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Drama in the Science Classroom: Reimagining the Teaching of Natural and Life Sciences[1]

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Abstract

The low levels of interest by students in science, technology, engineering, and mathematics (STEM)-related subjects and work is a challenge that needs to be resolved. And research has shown that arts-based, participatory, and humanistic methodologies—when integrated with the teaching of STEM subjects—have the potential to stimulate student interest, facilitate epistemological access, and hence, improve performance. Thus, in this self-study research paper, two science teacher educators share and reflect on their observations and experiences of using an arts-based teaching methodology (drama) in teaching science concepts and socio-scientific issues to pre-service teachers training to be high school teachers. Drama activities were used to teach the concepts of diffusion, DNA structure, meiosis, and a socio-scientific issue associated with albinism in African communities. Data were collected through the development of drama scripts, journaling observations, reflections, and discussions with a critical friend. Insights from the study show that the integration of drama into the science classroom creates opportunities for social interaction, for recognising students' active participation in their own learning, for power sharing, and for promoting engagement (cognitive, affective, and physical) that leads to the construction of new knowledge. In addition, drama pedagogy humanises science subject matter by showing its relevance and catering for varied learning styles. And drama ignites enthusiasm in students by invoking their innate sense of wonder. Consequently, adopting a STEAM (science, technology, engineering, arts, and mathematics) approach to teaching STEM subjects enriches epistemological access to scientific disciplines because such unconventional pedagogical strategies humanise abstract concepts, thereby increasing the likelihood of student success in these fields. There is, however, a need for heightened alertness in the teacher in order to pick up any misunderstandings and misconceptions about the science concepts that may manifest in the drama presentations.

Keywords: drama in science, science pre-service teachers, self-study, socio-scientific issue, participatory methodologies

[1] Ethical clearance number: H17/09/44

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Introduction and Background

We are two self-study scholars who teach natural and life sciences to pre-service teachers training to be secondary school teachers. We use drama, a participatory teaching methodology, in our teaching with the aim of exploring new ways of promoting student engagement. According to Abed (2016), drama can be an inspiring and powerful method of teaching science, which can improve students' understanding of scientific concepts as well as sharpen their aesthetic experience of science. In addition, using drama in science learning can promote the engagement of learners in science activities and help them to grasp challenging ideas (McGregor, 2012). As asserted by Alrutz (2004), drama accommodates students' multiple learning styles and interests. In an earlier paper based on this study (Nyamupangedengu, 2020), students' experiences of drama-based teaching and learning activities were reported on. In this paper, we turn the focus to us as teacher educators, and reflect on our experiences of using drama to teach science concepts for insights on how (if at all) drama can humanise and, in turn, promote inclusivity in the teaching and learning of STEM subjects that focus on natural and life sciences. The questions that guided our reflections are:

- What are our experiences of using drama when teaching natural and life science concepts to pre-service teachers?
- How can we as teacher educators use drama to humanise the teaching of natural and life sciences for enhanced student engagement, interest, and learning?

Literature Review

Teaching in ways that distance science content from students' reality, social life, and everyday context has resulted in a blind embracing of the notion that science, technology, engineering, and mathematics (STEM)-related fields are difficult and therefore not appropriate for everyone. This stereotyping has resulted in many students being prematurely excluded from STEM-related fields and work options (van Tuijl & van der Molen, 2016). Thus, appropriate all-inclusive teacher practices that involve concretising abstract STEM subjects' content could help build a strong foundation for students to find their footing early in their learning of these subjects, and thereby dispel controversial ability beliefs and the notion that some students are inherently born to be excluded from STEM subjects (Muijs & Reynolds, 2015). The early building of children's self-concept in STEM fields through designing suitable participatory learning activities is crucial because this can inform their career decisions and choices as young adults (van Tuijl & van der Molen, 2016). The early building of children's self-concept can also help address the concern that most STEM students do not perceive their courses (or their ability to complete those courses successfully) in as positive a way as do students in non-STEM subjects (Owston et al., 2020). Further, hands-on participatory teaching approaches in STEM subjects have been found to influence students' interest (Han et al., 2021) and future career prospects in these disciplines (Ching et al., 2019).

Notion of Arts-Based Education

Arts-based teaching methodologies are rooted in the use of arts subjects and methodologies for teaching STEM subjects as STEAM (science, technology, engineering, arts, and mathematics; Razi & Zhou, 2022), for example, using drama during the teaching of science as articulated in this article. Arts-based teaching approaches are based on the premise that because young children's responses to the world are mainly aesthetic and sensory, teaching strategies based on the arts have unlimited potential to captivate their interest, and enhance their motivation to learn and their cognitive engagement with the content as they play (Han et al., 2021). Thus, the rationale for embedding the arts in STEM subjects as articulated in this article is threefold. Firstly, human beings need the arts in order for their holistic development to be realised, and this innate human need for aesthetics should inform the design of curricula. Secondly, many attempts to integrate the arts with other areas of learning have occurred in the past, and further insights need to be unveiled in that direction. Thirdly and finally, a more robust and clearly articulated conceptualisation of the arts-based teaching and learning of specific content needs to be interrogated, modelled, and exemplified in STEAM subjects because children learn better in ways that are naturally suited to their motivational imperatives (Han et al., 2021). In the research literature, dramatisation has been found to be a crucial empirical aspect of student learning for three main reasons (Salimi et al., 2011). Firstly, students were found to learn from and through what they were doing in given specific drama episodes. This in line with the constructivist theory of learning, which purports that students learn better through their own manipulation of their immediate environment (Berger & Luckmann, 2011). Secondly, through dramatisation, students become active participants in their learning, compared to the passive role they play when traditional methods of talk, chalk, and board are used. Lastly, the arts encompass aesthetic components that are important for human well-being and cognitive development (Nutbrown, 2013).

The Notion of Drama Pedagogy

The use of drama as a pedagogy has been tried in many educational setups, and many benefits have emerged from it. In a study of Indian students by Alam et al. (2020), it was shown that modern classrooms need teaching approaches that can foster the learning process much more easily. In addition, the authors showed that the use of drama as a pedagogy improves reception of, and engagement with, the content for learning. Furthermore, through dramatic play, individuals develop valuable skills and abilities during their learning of educational concepts (Eisner, 2002). Drama pedagogies were found to not only be an art but could also be viewed as a science that was of aesthetic value to the participants. Furthermore, unique learning opportunities and insights are offered for the participants who learn new subject content from using drama pedagogies (Eisner, 2002). It has also emerged that drama pedagogy helps lay strong foundations for new and unique teaching and learning alternatives that uphold physicality, and are based on *performative experience* (Schewe, 2013). Research evidence has also shown that the use of drama pedagogies is a natural way of having students learn in the way that they live, that is, learning from simple concepts to complex. For instance, Schewe (2013) unveiled the notion that human life is a rolling play, and that we come to understand the complexities we face in life and life itself better through play. Corroboration of this notion arose from empirical evidence by Dunn and Stinson (2011), who concluded that there was a strong connection between dramatic play and living, teaching, and learning. In another inquiry, which examined the role reversal when players changed dramatising roles, it emerged that the students began to empathise with others' point of views; this happened even in instances where the students were not in agreement (Blatner, 1995).

Although research has shown that the use of drama can promote student engagement with content and hence learning, there is need to note that how the drama pedagogy is enacted has an impact on its effectiveness. For example, Dunn and Stinson (2011) asserted that for students to experience deeper understanding of the content to be taught, the drama pedagogies must be based on what they

termed sound *teacher artistry*. This artistry involves teachers being aware of dramatic form and able to "effectively manage the four roles of actor, director, playwright, and teacher, across both the macro and micro levels of planning and implementation" (Dunn & Stinson, 2011, p. 630).

Drama Pedagogies During Science Teaching

The choice of drama in this study was motivated by research that has shown that the use of drama improves student learning of science ideas. For example, a study by Najami et al. (2019) showed that learning chemistry through drama pedagogies contributed positively to students' achievements, their interest in chemistry, and their achievements. Elsewhere, Peleg and Baram-Tsabari (2015) found that drama pedagogies helped students perceive science as a social human experience, which enhanced and motivated their understanding of science concepts. Ødegaard (2003) revealed that the use of drama and theatre are humanistic ways of penetrating core difficult science concepts because the process of transforming and viewing textbook ideas as three-dimensional models that are alive requires rethinking and re-conceptualising knowledge. That rethinking of textbook ideas promotes unique ways of understanding the content. A study by Lerman (2003) showed that teaching through the sculpture and painting of abstract science concepts rendered them concrete and easier for the students to understand. Further, performing a dance that represented the combination and separation of chromosomes during mitotic cell division, and performing a television theatre based on Ozone the Clown enhanced the learning of mitosis and the ozone layer, respectively.

In a study in Turkey, the use of drama pedagogies revealed that learning about electrolysis through drama positively impacted those middle-school students' scores and overall achievement (Saricayir, 2010). In a later study conducted in Denmark, it emerged that students who took part in physics dramatic performances showed an increased interest in physics (Peleg & Baram-Tsabari, 2015). However, other studies on the use of drama in science teaching and learning have shown that drama activities do not necessarily assist with factual recall (e.g. Ødegaard, 2003) even though they lead to a deeper conceptual understanding of the learned science topic (e.g. Arieli, 2007).

Theoretical Framework

This research work draws from and uses the opportunities, recognition, interaction, and models (ORIM)-Arts framework (Nutbrown et al., 1996) as a theoretical lens. This theory postulates that for any arts-based learning (from children in the kindergarten to adult training), the person in the position of authority (e.g. informed adult, teacher, parent, or trainer) should provide four things for development or learning to occur: opportunities, recognition, interaction, and models.

Opportunities

In a typical arts-based learning classroom situation, teachers should provide many opportunities for students to express themselves (Nutbrown et al., 1996).

Recognition

In any social grouping, people need recognition because they are social beings. For children and adults, the authoritative others can show recognition in many ways (Hannon, 1995; Nutbrown et al., 1996), for example, praising good efforts, telling others what the individual has done well, celebrating and acknowledging their successes, and taking an interest in and following their unfolding activities.

Interaction

Human beings need social interaction with the more informed others for aesthetic reasons and for cognitive development or learning new things (Nutbrown et al., 1996). We interact with each other through, for example, talking, playing games, demonstrating, or even getting involved in real group tasks and projects. Through such social interactions, those more informed can assist the less informed to achieve more than they could do as individuals (Vygotsky, 1978). Furthermore, as the students interact in arts-based learning such as group dramatisation, they can also be exposed to individual constructivism of the STEM content embedded within the dramatisation (Berger & Luckmann, 2011).

Models

The more informed others can act as powerful role models for the less informed or novices to imitate that which they see unfolding in given different social contexts (Hannon 1995; Nutbrown et al., 1996) such as drama plays when teaching and learning in STEAM setups. Thus, being aware of and exploiting the power of the adult more-informed model is crucial for cognitive growth or learning to take place in arts-based learning fora. In this work, the role of the teacher is crucial when it comes to issues such as knowledge of the content to be represented as drama plays, and demonstrations of how a drama should unfold.

Research Design

The Methodology of Self-Study

This study took the form of a self-study in which we reflected on our use of drama in the teaching of natural and life science concepts. Self-study is a study of the self by the self. It is a methodology for studying professional practice (Loughran, 2007). It is about researching practice by teachers/teacher educators interested in better understanding and developing their knowledge of practice (Berry, 2008). Five principal characteristics typify self-study methodology. These five characteristics are that the work is self-initiated and focused; the work is improvement aimed; it is interactive; it uses multiple, primarily qualitative methods; and validity is exemplar based. Self-initiated and focused means that the teachers or teacher educators are both the researchers and the researched (Samaras, 2011). In this study, we the two authors were the participants and the researchers. However, students in the courses in which we implemented the drama pedagogy also became participants by virtue of being registered in those courses. Consent was therefore sought from those students. Improvement aimed means that the work of the teacher educators is aimed at the improvement not only of themselves but also of their students, their students' students, and their institutions and social contexts (LaBoskey, 2004). Given that in self-study, the researcher and the researched are one and the same, the study is interactive at one or more stages of the process. The interactive nature of self-study describes the monitoring process whereby critical friends, colleagues, and students are involved in the self-study project (Samaras & Freese, 2006). A critical friend is an individual in self-study who is invited to act as a sounding board (LaBoskey, 2004). Critical friends probe, prompt, and ask challenging questions with the aim of supporting the self-study scholar's reframing of events. Critical friends, therefore, join the professional learning experience so that they can adequately engage with the events, the activities, and the ideas being implemented in the study. The two authors in this study acted as critical friends to each other's work. Self-study methodology uses multiple, primarily qualitative, methods for gathering data. The use of multiple methods provides opportunities for the self-study researcher and for others to gain different angles or viewpoints on the educational processes being investigated thereby providing a more comprehensive view of the process. Validity being exemplar based means that validation is achieved through "the construction, testing, sharing and re-testing of exemplars of teaching practice" (LaBoskey, 2004, p. 859). Exemplars of practice are concrete documents and examples of practice that are presented as exhibits to allow members of a relevant research

community to judge for themselves the trustwothiness and validity of the observations and interpretations.

Participants

The main participants in this study were we, the two authors, and we chose to investigate the use of drama in the courses that we teach for ease of access and of planning. Tholani teaches a natural science course to 1st-year students and Eunice teaches genetics to 4th-year students training to be secondary school teachers. In addition, because we have been teaching these courses for several years now, we were familiar with the topics in the course, and the concepts that we find challenging to engage students in. Our students for that year, 150 1st-year students in Tholani's class, and 80 4th-year students in Eunice's class also became participants by virtue of being registered for the courses in which the class activities were planned. Eunice applied for ethics at her university because she was the lead investigator in the project. Students' consent were sought although the focus of the study was on the authors' following roles: play writer (which would manifest in producing the scripts), director (which would manifest in directing the actual acting by the students), and the teacher (which would manifest in providing the four things for development or learning to occur as explained earlier—opportunities, recognition, interaction, and modelling during both the planning and enactment of the drama activities).

The following four concepts were dramatised: diffusion, the structure of DNA, meiosis, and a socio-scientific issue. The concept of diffusion was dramatised in Tholani's class and the other three concepts in Eunice's class. Tholani chose the topic of diffusion because he had struggled to concretise the movement of molecules during diffusion to promote student understanding. Eunice chose the three aspects dramatised in her class for the following reasons. She chose to have the structure of DNA dramatised because even though the structure can be concretised through use of models, describing the structure of DNA introduces challenging content and many unfamiliar terms, which overwhelms students, making it difficult for them internalise its structure. The excerpt below is a short example of the challenging content and terminology that is presented to students when teaching about the DNA structure:

> *DNA is a nucleic acid macromolecule. The basic building blocks of DNA are called nucleotides. Each nucleotide consists of a sugar (deoxyribose), one of four bases (cytosine (C), thymine (T), adenine (A), guanine (G)), and a phosphate. Cytosine and thymine are pyrimidine bases and are single ringed, while Adenine and guanine are purine bases and are double ringed. DNA is made up of 2 strands/double stranded. Each strand is made up of a string of nucleotide molecules. The 2 strands are anti-parallel i.e. they run in opposite directions and have a sugar phosphate back-bone. A purine base pairs with a pyrimidine i.e. Thymine with adenine and guanine with cytosine. The 2 strands are joined by hydrogen bonds. The sugar phosphates are joined by covalent bonds. (Eunice, personal notes based on ideas by Reece et al., 2017)*

As can be seen in the excerpt above, the content is dense with terminology and descriptions that need to be understood in order to visualising the structure. Eunice therefore wanted to explore how (if at all) dramatising the DNA structure would allow students to engage with the concept without becoming overwhelmed. Meiosis is the second concept that was dramatised in Eunice's class. Meiosis is a biological process but it is represented in textbooks as static stages, making it challenging for students to visualise. Therefore, Eunice wanted to explore whether drama could bring the static stages to life. The third aspect dramatised in Eunice's class was a socio-scientific issue around the genetic condition, albinism. She teaches about genetic disorders in her genetics course, including their impact on individuals, on families, and on communities at large. This drama was based on a true story she had witnessed in her home village. She wanted to expose students to this story through drama, and find

out what lessons the students could take away from it. No changes were made to the content or structure of the two courses. The only change was the introduction of drama pedagogy to the teaching and learning activities.

Sources of Data

As is required in self-study, multiple forms of data were collected. These comprised scripts (i.e. descriptions of drama activities), journal entries of our discussions of the drama activities, and journal entries from our reflexivity. Four scripts were produced—the descriptions of the four drama activities we used to teach the concepts of diffusion, DNA, meiosis, and the socio-scientific issue, respectively. Next, we offer five examples of various data forms that were generated.

1. Drama Script: Socio-Scientific Issue, a Child With Albinism Born to Parents with Melanin Skin Pigment

> *In the rural village of Nyanga, there is a couple who after getting married the wife got pregnant and gave birth to their first child. The birth was celebrated by the whole family. The wife got pregnant again and gave birth to an albino child. The husband's relatives and even hers accused the woman of infidelity because there has never been an albino in the history of the family. They wanted their son to divorce the woman. The husband was sure that his wife did not cheat him. He however could not explain how they could possibly have an albino child. The birth of this child therefore brought division and misery in a once happy family. A social worker at a local clinic then suggested that the family go for genetic counseling and DNA tests. The genetic tests showed that both parents and the normal boy were all carriers of albinism. Because of the tension and the charged atmosphere within this family, it was decided that the results of the DNA tests be presented and explained at the chief's compound.*

2. Eunice's Journal Entry of Part of the Discussion of her Drama Script With her Critical Friend

Tholani: What motivated you to come up with this story around albinism?

> *Eunice: I was teaching the topic genetic disorders, which included teaching about genetic tests and genetic counselling. When I am teaching biology, I want my students to always appreciate the relevance of the knowledge that they are learning. Therefore, in this case, I wanted them to see why it is important for them to have knowledge of albinism as a representative case as well as knowledge of the importance of the associated concepts of genetic tests and of genetic counselling etc. The story is based on a real-life story. . . . The actors were the Chief and his policeman, the social worker, the couple with the albino child, the wife's relatives including her parents, the husband's relatives also including his parents, and people from the husband's village where they lived. The class was divided into two groups that dramatised the script.*

Tholani: Why did you decide to get it dramatised?

> *Eunice: Most socio-scientific issues are controversial and impact individuals and families. Therefore, I was of the idea that dramatising the issue would provide opportunities for the class to engage in and possibly experience the human suffering that may arise when family and/or community members are not familiar with the science behind manifestation of the albinism condition.*

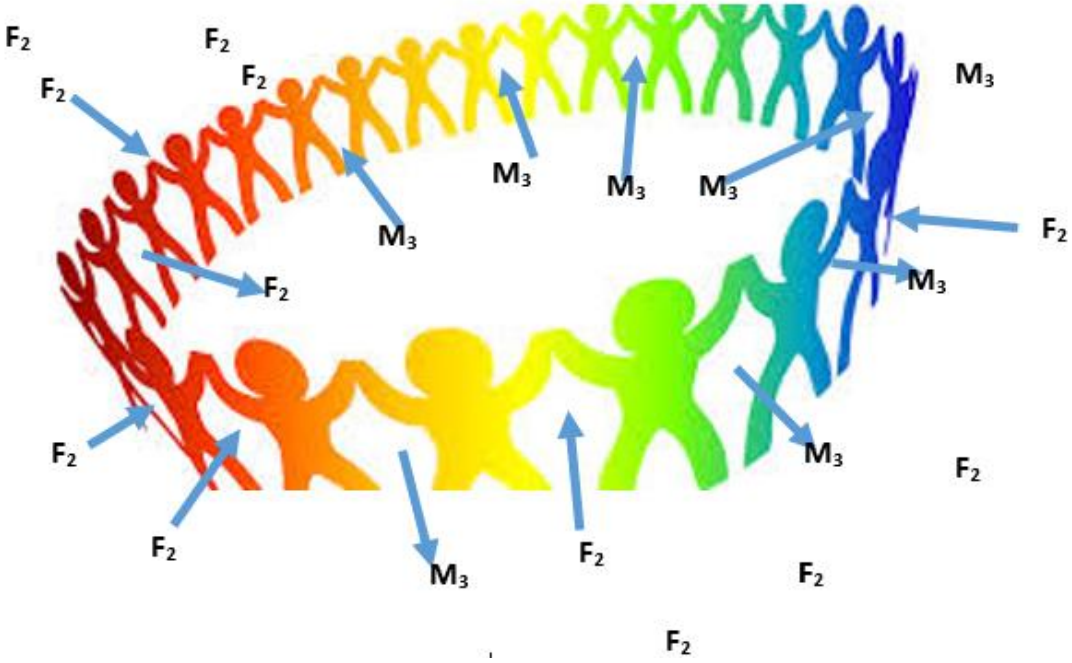
3. Drama Script in Tholani's Course: Diffusion in the Alveolus

In Tholani's class, the students were required to dramatise the process of diffusion as it happens in the alveolus. The students therefore, were to dramatise the behaviour and movement of oxygen and carbon dioxide into and out of the alveolus down their concentration gradients, respectively. Description of the drama activity:

> *A few students will form a circle as shown in Figure 1 below from the drama script. The drama will be done in an open space of the soccer field, the 60 female students (F) will represent oxygen, and will all be dressed in white coats. Ninety male students will represent carbon dioxide as follows: a third of them will be dressed in blue to denote the carbon in carbon dioxide structure, and the other two thirds (60) will be dressed in white coats to represent the two oxygen atoms on the CO_2 molecule. The female students will join hands in pairs to denote an oxygen molecule (O_2), which is a diatomic molecule. The male students will join hands in a ratio of two in white and one in blue to denote carbon dioxide (O=C=O) as also depicted in Figure 1. A whistle will be blown to indicate that "diffusion" should start. When the whistle is blown, music will be playing in the background and the dramatisation will begin with students in their respective pairs and groups (males or females) attempting to move from where their kind are many to where they are few. This movement will be allowed to continue for about half a minute until the whistle is blown again and the slow tune of the music turned off.*

Figure 1

Diagram Depicting the Dramatisation of Gaseous Exchange in the Alveolus



4. Tholani's Journal Entry of Part of the Discussion of his Drama Script With his Critical Friend

Eunice: What motivated you to use drama for teaching this content?

> *Tholani: Over the years when teaching the topic of gaseous exchange, I struggled to explain in concrete terms what happens at atomic and molecular level. This is because I struggled to have real-life examples to refer to when teaching the issue of atoms and*

molecules making up oxygen and carbon dioxide. I envisaged that it is quite abstract for the students to visualise things they only read in books and have not seen in everyday life. My pedagogical reasoning was that having the students acting as atoms and molecules, with some background music playing, would provide something to relate to when learning about this topic.

5. Example of a Journal Entry of Tholani's Observations During the Dramatisation of Diffusion

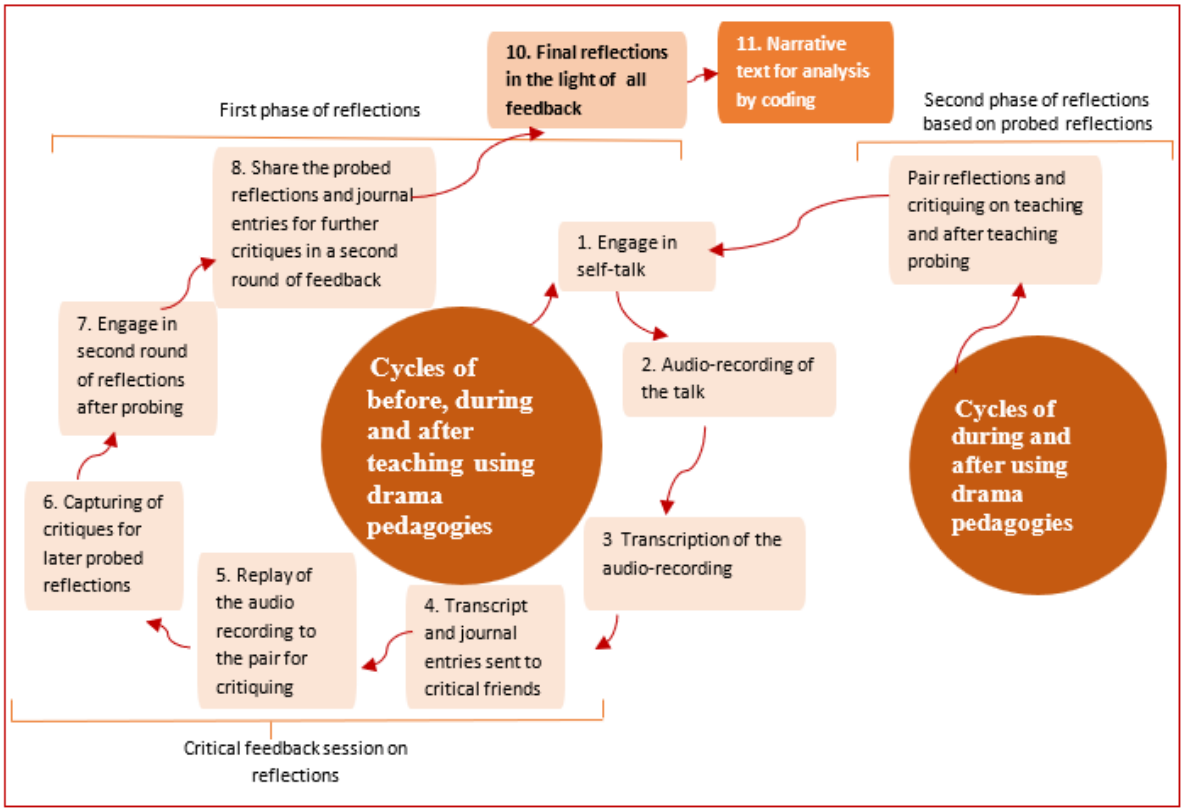
Some students danced to the rhythm as they move in a gliding style. The students had to move in relation to the slow tone/beat of the rhythm. The rationale for using the country music beat was to have the students move at a flowing pace the way oxygen and carbon dioxide gases enter and leave the alveolus. After the whistle was blown, and the music stopped, the numbers of pairs and groups of students, both male and female were counted on both sides. Seemingly, after the movement, some female student pairs were inside the circle and some still outside. The male students were also distributed randomly both inside and outside. After four phases of blowing the whistle and stopping, most of the female students were inside the circle and most male students were outside the circle.

Data Analysis: Engagement in Reflexivity

Data analysis in this study followed what Samaras (2011) described as a "hermeneutic process" (p. 197), whereby data collection and analysis happen concurrently and continually back and forth. We engaged in reflexivity that entailed three phases: before, during, and after the drama activities. The purpose of engaging in reflexivity was to document our individual thoughts on how the drama activities had unfolded—including challenges and any insights on how to represent content for teaching through drama pedagogies. Our documentation kept a trail (Samaras, 2011) of the pedagogical reasoning and actions of each of us throughout the inquiry. The documented trail made it easy to share our thoughts and ideas about the use of drama pedagogies when teaching natural and life sciences. The reflexivity entailed 11 steps as depicted in Figure 2 below. The rationale for engaging in these steps was to maximise the validation of our research findings.

Figure 2

Reflexivity Phases Engaged in During This Investigation (based on ideas by Tshuma, 2023)



Reflections Before, During, and After Teaching

The first phase entailed two steps: a) journal entries and free flow reflections on our individual perceptions about drama pedagogies, and b) we then exchanged our journal entries and reflection transcripts in order to look at each other's work and write probing critical comments. During the critical feedback, we posed critical comments to the reflections and journal entries we had shared. This was a crucial validation step because it assisted us to view drama pedagogical issues beyond our personal biases and limitations. We each captured the critiques to use to re-engage with our actions, views, and experiences in a second phase of reflections or probed reflections as shown in Figure 2, Step 8.

In the second phase of reflections, we shared reflections on how we had responded to each other's critiques raised in the initial feedback session. These cycles of reflection and feedback took centre stage at every step of this inquiry in the repetitive style shown in Figure 2. After the teaching and all the feedback sessions, we engaged in the final reflection sessions where we produced narrative descriptions of our observations and experiences including lessons learnt throughout the entire study for thematic coding as also depicted in Figure 2.

Analysis of Narratives From the Reflexivity Cycles

The last of the reflexivity phases shown in Figure 2 (Step 11) was the generation of narrative texts for thematic analysis. Below, we present examples of three coded narrative texts—two from Eunice, followed by one from Tholani.

1. Coded Extract From the Narrative Description of the Drama on Meiosis

> *The meiosis process was the first to be dramatised at the time of introducing drama as part of the activities in the biology course. I had to use some authority (lecturer uses authority) to get students to engage in the drama activities as some students could not see immediate relevance of the drama activities to the learning of science concepts. However, once students had gone through the script, the drama idea began to make sense and they engaged in the discussions assigning roles to each other in their groups (opportunities created for social interaction). Those with a good understanding of the phases and events were also observed explaining to the group and demonstrating the behaviour of chromosomes (opportunities created for more knowledgeable other [MKO] mediation). To accurately dramatise the process, students were seen referring to their notes and searching the internet to acquaint themselves more with the content they were about to act out (opportunities created for engagement with content). As the discussions were proceeding, I would move between the groups, listening to the explanations, acknowledging (opportunities for teacher to recognise-recognition) the correct explanations as well as prompting them to think further, where I could see that they are missing key aspects of the process (opportunities created for MKO mediation). The different groups began to add their own ideas to the scripts including more roles (engagement and social interaction). Therefore, two groups out of four were eventually agreed upon. Individuals from the dismantled groups got added to the two groups as they needed more people to effectively dramatise the process.*

2. Coded Extract From the Narrative Description of the Drama on a Feud Within an African Family After the Birth of a Child With Albinism

> *Unlike the drama on meiosis, which was based on content only, this one included both science and social aspects. While the meiosis one was prepared and acted on the same day during a 3h practical session, the socio-scientific issue drama required more time as there was need for research on both the science content and the social aspects e.g. the roles and responsibilities of the chief and his policemen. Students needed to think through how to explain how it is possible for normal parents to give birth to a child with albinism to lay people, what genetic counselling entails etc. The script therefore provided opportunities for students to do research as it alerted students to what they didn't know. During the dramatisation, students engaged with scientific- concepts such as DNA, genes, alleles, genetic tests, paternity tests (students engaged with science concepts) as they were explaining them during the "hearing" at the chief's compound. Misunderstandings got exposed in both the talk and the actions (misunderstandings exposed in the social exchanges). Many African students identified with the issue (relevance). Some white students were fascinated by the set-up and indicated that they had learnt something about the African culture (diversity). There was both cognitive and affective engagement during the drama as participants intensely brainstormed the dilemma that the birth of this child had brought to this African family (cognitive and affective engagement). Participants had to also think out of the box to come up with understandable ways of representing scientific concepts.*

3. Narrative Text From Tholani

> *When representing alveolus gaseous exchange content through drama, I included music to cater for those students who enjoy music as they learn (knowledge of pedagogy). I also had in mind that there is a child in every adult, and thus, I envisaged that playful learning could invoke deep-seated understanding of abstract concepts. I observed that some of the students were reluctant to play as kindergarten kids before the dramatisation started. This is because when I asked them to leave the lecture hall for the spots field, some of them*

seemed reluctant. However, when in the field and the drama unfolding, I could see that I had awoken the little kindergarten kids within them (excitement ignited). I noted that they would all pay attention so that they hear the whistle blow so that they navigate in limited spaces between groups to make as much progress towards their targeted direction (physical engagement). Because the students were joining hands as pairs and groups, their movement was slowed down as they would bump into each other the way diffusion molecules will also not flow smoothly. The students seemed excited as they played like small children and some of them danced as they move.

Presentation of Findings

The following themes came out of the analysis of our narrative texts:

- Opportunities for social interaction.
- Opportunities for recognition.
- Opportunities for power-sharing.
- Opportunities for engagement (cognitive, affective, and physical), which led to construction of new knowledge.
- Relevance of the science subject matter.
- Varied number of learning styles catered for.
- Opportunities for constructivist ways of learning.
- Tensions.

Discussion of Findings

Drama, by its nature, requires collaboration because it is a collective activity. Every participant is assigned a role to play. As a result, dramatising the natural and life sciences concepts promoted social interaction (Vygotsky, 1978) because each student was continually engaging with their environment—that is, other students, with us their lecturers, and with the content—(Khoza & Nyamupangedengu, 2018). Further, this social interaction in turn promoted all three forms of engagement (cognitive, affective, and physical), which led to the construction of new knowledge. The students came up with their own understanding of content as they dramatised the science content in the company of each other. For instance, one student came up with insights about issues of molecular sizes as excerpted below:

Rose: I did not know that carbon dioxide molecule is bigger that oxygen molecule, I just thought they were gases.

Tholani's reflection: The comment by Rose was an eye-opener in relation to what I wished to see happening in the classroom, I thus quizzed the student to find out the details behind the conclusion: "What is it that makes you say carbon dioxide is a bigger molecule than oxygen?"

Rose: Male students were in larger small groups than the female students, as they even struggled to move around.

Rose's response is evidence that students construct their own understanding of the abstract science content as they actively dramatise that content during the teaching and learning process. This corroborates the theory of constructionism of knowledge as put forth by Berger and Luckmann (2011).

The social interaction provided a unique opportunity for students to internalise the content in relation to their participation involving that content. This is because they had opportunity to visualise the abstract concepts in the social plane of their playful encounters and, in some instances, to take on the role of more knowledgeable others as they taught and learnt from each other. For instance, during the alveoli gaseous exchange drama, one member of the group of the male students suggested to his group how they could navigate or "diffuse" faster out of the circle:

> *Jack: For us to move faster, let us not hold hands and walk side by side, but let us hold hands and move in a file one behind the other.*
>
> *Journal entry: This statement by Jack alludes to factors that affect the rate of diffusion in general and in the alveolus in particular. I am going to use this suggestion by Jack to initiate a class discussion in the next class.*

In addition, the use of drama pedagogy led to us relinquishing power because we were no longer the only sources of knowledge. Providing open scripts that students could add to, allowed them to make choices on how they wanted to present the content they were dramatising. In this way, power was shared between us the lecturers and our students. Dramatising the concepts also brought relevance to the science subject matter, which in turn, humanised the concepts. Many African students identified with what was enacted in the albinism drama and some of them shared their experiences of how children with this condition are badly treated in their own communities because of lack of knowledge by members of the community. Many students appreciated the importance of science knowledge in everyday life. The drama also provided a window into less known professions and services like social workers and counselling services, and the roles of chiefs.

> *Kate: I have always wondered what the role of chiefs is.*
>
> *Thabiso: I now have an idea of what social workers' work involve.*

As can be seen in the utterances above, Kate was a white student and the drama gave her a glimpse into the roles of a chief and how they conduct their business:

> Ma'am, this is so fascinating. The chief was very patient and listened to everyone but when *he* began to speak, he spoke with authority but at *the* same time merciful understanding. He seemed to know what causes albinism. So, are all chiefs learned?

Thabiso, an African student acknowledged that in Black African communities, professions like social work are hardly spoken about: "I had no idea what they really do." Therefore, drama activities such as this one, if done at high school level, can not only humanise life sciences concepts, but also increase students' awareness of careers associated with the discipline beyond mainstream ones, and possibly influence their interest (Han et al., 2021) and future career prospects in these disciplines (Ching et al., 2019).

Tensions From Use of Drama Pedagogy

Although there were many positives arising from the use of drama in the teaching of natural and life sciences concepts, there were also some tensions. See excerpts below from each of our journals:

In today's drama, Tom seems to have forgotten that genes and allele are different concepts, and explaining them is crucial for a better understanding of albinism. I had no choice but to intervene. My intervention however seemed to have derailed Tom's enthusiasm. Do I need to desist from interfering when incorrect statements are made? At what point was I to get involved? Will the drama bring the understanding that I was expecting it to bring? At what point should I correct misunderstandings and misconceptions? (Eunice)

During the drama, I itched to stop the drama and comment on what was unfolding in relation to the content of alveoli gaseous exchange. This is because we were outside, and that unusual learning environment seemed to excite the students to focus on their next drama more. I felt I was missing out on good opportunities to explain and have the students see the link between the content being learnt and their drama moves. I had these questions at the back of my mind: What is the best time to highlight the link between the unfolding drama episode and the actual science content? Will stopping the drama to explain issues not disturb the fun and flow of the drama and have the "children" in them being switched to the "adult" in them? (Tholani)

Those are some of the tensions that we grappled with, and are still grappling with. This is because even though our observations in this study showed that students gain a lot (relevance, social interaction, knowledge of the concept), in a few cases, the incorrect explanations stick with the students and sometimes, just as with any use of models, there is a misinterpretation of the represented structures—leading to misconceptions.

Conclusions

Although drama is usually common in the domains of language, this study has shown that bringing it into the science classroom creates opportunities for social interaction, for recognising students' active participation in their own learning, for power-sharing, for promoting engagement (cognitive, affective, and physical) that leads to construction of new knowledge, relevance of the science subject matter, and catering for varied learning styles. In addition, drama pedagogy sparks excitement amongst students because it awakens the kindergarten children in them. The excitement during playful learning elicits deep concentration that is crucial for grasping abstract concepts. Thus, the approach of teaching STEM subjects as STEAM improves epistemological access to the sciences subjects. This is because such unusual pedagogical approaches humanise the science subject matter. Furthermore, whilst it calls for a deep understanding of content to represent it in the form of a drama episode, the use of drama allows for power sharing. This power sharing provides students with opportunities to act as more knowledgeable others to each other and, in turn, takes from the teacher, the burden of being the only one to explain abstract science content to the students. The teacher must, however, be alert in order to clarify any misconceptions and misunderstandings that can arise from the dramatisation activities.

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