning and indigenous knowledge. Indigenous knowledge, per definition, is socially constructed knowledge that is orally transferred from one generation to the next. Cooperative learning is thus ideally suited for teaching indigenous knowledge in the Life Sciences classroom.

TEACHING-LEARNING STRATEGIES IN THE 21ST CENTURY

Several teaching-learning strategies are applicable in the 21st century and the term 'learner-centeredness' is generally used in the teaching-learning literature (O'Neill & McMahon, 2005). The strategies applied to approach teaching and learning in this manner is through participation and active learning. It gives learners the opportunity of applying the methods and focussing on the learner playing the central role in the teaching-learning activities (Jacobs et al., 2004). Hence participating learning takes place when learners become actively involved in the discovery, analysis, discussion and learning of new content and it enables the learners to apply self-directed learning (SDL).

Because learners fully participate in the learner-centred process, it is the teacher's main role to facilitate learning and, by making use of scaffolding (facilitation by giving support), guide learners to find their optimal self – a theory created by Lev Vygotsky (1978). The teacher's role is, according to Vygotsky, to guide the learner from his/her actual level of development to his/her potential level of development, and scaffolding is necessary to support the learner in this zone of proximal development (ZPD) (Vygotsky, 1978). It is essential therefore that teachers' pedagogical content knowledge (PCK) be broadened and deepened, in order for them to be able to act and serve as effective facilitators in active learning.

Teachers' pedagogical content knowledge

According to Shulman (1987) pedagogical content knowledge (PCK) refers to a teacher's ability to transform and transfer their content knowledge in ways that are pedagogically sound and powerful. That is, a teacher is capable of conveying knowledge of their subject and its content by presenting it to learners in the most effective manner possible. Teachers must command both knowledge and an understanding of the content which they are responsible for, obstacles to be overcome by learners during the learning process and the appropriate approaches and strategies at their disposal to provide the content to learners in an effective manner (Sanders, 2006). This article focuses specifically on research relating to the strategy of cooperative learning as well as teachers' understanding, experience and application of this teaching and learning strategy.

Self-directed learning and the cooperative learning strategy

Knowles (1975) defines self-directed learning (SDL) as a process in the course of which individuals take the initiative, with or without assistance from others, to identify their own learning needs, to diagnose learning problems and, from there, to set learning objectives. For effective and independent learning they will make use of available human and material resources by choosing, implementing and evaluating applicable learning strategies to determine whether the objectives have been reached. According to a study of Strods (2014), SDL can be improved by using cooperative learning strategies in the classroom. This means that learners can act cooperativiely to receive greater learning support from one another by interactively participating in the teaching-learning process.

According to Johnson, Johnson and Smith (1998), cooperative learning refers to the process during which individuals work together in groups of more than two members and communicate to learn and, in so doing, obtain a better understanding of the content to solve problems easier. When interaction and communication takes place by means of which learners participate actively in the learning process, learners understand and remember better, since their higher-order thinking is stimulated in the process (Park, 2003). It can also be related to Vygotsky's (1978) socio-constructivist learning theory which states that individuals learn through social interaction with people and their surrounding environment and through dialogue. Johnson and Johnson (2014) are of opinion that five basic principles exist, which need to be present during cooperative learning in the classroom: positive

interdependence among group members, constructive (face-to-face) interaction, individual accountability, interpersonal small-group skills and group processing. This research attempts to introduce teachers to the CL strategy for effective teaching of indigenous knowledge in Life Sciences.

INDIGENOUS KNOWLEDGE INTEGRATION IN LIFE SCIENCES

Nature or Science

The nature of science involves the values and philosophic suppositions that form the basis of the scientific method (Cronje, 2015). It attempts to describe the nature of the scientific undertaking and the characteristics of the knowledge it generates (Casey, 2012). Furthermore, Casey (2012) explains that it helps us in defining the boundaries of science and non-science better, to nurture an increase in learners' interest and to develop the awareness of the impact of science in the community. Hence teachers need to understand the nature of science, what the values and suppositions include, which are seen to be inherent to the development and they must be able to interpret scientific knowledge, amongst others, indigenous knowledge (Lederman, 1992).

Indigenous Knowledge systems

This research focuses on the teachers' ability to integrate IK in the Life Sciences curriculum by using appropriate cooperative learning strategies. Syntactically it makes sense because indigenous knowledge involves collective knowledge which is conveyed orally and cooperative learning respects the essential nature of IK. 'Indigenous knowledge' is a term that describes the knowledge of a geographical area. It can be integrated in the classroom, especially in Life Sciences, because the subject content is mostly based on the scientific study of living things from molecular level up to their interactions with one other and their environment (Department of Basic Education, 2011). Furthermore, Gadgil, Berkes and Folke (1993) explain that CL can also be defined as a cumulative body of knowledge and beliefs transferred by generations within culture and entails the relationship between living organisms (humans included) with one another as well as with the environment.

It can thus be concluded that IKSs serve as local community-based knowledge systems unique to a specific culture or community. It develops as the culture changes across generations so that they can adapt to their specific ecosystem (Cronje, 2015). The CAPS for Further Education and Training (FET) in Life Sciences indicates that IK needs to be addressed in the classroom (Department of Basic Education, 2011). However, most teachers are not capable of doing it effectively; therefore it is important to improve teachers' pedagogical content knowledge regarding IK through professional development programmes for teachers (Govender, 2014).

PROFESSIONAL DEVELOPMENT PROGRAMMES FOR TEACHERS

Introduction of teacher professional development programmes

In order for teachers to facilitate learners' development of the requisite complex and analytical skills, they need themselves to be well trained by means of attending professional development programme and mastering sophisticated teaching strategies (Darling-Hammond & Richardson, 2009). The research outlined in this paper was conducted aimed at developing a broad PCK on the part of Life Sciences teachers through their attendance at and participation in professional development programmes. The research was thus informed by the following objectives: firstly, to evaluate teacher participants' knowledge and understanding of IKS and CL; and, secondly, to improve their knowledge and understanding of IK and their competency regarding CL through the use of professional development programmes. A 16-credits short course programme in Mathematics and Natural Sciences was

developed at workshops attended by researchers of the North-West University, University of Limpopo, UJ, University of KwaZulu-Natal and the Mphebatho Museum. The researchers are part of a consortium funded by the National Research Foundation (NRF). Teachers from the Limpopo Province attended the short course on 27–29 June (n=75), 62 of whom completed the questionnaire, and teachers from the North-West Province completed the course held on 18–20 July (n=10).

Educational advantages and motivation of intervention programmes

According to Blank (as cited by Darling-Hammond & Richardson, 2009), professional development, which focuses on teachers' learning and what helps them to develop pedagogical skills, has a positive effect on the practice of education. Since these TPD programmes precisely focus on the teacher's pedagogical and IKS content knowledge, it might have a positive effect on the teaching of Life Sciences because the teachers will be able to effectively select the most appropriate strategies for facilitating learning effectively. Cronje (2015) points out the success of short learning programmes in the professional development of teachers regarding IKSs. This author is of opinion that the programme covering the integration of IK in school science can lead to effectiveness, seeing that the design principles on which the interventions are based are well-informed by good and trustworthy theoretic frameworks, namely the nature of science, the nature of IK and the principles of professional development. These proofs make it clear that teachers also need to participate in the learning process during the professional development programmes.

PROBLEM STATEMENT

Two issues emerge from deficient CL and IKS integration in the classroom: (1) the gap between teachers' knowledge, learners' prior knowledge and IK as a context, and (2) the gap between theory and practice. One of the subject-specific objectives for classroom teaching and learning is that learners must command knowledge and understanding of IKSs and be able to make further connections between the content and real-life situations (Department of Basic Education, 2011). Teachers generally do not attend to this objective (Ogunniyi, 2007). The reason for this is that teachers are not equipped with the necessary PCK to be able to teach IKSs (De Beer & Whitlock, 2009). Ogunnyi (2007) further explains that while teachers may be well acquainted with the essence of IK teaching, they do not command the necessary knowledge of appropriate teaching methods which can be applied to great effect during the integration of IKSs in the curriculum. There are still teachers who are unaware of what CL entails, what its characteristics are, and how it is to be practiced (Jacobs & Hall, 2006). Making use of teacher-centered approaches consequently deprive learners of opportunities to develop higher cognitive thinking skills such as creative problem-solving (Greyling, Geyser & Fourie, 2002). However, there is a clear lack of professional development programmes that would enable teachers to participate in cooperative activities and personally experience the potential effectiveness of the strategy in promoting self-directed learning (Ganyaupfu, 2013).

RESEARCH QUESTIONS

Primary question

The primary research question is formulated as follows: What are teachers' understanding, experience and application of indigenous knowledge and cooperative learning in Life Sciences education?

Secondary question

Three secondary questions are formulated, namely:
What is Life Sciences teachers' understanding of indigenous knowledge and cooperative learning prior to and after the professional development programme?

What is Life Sciences teachers' experience in connection with indigenous knowledge and coopearive learning prior to and after the professional development programme?

What tentions inhibit the teaching of indigenous knowledge and cooperative learning in the classroom?

THEORETICAL AND CONCEPTUAL FRAMEWORK

The research was based on the socio-constructivist theory of providing staggered or scaffolded learning support across the ZPD (Vygotsky, 1978). The third-generation CHAT (Engeström, 2015) was derived from socio-constructivism and postulated by Vygotsky in the early 1900s as a notion of restricting passive learning in classroom situations (Vygotsky, 1978). CHAT was employed as a research lens, while CL principles and the essential nature of IK came to serve as intermediary theories (filters as indicated in Figure 1). The application of this CHAT lens aimed to identify factors ('tensions') that were likely to inhibit or promote IK teaching by using the CL strategy in the learning of Life Sciences. CHAT cannot be discussed in detail in this paper due to ongoing research. The processes of self-directed learning, coopearive learning and indigenous knowledge were integrated in a socio-constructivist context, as indicated in Figure 1. The facilitators of the short courses were therefore guided by the important consideration that coopearive teaching-learning activities must reflect evidence of five elements as defined by Johnson and Johnson (2014) as well as the distinctive characteristics of IK. Coopearive learning and indigenous knowledge must be integrated in the classroom teaching with due regard for these elements and characteristics, thus increasing the possibility that learners' self-directed learning ability can be influenced.

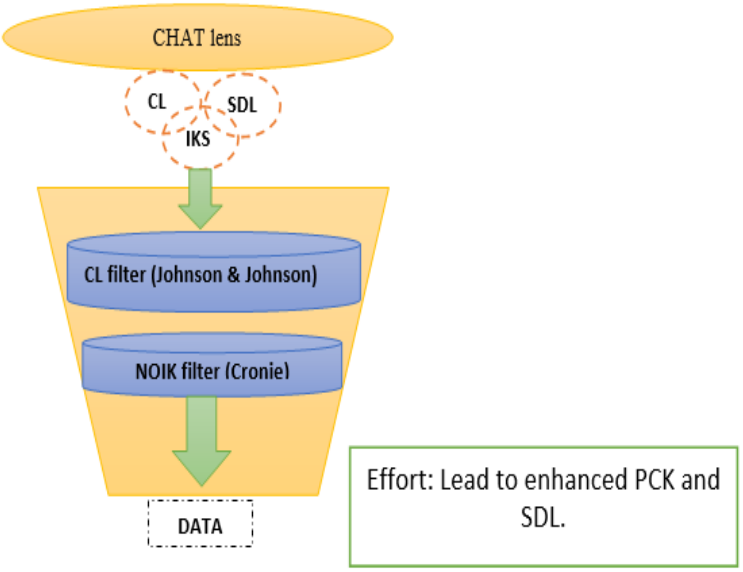

Figure *1*: *Research is approached by socio-constructivism which is studied by the third generation CHAT lens where SDL, CL and IKS will be integrated in the Life Sciences classroom.*

RESEARCH METHODOLOGY

Research approach and philosophic approach/paradigm

Empirical research was conducted and located within the framework of a sequential exploratory mixed method approach. It made use partly of quantitative data yet focused primarily on the collection of qualitative data in order to capture the teachers' experiences of indigenous knowledge and cooperative learning. Triangulation of data has been done, and we show how the qualitative data support the quantitative findings. This acknowledges the assertion by qualitative researchers that views reality as a social construct (Johnson & Christensen, 2012). The research was approached in an interpretative manner and resulted in inductive conclusions and insights. It is based on the interpretation and understanding of a particular phenomenon which the individual (researcher) has in this regard (Fouchè, Schurink & De Vos, 2011). The interpretative approach informing this research thus recognized the significance of participants' perception by focusing on Life Sciences teachers' understanding and experience. Central to the qualitative research design was the use of a case study which created the real possibility of a systematic examination of teachers being conducted. Fouchè et al. (2011) hold the view that such a design would meet the need of researchers wishing to develop a deeper understanding of the significance which participants attach to their own lives, since the latter can readily be derived from a context that evolves during the research and portrays the social patterns of participants concerned. The intrinsic case-study design is to be used when researchers' primary interest is essentially to understand the nature and constituent facets of a given situation (Johnson & Christensen, 2012). The purpose of the design is to create some understanding of a case in terms of it being a holistic entity, but also to facilitate evaluation of the internal functions of a case and to arrive at a better insight on the whole (Johnson & Christensen, 2012). Furthermore the quantitative approach was based on the one-shot case study design to determine if the teacher professional development programme was successful (Fouchè, Delport & De Vos, 2011).

Participants' selection

The systematic research was conducted by using the non-probable purposive method of sampling. Participants were selected for a specific purpose, and they consequently conformed to profile criteria of being Life Sciences teachers who attended the teacher professional development programmes and were subsequently prepared to provide further support for research thereafter (that is, research following their completion of a short course for example). Teachers who voluntarily attended the professional development programme presented by the North-West University of Potchefstroom were drawn from two provinces and surrounding areas, namely Limpopo (n=75) and North-West (n=10). Seven volunteers of differing ages and from wide-spread areas were interested in participating in the personal interviews and class observations.

Data generation strategies

The use of specific strategies was required in order to collect data pertaining to CL in classroom situations and to arrive at a better understanding of the context and implementation of such an approach. The research drew on intervention programmes that were conducted, and it aimed to describe and evaluate teacher participants' experience integration of CL by means of a questionnaire which they completed prior and subsequent to the short course attended. The use of questionnaires provided a valuable understanding of teachers' view of CL and IK respectively prior and subsequent to the professional development programme. Observations were made and were recorded by making use of a researcher's journal and an audio recorder. The purpose of the observations was to develop a thorough understanding of teachers' PCK and views regarding the indigenous knowledge TPD programme. Personal semi-structured interviews were conducted with seven teachers who participated (during and following the short course). Significant insights were derived from analysis of completed questionnaires. Factors inhibiting CL were identified and evaluated through the use of the CHAT lens during the short-course programmes. A range of data collection instruments came to be

employed therefore and served to ensure crystallisation. Moreover, the process showed evidence of rigorous results validation.

Data analysis

Discourse analysis was conducted and it was applied with effectiveness to the written and spoken discourse that was available. The latter included observation notes, the researcher journal, questionnaires and transcriptions of interviews conducted with teacher participants. All transcribed data and information were closely scrutinised during a coding process that followed. Through the use of descriptive words and unique identifying words this process also served to help sort data. The information processing included organising the data in a table and adding notes of description as well as summaries, thus leading to a conclusion. Open coding or processing was applied, since no themes and codes had been agreed upon beforehand and an inductive approach or method had been used. The process involved a close examination and division of information, comparison, conceptualisation and categorisation. Four themes became apparent and could be identified.

Validity and reliability

Credibility or internal validity refers to the importance of the accurate presentation of research results and the honesty value thereof; in other words, the results are presented in the same context that the researcher investigated (Nieuwenhuis, 2007). This indicates that the description of a situation or set of data is supported by the data collected. In the study, construct validity was ensured by asking a panel of experts (seasoned researchers) to peruse the questionnaire and interview protocol. Generalizability or external validity indicates the extent to which generalizations could be made from the data and context of the research to wider population and circumstances (Cohen, Brody & Sapon-Shevin, 2007). In this case, cooperative learning and indigenous knowledge can be generalized in any subject / learning area because it can be applied to any subject or grade by teachers.

Reliability is the degree of consistency or repeatability of an investigation, so that the same results are obtained when the same study, with the same or similar methodology, are executed (Golafshani, 2003). It will not always be appropriate in qualitative research studies because people's understanding and experiences changes (Golafshani, 2003). There were two groups of teachers who participated in the professional development programme and the results were very similar to each other.

Validity, reliability and credibility is assured in this study by using crystallisation. The researchers made use of a variety of data collection instruments to ensure crystallization, suggesting the practice of reselt validating by using more than three data-collection methods (Maree & Van der Westhuizen, 2007).

FINDINGS

The following themes were identified:

Teachers have a naive understanding of cooperative learning and many teachers confuse it with group work. Teachers were acquainted with the CL strategy and were putting it into practice, but they understood it to be groupwork or team work: *"Very familiar, but I know it as groupwork*". It could be deduced therefore that teachers were not aware of the term itself, but knew that the notion of 'cooperative' indeed referred to people working together in small groups. There were also participants who showed that they were unaware of the strategy: "*Not really well informed. Still need support. I do improvise where necessary".* According to Johnson et al (1998) CL refers to the process that involves individuals working together in groups communicating in order to achieve learning. Teachers indicated that learners would be understood to work together as a team or group in exchanging ideas with one another and creating knowledge. Their conception was borne out in statements to the effect that CL

occurred when learner and educator were working together, e.g. "*Learning of a cooperative nature which requires group members to play an active part in the process of mastering content".*

Teachers have restricted pedagogical content knowledge to effectively implement cooperative learning in the classroom. The participants were unaware of the jigsaw method and De Bono's thinking hats. This is illustrated by the following statement: *"I often administer it, but I was not familiar with the jigsaw model of cooperative learning".* It was also observed that the teachers were struggling to understand exactly what they had to do to start the activities. Teachers must have knowledge and an understanding of the content that will be taught, of obstacles that the learners will likely encounter, and the appropriate approaches and strategies that may be employed to provide learners in an effective manner with content (Sanders, 2006). Equally, it is also the teacher's responsibility to facilitate learning and by means of scaffolding to guide learners towards optimal performance (Vygotsky, 1978).

Where appropriate pedagogies are used in short courses, teachers display positive attitudes towards such professional learning. During group work we observed positive interdependence, individual and group accountability, interpersonal and small-group skills, and face-to-face interactivity. It emerged that teachers had a positive view of CL and they indicated their awareness that CL was *"learning which requires learners to respect each other and work together for the benefit of both individual and group".* Participants furthermore held the view that CL could "*help all learners to participate in the classroom"* and also *"help learners with different abilities to understand all levels of topics in the classroom".* In focusing on the aspect of IK in the teaching of Life Sciences, participants indicated that IK was an integral part of the learner's knowledge. This was explained in statement such as: "*Most learners can relate to IK", "IK is what they experience in their daily lives",* and *"when learners learn from the environment, then learning becomes meaningful".* The three statements above support the view that IK is an important factor which can be integrated in the teaching of Life Sciences, as learners were already aware of such knowledge and would benefit in their learning by connecting the content with real life (Jegede & Aikenhead, 1999).

The short course is effective in providing teachers with a more nuanced understanding of cooperative learning. The following statements support this: *"After the interaction, I clearly understand that cooperative learning involves different teaching methods such as the jigsaw method and the De Bono's Hats method. At first I did not know what it was and it is only now after attending the course that I understand it".* This result supports the vision of Cronje (2015) regarding the success of short learning programmes in the professional development.

The primary question, *"What are teachers' understanding, experience and application of indigenous knowledge and cooperative learning in Life Sciences education?", was answered in this paper.* Teachers are aware of the importance of both cooperative learning and indigenous knowledge but lacked a nuanced understanding of what it is prior to the teacher professional development programme. We also found that the teachers did not apply this in their Life Sciences classrooms but that the programme changed their understanding and experience by participating in lessons that contained indigenous knowledge as well as cooperative learning. This qualitative findings support the 59.6% of Life Sciences teachers (n = 62) that indicated that the course played a major role in changing, in a positive manner, their views of coopearive learning in the classroom; and the further 37% that indicated that the course made a significant difference in how they came to view cooperative learning.

CONCLUSION

It can be concluded that the short learning programme had a positive impact on teachers' experience and use of CL and IKSs in their teaching practice. When such a professional development programme is

developed and conducted, the teachers must be respected as professionals. It is equally important that teachers should participate in the programme, since it was quite clear during the TPD programmes that active involvement helped them achieve considerable learning. In this way they are likely to apply, with great effect, that to which they were exposed and thereby help develop self-directed learners. CHAT's usefulness as a lens for research was not taken full account of. However, a number of tensions were identified. Several teachers, for instance, emphasised that they required more knowledge and experience regarding the jigsaw method and maintaining of classroom discipline during cooperative learning. There clearly was tension between the subject (learner) and the object (teaching through the use of CL). Thus, teachers do not necessarily command the requisite 'tools' to ensure that their object is reached.

ACKNOWLEDGEMENT

We would like to acknowledge financial support from the National Research Foundation.

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