THE JOURNEY STARTS WITH A SINGLE "SIP": THE USE OF THE JAPANESE LESSON STUDY AND SENSORY TEA WHEELS IN THE TEACHING OF INDIGENOUS KNOWLEDGE IN THE LIFE SCIENCES CLASSROOM

Brits JS[1], De Beer JJJ[2] & Kgopong RM[3]
Univ of Limpopo[1, 2], North-West Univ[2],
sanette.brits@ul.ac.za[1], josef.debeer@nwu.ac.za[2], kgopongrm@gmail.com[3]

ABSTRACT– South Africa is home to a rich cultural diversity and heritage. The inclusion of indigenous knowledge in the school Life Sciences curriculum provides many opportunities for authentic learning and the enhancement of science education in South Africa. Tea is the most widely consumed beverage in the world, other than water. South Africa is home to a variety of indigenous teas (also called herbal infusions). Sensory wheels (describing smell, taste and flavor) have come into use in for food industries such as wine, whisky, beer, coffee, cheese, honey, chocolate and tea. Over the last five years, sensory (flavor) wheels have been developed in our country for rooibos (*Aspalathus linearis*) and honeybush teas. It is not only the senses of smell and taste that are important for experiencing flavor, but a combination of experiences from the senses of smell, taste, touch, and sight. The senses form part of the nervous system curriculum as outlined in CAPS (Curriculum and Assessment Policy Statement) Life Sciences Gr 10-12. In this qualitative research the authors were guided by the following research question: How can student teachers' pedagogical content knowledge be developed in utilizing inquiry learning approaches when infusing indigenous knowledge related to teas into the curriculum? From focus group interviews with fourteen 3rd and 4th year B.Ed Life Sciences student teachers from the University of Limpopo, several themes emerged, amongst others that tea is not only used as a beverage, but also for medicinal purposes, e.g. to cleanse the blood and assist with digestive problems. In the laboratory the student teachers tasted ten different teas, including rooibos, honeybush, green rooibos, white tea, black tea, *Sutherlandia frutescens* (cancer bush) tea and various infusions of rooibos with vanilla, ginger, mint and *Hoodia gordonii (ghaap)*. They also recorded the color, feel and smell of the dry tea leaves, before the boiled tea was tasted. To develop their pedagogical content knowledge within a community of practice the researchers used the Japanese lesson study approach, and the student teachers conducted this research in small groups. Among others, they were asked to develop Life Sciences activities to teach the senses using indigenous teas. They were also asked to plan a lesson in which the learners need to take on the role of "science detectives", who has to solve the mystery of pyrrolizidine alkaloid contamination of rooibos tea. The Japanese lesson study offers the student teachers the opportunity to develop communities of inquiry, exploring how indigenous knowledge (specifically indigenous teas) could enhance learning in the Life Sciences curriculum, and how inquiry approaches could be used.

Keywords: Indigenous teas, indigenous knowledge, Life Sciences education, Sensory tea wheels, Japanese lesson study, PCK.

1. Background: Contextualized Life Sciences education

South Africa's rich cultural heritage and biodiversity contribute to our indigenous knowledge (IK). IK is described as knowledge that is local and specific to a place (Khupe, 2014). The integration of indigenous knowledge into the science classroom is mentioned as a principle in CAPS Life Sciences (page 5) as follows: "…valuing indigenous knowledge systems: acknowledging the rich history and heritage of the country as important contributors to nurturing the values contained in the constitution"; it is also mentioned under specific aim 3 in CAPS of Life Sciences grade 10 – 12. Nowadays the "decolonization" and "Africanisation" of the curriculum are receiving a lot of attention, and these arguments are often embedded in political ideologies (Hall and Tandon, 2017). In this research, we argue for the inclusion of indigenous knowledge from the learning psychology, and specifically from embodied, situated and distributed cognition (Hardy-Vallee and Payette, 2008). Through contextualized science education, learners will achieve a better understanding of the subject

and appreciate the affective domain of learning (DoE, 2011). Research in the areas of neurobiology, and embodied, situated and distributed cognition research support the claims that the inclusion of indigenous knowledge could enhance learning (Wilson, 2002). Mode two-knowledge construction is context sensitive science (according to Gibbons, 2000). Indigenous knowledge provides affordances for such context sensitive science to be part of teaching and learning. We have a multicultural society in South Africa and teachers face challenges when they infuse indigenous knowledge into their classrooms. Research indicates that many teachers do not have the pedagogical content knowledge to incorporate IK in their teaching (De Beer and Van Wyk, 2012; Cronje, 2015).

The Japanese lesson study approach can assist the student teachers to develop communities of teaching and learning that can make a positive contribution to their skills development. Lesson study originated in Japan and is a collaboration-based teacher professional development approach where teachers with a shared interest collectively plan lessons that would ensure maximum student learning (Van der Walt and De Beer, 2016). The lesson study provides opportunities for teachers to do research and reflect on their teaching practices and student learning. Lesson study groups provide a good opportunity to explore how indigenous knowledge (specifically indigenous teas) through inquiry approaches, could enhance learning in the Life Sciences curriculum.

1.1 Indigenous teas

South Africa is home to a variety of indigenous teas (also called herbal infusions) (DEA, 2014). Tea is a complex product because of the many different flavor and aroma compounds that are often difficult to identify and describe. The international tea market is highly competitive and teas can be marketed more successfully when the characteristics of a specific tea can be described (Koch et al., 2012, Theron et al., 2014).

Rooibos tea, prepared from *Aspalathus linearis* (Burm. F); is a leguminous shrub with needlelike leaves *commonly* known as red bush tea (Joubert et al., 2008). Rooibos tea is a traditional beverage of the Khoi-descended people of the Clanwilliam region, and is one of only a few indigenous plants that have become an important commercial crop (Van Wyk, Van Oudtshoorn and Gericke, 2002). Rooibos tea is a popular tea in South African households due to its medicinal property and taste (Joubert et al., 2008, Nel et al, 2007). To describe the aroma of rooibos just as 'rooibos' does not do justice to the mixture of different characteristics that form part of the unique aroma and taste. Over the last five years sensory (flavor), wheels for rooibos (*A. linearis*) and honeybush (*Cyclopia*) teas have been developed in our country (Wynberg, 2017, Koch et al., 2012). The sensory wheels give a description of the spectrum of aromas and tastes that can be associated with the teas (Koch et al., 2012, Theron et al., 2014). High quality rooibos tea is associated with honey, woody, herbal-floral flavors and a sweet taste (Koch et al., 2012). Honeybush, another familiar South African herbal tea, can be described as having a combination of floral, fruity, woody and plant like aromas with a sweet taste and slightly astringent mouth feel (Theron et al., 2014). It is not only the senses of smell and taste that are important for experiencing flavor, but a combination of experiences from the senses of smell, taste, touch, and sight. Smell or the olfactory (smell) sense together with taste, contributes to our evaluation of food and beverages (Breslin, 2013). It is part of the protection of living organisms, to identify and avoid rotten and toxic substances that could be harmful (Breslin, 2013).

1.2 Pyrrolizidine alkaloid contamination of rooibos tea: an opportunity for learners to engage in problem-based learning

When infusing indigenous knowledge into the teaching of CAPS themes, the danger exists in doing it in ostensive ways, e.g. by including it simply as examples, and not embedding it within the tenets of the nature of science (De Beer, 2016). The pyrrolizidine alkaloid contamination of rooibos tea provides a lovely example of how problem-based approaches could be used in teaching indigenous knowledge

systems in the classroom. The safety of any product for human consumption is of concern to producers and consumers. Certain plants produce toxins called pyrrolizidine alkaloids (PAs), to protect themselves from the attacks of herbivores. Research reports indicating the presence of PAs in honey, fodder and herbal teas have led to concern about the safety of these products (BfR, 2013) as it is known to be hepatotoxic to humans (Van Wyk, Stander and Long, 2017). The PAs can be dangerous to human and animal health and can cause liver damage in the long run (Wiedenfeld, 2011). The occurrence of PAs is problematic, and took the rooibos tea industry by surprise. Environmentally friendly production of rooibos tea is encouraged and as a result, weeds can be present between the rooibos tea plants in the plantations (Van Wyk et al., 2017). In the plant kingdom, there are plants that resemble one another to a greater or lesser extent. This is the case with *A. linearis (rooibos tea)* and *Senecio augustifolius* (a weed also known as 'bitterbos'). In the contamination case of rooibos tea, *A. linearis* and *S. augustifolius* were harvested together and the PAs from the weed contaminated the tea (Van Wyk et al., 2017). Recommendations by Van Wyk et al (2017) included the following: *S. augustifolius* needs to be removed before harvesting and workers should be trained in the identification of the weed, because untrained workers could overlook the plant that at first glance is very similar to the rooibos plant. Young plants (*S. augustifolius*) can germinate and older ones can be the source of wind-blown seeds that could lead to the proliferation of the weed plants (Van Wyk et al., 2017). This could be a very good case study for Life Sciences learners to study in the Life Sciences classroom.

1.3 Teaching and learning (using the Japanese lesson study)

Teaching and learning are social activities, but still teachers prepare and teach mostly in isolation. This is not only the practice in South Africa, but occurs in many countries all over the world (Ono and Ferreira, 2010). Lesson study as a model for classroom instruction and teacher development has as its focus a need for collaboration of colleagues. It has been used in Japan for over 50 years and has been credited for much of the success in teaching mathematics and science (Fernandez, 2002). The Japanese lesson study has the advantage that the process assists experienced and inexperienced teachers to develop teaching skills and learn from each other because of one unique element: "joint". The lesson study cycle consists of joint planning and discussion, joint observation and joint analysis and reflection (Hamzeh, 2014; Ono and Ferreira, 2010). To develop the pedagogical content knowledge (PCK) of teachers, also pre-service teachers, guidance and interaction with peers can be valuable (Hamzeh, 2014). Joint planning and discussion of lessons can assist teachers to learn about the multicultural nature of IK and how learners from different cultures may respond to scenarios or information that an individual teacher may be ignorant of. The features of the Japanese lesson study include:

- A shared long-term goal. This is also applicable to unfamiliar content that has to be included in teaching and learning (Fernandez, 2002). This approach could assist in the infusion of IK into the Life Sciences classroom. Joint exploration and discussion could lead to the development of appropriate teaching strategies. Both academic and social development of learners can be addressed through the inclusion of indigenous knowledge into the Life Sciences curriculum.
- Thinking carefully about the goals of the content and the relevance for the learning of the learners. Reflection takes place at every step in the cycle. The teachers learn and observe from each other. As the teachers interact, they can individually realize where the gaps in their content knowledge is and then learn from each other in their interactions. A learning environment is created among the teachers and in this case the student teachers. Student teachers need interaction from peers to critically debate and reflect on their lesson plans and teaching strategies to achieve the outcome and long-term goal. During the lesson study cycle, colleagues may mention aspects of the learners and the classroom that was never thought of or mentioned explicitly. As a result of the lesson

study cycle, meaningful engagement with inquiry activities can occur (Hamzeh, 2014; Ono and Ferreira, 2010).

In this research project, the Japanese lesson study offered the student teachers the opportunity to develop communities of practice, exploring how indigenous knowledge (specifically indigenous teas) through an inquiry approach could enhance learning in the Life Sciences curriculum.

2. Aim of the research, and methodology

To investigate the question: How can student teachers' pedagogical content knowledge be developed through the Japanese lesson study approach when developing inquiry based learning activities to infuse indigenous knowledge (in this study: South African indigenous teas) into the Life Sciences curriculum? A qualitative research approach was adopted to address the above question.

A qualitative research design is effective to explore the views, knowledge and tea-tasting experiences of the student teachers and holds promise to provide what Geertz (1973) calls a "thick description". This was a single case study of multiple lesson study teams with social constructivism as theoretical framework. In this research, we looked at student teachers' PCK development through the lens of Vygotsky's (1978) 'zone of proximal development', and specifically in the parlance of Warford (2011), namely the zone of proximal teacher development (ZPTD). According to Warford (2011:253) situating learning within a Vygotskyan context blends the academic discourse of the university classroom, with the experiential discourse of the school classroom. Warford (2011) states that the ZPTD represents the distance between what student teachers can do on their own without assistance, and the proximal level that they can attain through mediation or scaffolding.

This research took place in four phases. During phase 1, two consecutive focus group discussions were held with fourteen 3rd and 4th level Life Sciences student teachers from the University of Limpopo. The aim of the first gathering was to talk about the sociocultural meaning of tea and tea drinking. Convenient sampling was done, based on the Life Sciences student teachers who were willing to participate. During the focus group interviews, it was indicated that each participant had the right to his or her opinion and to withdraw from the study if they wish to do so.

In phase 2 the student teachers were asked to engage in a tea-tasting exercise in the laboratory (which is described later in this paper). In phase 3 the student teachers engaged in a problem-based learning activity to focus on pyrrolizidine alkaloid contamination. For the latter activity, the Japanese lesson study approach was followed. During Phase 4 (sometime after the intervention), student teachers were asked to submit written reflections. These student reflections were analyzed, in order to determine what student teachers' lived experiences of the intervention were.

Methodology followed during Phase 2: Tea tasting in the laboratory
In the laboratory, the following procedure was followed:
Student teachers grouped themselves in groups of 2 to 3 students at a laboratory bench. The reason for grouping the students was to facilitate discussion. The following words were provided as a guide as it was the first time that the ESL (English second language) student teachers encountered tea tasting as a scientific activity.
Aroma: fruity, wood, floral, earth, nutty, spicy, citrus, apple, berry, grape, rose, lavender, violet, cherry, jasmine
Taste: salty, bitter, sour, sweet, umami (spicy), vanilla, pepper, mint, ginger, nut, mushroom, soil, mushy.
For the identification of the tea samples, they were provided with samples #1-10. The student teachers tasted ten different teas, including rooibos, honeybush, green rooibos, white tea, black tea,

Sutherlandia frutescens (cancer bush) tea and various infusions of rooibos with vanilla, ginger, mint and *Hoodia*.

Ten transparent plastic containers were filled with the leaves of the ten teas as listed above. The containers were marked 1 to 10. In their groups, the student teachers had to record the color of the tea leaves (sight), how the leaves felt when they rubbed it between their fingers (touch) as well as the smell (nose). Each student was provided with a container with distilled water. They were requested to rinse their mouths after tasting a sample of tea given to them. They recorded the taste and the aroma. The tea was prepared in an area where they could not see the specific packaging identifying the type of tea. Water was boiled and the tea (leaves or tea bags) left to seep for 3 minutes. The tea was then poured in sample cups that were transparent, sealed with a lid and taken to the groups. The cups were closed off to prevent the tea from cooling off too quickly and to preserve the aroma of the tea. Each participant was provided with a spoon to prevent burning when they tasted the tea if the provided sample was too hot. The participants swallowed the tea to also experience and record the after taste of the specific tea sample. Finally, they identified and wrote down the names of the ten unknown tea samples they tasted.

Methodology followed during Phase 3: Exploring pyrrolizidine alkaloid contamination of rooibos tea using a Japanese lesson study approach

It was expected from the student teachers to plan a lesson in which the learners took on the role of "science detectives", who has to solve the mystery of pyrrolizidine alkaloid contamination of rooibos tea. However, this meant that the student teachers had to first solve this problem themselves, and it involved desktop research.

Validity

Construct validity (ensuring that the interview questions measured what it is intended to measure) was ensured by asking a panel of experts to peruse the instrument. Member checking was used- the generated data was taken back to the student teachers in order for them to judge whether what was written reflected their views accurately (Creswell, 2007).

Data analysis

We made use of Saldana's (2009) coding technique to analyze the data. The in-vivo codes (codes taken from the exact words spoken by the participants) were then organized into categories, and from these categories themes emerged.

3. Findings of the research

The following themes emerged from the data collected.

Theme 1: Student teachers acknowledged that indigenous teas hold affordances for teaching and learning in the Life Sciences classroom

The student teachers in the focus group interviews indicated that tea is not only used as a beverage at social gatherings, but also for medicinal purposes, to cleanse the blood and assist with digestive problems. Rooibos tea can also be used as a milk substitute for infants who suffer from colic. Student teachers acknowledged that the learners could do some desktop research on the medicinal uses of tea, and for instance focus on the antispasmodic activity of rooibos. They acknowledged that they actually did not think of using tea as a topic in the Life Sciences classroom, but that they now realize that it could serve to make science more relevant for learners, as it relates to everyday life. (Mode 2 knowledge construction, referred to earlier in this paper). The student teachers realized that there are many everyday examples that can be included as inquiry activities in Life Sciences education lesson plans.

"It is the first time that I thought about including indigenous teas in my teaching and learning." "I am looking at topics differently now."

"I have an idea of how inquiry learning can contribute to the development of critical thinking by analyzing research on the contamination of the rooibos tea."

Theme 2: Student teachers realized that the "taste wheel" can assist learners in making accurate observations

The student teachers could identify the rooibos, *Sutherlandia frutescens* (cancer bush) and black teas correctly as well as the infusions of rooibos with vanilla and ginger. Only 50% identified green rooibos and rooibos with mint correctly. However, they struggled to match the tea tasted to white tea, rooibos tea with *Hoodia* and honeybush tea (10% correctly identified). The student teachers listed the following aromas associated with rooibos tea: rose, floral, jasmine, woody, citrus, spicy, earth and taste: ginger, mushroom, bitter, sour, fruity. On the sensory (flavor) wheel, that was developed for rooibos, woody, herbal-flower aromas and fruity taste is found.

The aromas associated with honeybush tea were floral and rose and the taste: sweet. The sensory wheel for honeybush has floral, fruity, woody and plant like aromas. As was also seen in the identification of the tea samples, the student teachers were not so familiar with honeybush tea.

Regarding preferences, the tea that 100% of the student teachers did not enjoy was the *Sutherlandia frutescens* (cancer bush) tea. The favorite tea was rooibos with vanilla (90% choice 1) with rooibos infused with ginger in second place.

After the tea tasting, student teachers indicated that this activity was actually more demanding than they thought it would be, and that it could assist the development of observation skills in the Life Sciences classroom. They also highlighted the affective outcomes that could follow such a "taste wheel" activity (see also Theme 4).

Theme 3: Student teachers indicated the value of being part of the lesson study groups (communities of practice) for their own professional development

As can be seen from the following comments, the students valued the lesson study approach:

"Debating and deciding on what learners will learn in a specific lesson that forms part of a bigger topic. Also what they need to learn and why we decided on the outcomes was made possible through the Japanese lesson study approach."

"I feel more confident about teaching aspects mentioned in CAPS Life Sciences."

"At the beginning of the study I did not want to share my ideas openly but later my fellow student teachers learned from me and I learned from them."

"Every time we reflected I built on previous knowledge and ideas."

The student teachers also commented that the lesson study approach helped them in meaningful engagement with the Life Sciences curriculum documents.

"We discussed the strands in CAPS Life Science gr 10-12 document together as a group. Debated where IK of indigenous teas can be included in a meaningful manner. I realized it can be included from grade 10 to grade 12."

"I am making a connection between aspects of taste, smell, sight, touch and tasting tea."

"From biodiversity, plant morphology, invasive plants, impact of human activities on the environment where rooibos is mentioned in CAPS, were discussed passionately in our groups."

Theme 4: Student teachers realized how the affective domain can be promoted through such an inquiry approach

Student teachers enjoyed the lesson study and inquiry activities, and commented on how they enjoyed the "detective work" in solving the pyrrolizidine alkaloid contamination. Some of the student teachers also commented on how infusing an everyday topic and activity (drinking tea) into a lesson, will make learners enjoy Life Sciences more, as they will see the link between science and everyday life. "Learners

will be amazed to see, that an everyday activity such as drinking tea is having a rich cultural history and scientific application."
"They will be able to explain the scientific foundation of our indigenous teas such as the medicinal properties of rooibos to members of the community."

5. Conclusion and recommendations

The Japanese lesson study offered the student teachers the opportunity to experience the affordances of well-functioning communities of practice. A greater understanding of how to incorporate inquiry learning with IK examples in the Life Sciences curriculum, developed. Such activities familiarize student teachers with epistemological border crossing, and how indigenous knowledge could be used to contextualize the CAPS curriculum better. Such indigenous knowledge activities, using scientific methods, could also provide student teachers with more nuanced views of the similar epistemological and ontological tenets shared by 'western science' and indigenous knowledge systems. Focused and energized collaboration resulted in enrichment of content knowledge, expansion of different teaching strategies to use in the classroom and ultimately increased the PCK of the student teachers. Both tea tasting, with the compilation of sensory (flavor) tea wheels and analyses of case studies such as the contamination of rooibos tea by pyrrolizidine alkaloids promoted inquiry learning. Various unique, South African indigenous knowledge examples are found in everyday living and can successfully be used in the Life Sciences classroom to promote contextualized learning, while appreciating our diversity. This, the authors claim, should be promoted in both pre- and in-service teacher education.

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