THROUGH THE EYES OF A PUPPET: A PEDAGOGY OF PLAY FOR THE INCORPORATION OF INDIGENOUS KNOWLEDGE IN THE LIFE- AND NATURAL SCIENCES CURRICULUM

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ABSTRACT– In recent years there have been many scholars advocating for the inclusion of indigenous knowledge in the Life Sciences curriculum and classroom. In order to successfully convey indigenous knowledge information to both learners and teachers, unique and novel science communication approaches need to be considered and developed. Nowadays there is a strong movement that we should talk of STEAM (Science, Technology, Engineering, Arts and Mathematics) and not just of STEM. Storytelling is part of the oral tradition of indigenous knowledge holders. Therefore storytelling would also be a very appropriate medium to use to incorporate indigenous knowledge in the Life Sciences and Natural Sciences classroom. In this paper we report on how we have used puppets and storytelling to teach learners, student-teachers and teachers attending in-service teacher professional development programmes about the tenets of indigenous knowledge. In the puppetry storyline the puppets engage, for instance, with traditional healing practices. This emphasize to both learners and teachers the scientific merit of such alternative health practices. Such an intervention could therefore result in teachers developing a more nuanced understanding of the nature of science, and the nature of indigenous knowledge. This resource (puppets) and pedagogy (puppetry) can be used in student teacher education, teacher training, presentations for learners and community outreach projects. In this paper we share research on teachers' views using puppets in science education. Four themes emerged from our research: (1) teachers do not use drama or puppets as a pedagogy; (2) teachers don't have the pedagogical content knowledge to use such an approach; (3) after the puppet show more teachers tend to see the affordances of such a pedagogy; and (4) for many teachers such dual border-crossing (between science and arts, and between indigenous knowledge and western science) is new, and might spark self-directed learning.
The audience will be provided with guidelines on how they should go about utilising puppets in their classrooms, and puppetry as a pedagogy will be argued from a Vygotskyan perspective.

Keywords: Indigenous Knowledge; Puppetry; Teacher education; drama as pedagogy, epistemological border-crossing.

1. BACKGROUND

The past decade saw a number of international voices going up for the inclusion of indigenous knowledge in the Life- and Natural Sciences classroom. The South African education system is no exception. There is emphasis in the Curriculum and Assessment Policy Statements (CAPS) on the integration of indigenous Knowledge and science, aimed at achieving better learner understanding and therefore enabling learners to appreciate the affective dimension of science education (DoE, 2011). This epistemological border-crossing (between science and indigenous knowledge) hold many affordances for science education.

Various views exist about what indigenous knowledge (IK) entails. Khupe (2014) describes IK as specific forms of knowledge that is local, specific to place and could be synonymous to ways of knowing. The claims regarding the inclusion of indigenous knowledge in education is substantiated based on insights from neurobiology, and embodied, situated and distributed cognition (Wilson, 2002). Distinctions between perception, cognition and action (mind, body and world) have changed over the last number

of years. Cognition is not only embodied (brain embedded in the body) and situated (in an environment), but also distributed among agents (people), artifacts and external structures (Hardy-Valee & Payette, 2008). The mind must be understood in the context of its relationship to a physical body that interacts with the world. Our argument is that capitalizing on the cultural context of the learners holds affordances for more meaningful science education.

While promoting indigenous knowledge, educators should consider the fact that South Africa is a multicultural society. In the same classroom learners from different cultural backgrounds and different social settings together engage in learning tasks. According to Pius (2005:3) multicultural education does not alienate learners from their own culture, it enables them to have a broader view and respect for other cultures without losing their roots. By including IK in education, recognition is given to diverse ways of knowing as well as the value of indigenous knowledge. Gibbons (2000) speaks of mode two knowledge construction, which he describes as context sensitive science. Indigenous knowledge provides affordances for such context sensitive science. However, research shows that teachers do not have the pedagogical content knowledge to incorporate IK in their teaching (de Beer & van Wyk, 2012).

The question is how to best incorporate indigenous knowledge in the curriculum, and make learners aware of the tenets of the nature of indigenous knowledge. Cronje, de Beer & Ankiewicz (2015) indicated that there are several tenets of the nature of science shared by indigenous knowledge as epistemology. Examples of such tenets are: human creativity, subjectivity as well as social and cultural tenets that are present in both the Nature of Science and the Nature of Indigenous Knowledge. However, indigenous knowledge also differentiate itself from science in so far that it is transmitted orally and often dealt with metaphorically. It can't be separated from ethics and spirituality, it is both holistic in nature and contextualized (Cronje, de Beer & Ankiewicz, 2015; Aikenhead & Ogawa, 2007).

In our paper we also describe a second type of border-crossing, in addition to that of western science and indigenous knowledge, namely the border-crossing between science and arts. We contextualise the use of puppetry from a Vygotskyan perspective. Vygotsky is considered the first modern psychologist to suggest mechanisms by which culture becomes a part of a person's thinking processes. Thought is not free from social and cultural influences (Vygotsky, 1978). We can differentiate between concepts learned spontaneously for example through cultural practices and scientific concepts that is learned through formal schooling. Vygotsky reasoned that improved scientific concepts are established when the foundation is laid through spontaneous learning. And this is exactly our argument: we should build in science education on children's spontaneous (and often cultural) concepts.

In order to successfully convey indigenous knowledge information to both learners and teachers, unique and novel science communication approaches need to be considered and developed- especially in the Foundation and Intermediate Phases. Storytelling is part of the oral tradition of indigenous knowledge holders, and could play a part in decolonizing the curriculum (Sium & Ritskes, 2013). Therefore storytelling and play as pedagogy through dramatic science activities, might be an appropriate medium to use to incorporate indigenous knowledge in the Life- and Natural Sciences classroom.

1.1. Drama and Storytelling as Pedagogy: learning as *Homo ludens*

Science communication is a growing area of practice and research. During the past two decades, the number of activities, courses, and practitioners have steadily increased. The most effective communication is that which involves storytelling. The power of storytelling lies in its "narrative effect," whereby it creates interest and enhances understanding and memory of the information being conveyed in the story. When it comes to science communication specifically, this effect manifests itself by increasing attention and eliciting faster and fuller comprehension of information (Dahlstrom, 2014). Stories have an emotional component and when you engage people's emotions, you stand a better chance of them paying attention and remembering your point (even if they do not agree with your

viewpoint). Research in neuroscience (Dubinsky, Roehrig and Varma, 2013) shows us that learning experiences with an emotional stamp become committed to memory.

The communication of stories can be facilitated by the use of drama activities. Natural science is ideally rational by nature. An aspect that seems to receive less attention is that science also relies heavily on creativity and imagination. To fulfil its educational potential, science education must seek creative learning environments where learners can engage with science as *Homo ludens* (the playing human), a construct of Huizinga (1955). Wagner (1980:13) speaks of the doyenne of drama in education, Dorothy Heathcote, who "…always looks for the precise dramatic pressure that will lead to a breakthrough, to a point where the students have to come at a problem in a new way, to fight for language adequate to the tension they feel". Learners are curious and critical about science and the world. Talking about their ideas helps children to clarify their thinking and it also develops their capacity to reason. At the same time it offers them insight into the value of critical reflection and promote opportunities for "interactive dialogue" dialogic teaching. Researchers suggest that a highly dialogic learning environment assists in knowledge development through complex negotiations of meaning (Lehesvuori, 2013). The pedagogical advantage of drama is that it can create environments that will appeal to the affective domain. This, according to authors such as Dubinsky, Roehrig and Varma (2013) could lead to learning committed to long-term memory. According to Heathcote as indicated in Wagner (1976), once teachers and learners have experienced the imaginary world created by drama activities they will have a deeper understanding of the real world. Odegaard (2003) indicates that drama contributes to learning about the nature of science as well as the interaction between science and society.

Characteristic of drama activities is its focus on reading, opportunities for dialogue, learner-centered discourse, and identification with the learning content. A drama approach on the one hand incorporates social interaction, humour and a sense of fun. On the other hand, learners are made conscious of interpersonal differences, which could stem from the self as well as their own prejudices, moral standing and values (Wagner, 1976).

Two strategies for teaching science through drama are described by Dorion (2009). The focus of the first strategy is on the effective contexts of cultural, social and intellectual debates. The second approach focusses on the abstract phenomena, not normally visible (Dorion, 2009). Exploring the use of a drama script and puppetry in infusing indigenous knowledge into the science classroom will make use of the first strategy. From the literature it is indicated that drama activities result in fun and excitement, aspects that are not normally associated with science related activities in the classroom (Odegaard, 2003; Dorion, 2009). Drama activities create empathy, teach about ethical issues and can make learners aware of their own morality. It offers learners the possibility of experiencing cognitive, affective and active aspects of learning in an integrated way (Odegaard, 2003). All these elements are important when infusing indigenous knowledge into the classroom.

Engaging with drama activities can result in creativity, expression of independent thinking, self - knowledge through reflection, cooperative learning and the desire to explore and learn more and independently. These characteristics can stimulate self-directed learning (SDL). Self-directed learning is a construct of Knowles (1975), and it assumes that the learners' experiences become an increasingly rich resource for learning that should be exploited in education. And where can we find a better way than to use drama as a pedagogy?

1.2 A theoretical model for drama in science education

Learners' often negative views of science are rooted in their perception that science consists only of facts and that it rarely leaves room for creativity. Drama and science have more in common than is realized by both teachers and learners. Curiosity, imagination and exploration are characteristics of both fields (Odegaard, 2003). Drama has a link to the constructivist paradigm, but despite this, it receives little attention from teachers. Drama can also be referred to as an active approach to learning.

During participating in drama activities, knowledge is constructed or re-constructed through interaction with fellow learners and the teacher (Braunt, 2015).

A theoretical model that can serve as a lens through which drama activities used in science education can be studied, is proposed by Braunt (2015) (Figure 1 under Methodology). According to the model, the science world of knowing, often conflicts with the learner's world of knowing. The nature of the activity and the effort from the teacher to address the cognitive dissonance will bring the two worlds' closer together. In this regard indigenous knowledge holds much promise in the science classroom. Research by Dorion (2009) indicated that the pedagogical viewpoint of teachers on the use of drama will determine the use and success of it in the classroom. The proposed, exploratory research with puppets and indigenous knowledge hope to share more light on this aspect.

1.3. Puppetry as communication medium

In a world flooded with information, it is essential to attract attention to the message being conveyed. The manner in which the information is packaged will affect whether the public (including teachers and learners) engages or not. Puppetry is an ancient form of theatre or performance, which is believed to have originated 3000 years BC. Puppets have been used since the earliest times to animate and communicate the ideas and needs of human societies. This art form continues to be popular around the world, featuring within a wide range of folk practices including storytelling, masked performance and ceremonies. Puppets are also used within creative therapies to enhance personal and social skills, explore emotions and support learning (Peyton & Koenig, 2007). Keogh et al (2008) refer to research that shows that teachers who use puppetry noted that it created the opportunity to present authentic problems rooted in children's everyday experience, enabling them to readily identify with the problem and with the puppet character (Keogh et al., 2008).

Puppets are widely recognized for their beneficial influence on learning and social development. They exert a powerful influence on children of all ages. Puppet language is unique in its ability to help teachers and children learn from one another, grow and relate openly, to be self-confident and self-expressive. Through "puppetry language", a teacher can personally transform common learning barriers such as oppositional behaviour, negative moods, defensive attitudes into learning benefits (Naylor et al., 2007).

To convey information in a relevant and interesting manner to young people is only one aspect, it is another to reach them emotionally (addressing the affective domain). This is also true of infusing indigenous knowledge into the curriculum (specifically in the context of science education). Puppets can engage and challenge an audience in non-threatening ways. Learning takes place in a related manner and allows learners to think and reflect. Puppets help span, integrate and unify the school curriculum, and goes a long way in providing more "contextualized" or Mode 2 science (Gibbons, 2000). A puppet is a unique teaching tool because it is three dimensional, can move, it has personal features and personality. Puppets help integrate learning processes such as oral expression, comprehension and retention of knowledge. A puppet creates a space between itself and the puppeteer, the various roles can encourage even shy learners to become part of the social learning process. When learners engage in the active and creative art of puppetry they are learning within the zone of proximal development (ZPD), and the puppets (and puppeteer) can scaffold learning across the ZPD. The puppet and the puppeteer can scaffold the student's learning from their actual development to a potential development, by providing the learners a more nuanced understanding of the nature of science. Gardner, who coined multiple intelligences, is of the opinion that puppetry is a unique element that enables educators to integrate all learning styles as well as all "intelligences". Puppeteers in puppetry, function as personal communicators that stand in for people in reality as well as in our fantasies (Korosec, 2013).

Puppets have not only been used in primary school to promote engagement in science (Naylor et al, 2007), but also in secondary school working with learners with mixed learning disabilities (Reidmiller, 2008) and social skill development amongst children and young adults in Iran (Batool, 2014). The use of puppets to include indigenous knowledge in the classroom is present in Canadian (Bartlett, 2011) and Nieu-Zealand educational approaches (Williams, 2012).

In the light of the above literature review on the advantages of incorporating drama activities, storytelling and puppetry as communication medium in the classroom, the obvious question to ask is: Why don't more teachers make use of drama activities in the science classroom?

One of the main problems for science student teachers and teachers already teaching, is that they lack a pedagogy of drama and play. This idea of a pedagogical border crossing (between the empirical epistemology of science, and the creative epistemology of the creative arts) has featured in the analysis of drama and role play in science teaching. Puppets are perceived as taking too much time and is not seen as being part of serious learning. According to Peyton (2007): "The idea of communicating playfully using a device like a puppet is just too far out for most adults and I think that speaks volumes about the classroom environment" (www.edutopia.org, 2007). According to Braunt (2015) (and we are in agreement), many teachers are concerned that they might not have the expertise to stage a quality play (or puppet show) and they fear the mistakes that they might make during the performance. The affective qualities of drama, such as empathy, engagement and motivation cannot always be assessed as easily as factual knowledge in science (Odegaard, 2003). However, to be a critical independent learner, both factual knowledge and knowledge of the affective domain is needed.

1.4. Using puppets to introduce concepts of Nanotechnology (South Africa)

One of the researchers (JS Brits) has previously used puppets to present lessons in Nanotechnology to learners at a pre-school level. Everything that happens in the nano world is invisible in the normal vision range and thus falls in the abstract category that could be represented to learners through different drama activities. After the presentation of the lessons the following observations were made: the children enjoyed interacting and speaking to the puppets, and the puppets grabbed their attention. Even shy learners were eager to talk to the different puppets and were not afraid to ask questions. The puppets reduced anxiety among the learners but stimulated interest and excitement. The learners were interested in the "nano world" that the puppets created and they even talked to their parents about what they have learned from the puppet show (Brits et al., 2014).

2. METHODOLOGY

2.1. Braunt's model

The model as proposed by Braunt (2015), explained under section 1.2 and illustrated in figure 1 (below) is used as guide. This model is in line with Vygotsky's zone of proximal development, and scaffolding of learning.

The cognitive dissonance between the two worlds of knowing (the learner's world and the science world) can be bridged by drama activities. The "space" between the two worlds is not completely empty but filled with own experiences, preconceptions and even misconceptions. How will the teacher address the cognitive dissonance indicated in Figure 1 (below) and employ methodology to bridge this gap?

For the purpose of this research we used a specific form of drama, namely a puppet show based on a script. The purpose of the script was to create awareness of indigenous knowledge in our daily lives, not only relevant for historical reasons, but also for current situations and for future applications. Examples of indigenous knowledge related to plant use (medicinal aspects of ethnobotany) that can be tested scientifically (with examples of local plants that are used for various purposes) were also

included in the script. The puppet show stimulated debate about the differences between indigenous knowledge and science, exploring the similarity between the tenets of the nature of science and indigenous knowledge. Furthermore the puppet script sensitized teachers (and learners in future) towards respecting different opinions and views in multicultural classrooms.

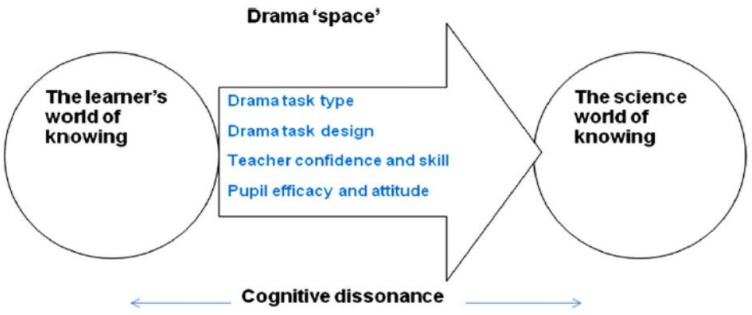

Figure 1. A model for learning science through drama (Taken from Braunt, 2015)

2.2. Interpretive qualitative research

In this study an interpretive research approach was used to explore the view of primary and secondary school science teachers (grades 4-11) regarding storytelling and puppetry as an appropriate medium to use when infusing indigenous knowledge into the science classroom.

Through two focus group interviews (the first with primary school teachers in Limpopo, and the second with high school teachers in North-West Province) data was gathered regarding the usefulness of storytelling and puppetry as medium for presenting indigenous knowledge aspects in lessons. Themes and categories were deducted from the perceptions of the teachers about the use of puppetry.

The University of Limpopo and North-West University offered short courses to teachers on the infusion of indigenous knowledge into the CAPS curriculum in 2016. These courses were attended by respectively 130 in Limpopo (27-29 June 2016), and 32 teachers in Potchefstroom (18 – 20 July 2016). A convenience sampling method was used, and six primary school teachers, and six high school teachers, participated in the puppetry research. A puppet show was performed for 6 primary school teachers to introduce them to puppetry and explore how it can be used for infusing indigenous knowledge into the sciences. A focus group discussion was held. The teachers were asked about the appropriateness and relevance of puppetry to stimulate discussion and debate in the science classroom. Similarly, a short video of the puppet show was shown to the six high school teachers in North-West, which was followed by a focus group interview. Convenient sampling was done, based on the teachers who were willing to assist.

During the focus group interviews we emphasized at the beginning of the discussions that each participant had the right to be heard and to be given time to speak out. A semi-structured interview schedule allowed for discussion to take place. Where applicable, pseudo-names were used in this article.

2.3. Validity

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

Focus group questions
1. Have you ever made use of puppets in your classroom?
2. What do you think about using puppets in the presentation of indigenous knowledge lessons? What are the possible advantages and disadvantages of the use of puppets?
3. Would you consider using video clips of puppet shows in your teaching? Why/ why not?
4. What is the meaning of puppets? What does it represent? Is this something that is common in your culture?

2.4. Data analysis

We used Saldana's (2009) coding technique, and the in-vivo codes (codes taken from the exact words spoken by the participants) were organized into categories, that resulted in four emerging themes.

3. FINDINGS OF THE RESEARCH

The following themes emerged from the data collected.

Theme 1: Teachers do not engage with puppets as a pedagogy in the Natural – and Life Sciences classroom

None of the twelve teachers have used puppetry in their teaching. Some of the comments from teachers supporting this theme are:

"I have never used puppets in my classroom"; "The department of Health came and presented a puppet show at our school regarding health issues… however, many of us were sceptical"; "I do not think that puppets portray the right image of science. Science is a serious and empirical subject, and there is no place for drama in it".

Theme 2: Teachers do not have the necessary pedagogical content knowledge (PCK) /or artistic skills/training to use puppetry as pedagogy

Eleven of the teachers in the two focus group interviews indicated that they never received training in drama or puppetry during their initial teacher education.

"Teachers might not be comfortable, they don't know how to play with puppets"; "We have not received any training."; "After seeing the puppet show I realise the value of such an approach, but I also think that it asks for technical expertise that I do not have".

Theme 3: Teachers saw the affordances of drama and puppetry as a pedagogy

After the intervention, nine of the teachers indicated that they see the benefits that puppetry could hold in the science classroom. Teachers made the following comments during the interviews:

"Learners will react positively, learners learn best through play. When you introduce a new thing they will be motivated."
"Even if language issues are addressed (Mother tongue) they will even learn better." (When prompted, the teacher indicated that such puppet shows could be scripted in African languages).
"Learners like to learn things when they see it. They also like to imitate what they are seeing."
"Learners like to see. When you see it and hear it, learners will remember."
"I enjoyed the cultural representation of the puppets (traditional hairstyle)."
"A video will make it possible for teachers to pause and ask learners specific questions and then continue with the video."
"Learners could be asked to say what would happen next then they can give their own ideas."
"For older children an "open" script (the children write it themselves) is suggested so that role play can take place."

One of the high school teachers commented that a fellow student-teacher used a puppet show during a micro-lesson in his pre-service teacher education, and he still clearly recalls the impression it made

on him. “It was such a powerful experience, and I realize that the use of puppets could create powerful lessons that make an impact”.

Theme 4: For some teachers the epistemological border-crossing is a new concept that may prompt self-directed learning in future

Ten of the teachers admitted that these border crossings between science and respectively indigenous knowledge and art/ drama creates some discomfort, and that they will have to learn more in order to facilitate such border-crossings in their classrooms. “Eish… this is all new to me. I like it, but I will have to learn more about the use of puppets in my classroom. I think I would like to experiment with it”. Another teacher commented that “I find it a bit stressful to think that I will have to do a puppet show on indigenous knowledge in my classroom. I do not see how it links with the scientific method, and I am afraid that the learners will not take it serious”.

4. CONCLUSIONS AND RECOMMENDATIONS

The majority of the teachers indicated that they were not trained in using drama as a pedagogy, and this is probably the main reason why teachers do not incorporate it in their teaching. Drama as a field is quite broad and teachers might also not be aware of all the drama activities that can be used in the classroom. After being exposed to a short puppet show, teachers indicated that they now realise what affordances puppetry have in science education. However, several of the teachers acknowledged that this border crossing is a new concept for them, and that they will need to learn more about puppetry, before they will be able to use it in their classroom. Some of the teachers also indicated that learners might not see such learning (through puppetry) in a serious light. In an education system where many teachers are used to rote and ostensive teaching and learning, a pedagogy of play is somewhat foreign.

Drama and puppetry as pedagogy deserves more attention in the education of pre-service and in-service teachers. Drama as a pedagogy could assist in expanding the constructivist approach. The drama activity can be structured and have elements of spontaneous play. The teacher has to decide how much scaffolding is needed to guide the learners. The teacher plays an important part in guiding the reflection after the puppet show has been performed or the video of the puppet show played. As various elements in drama and puppetry support self-directed learning (SDL) inclusion of these elements can assist in stimulating SDL in both learners and teachers.

South Africa has been performing poorly in school science evaluations over the past number of decades (De Beer & Ramnarain, 2012). The infusion of indigenous knowledge communicated through novel approaches such as drama and puppetry is providing a contextualised opportunity for learning and understanding to take place. The cognitive dissonance between the two worlds of knowing (the learner’s world and the indigenous knowledge context on the one hand and the science world on the other hand, as indicated in figure 1) can be bridged by drama activities.

Odegaard (2003) mentioned that “stories of science” can assist to give learners new insights into scientific processes. Stories of indigenous knowledge and from indigenous knowledge holders could be included in the form of puppet scripts to engage learners in dialogue and debates. Argumentation skills for different viewpoints regarding indigenous knowledge and science can be stimulated. The ideal would be that science learners will enter the classroom as *Homo ludens* (the playing human), and later leave the classroom as enthusiastic entrepreneurs that appreciates the value of our indigenous knowledge.

We would like to recommend that teachers get more exposed to the tenets of the nature of science in their pre-service education. Many teachers have naïve understandings of the nature of science. They all realise that science is empirical, and value the so-called 'scientific method'. However, some teachers are not consciously aware that science is a human endeavor, and that creativity and human imagination is also a tenet of science. By developing a more nuanced understanding of the nature of science, teachers might be more willing to engage in such creative pedagogies that cross epistemological borders.

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