https://doi.org/10.36315/2024v1end013
Education and New Developments 2024

TEACHING SCIENCE THROUGH HUMANISING PEDAGOGIES: THE SOUTH AFRICAN PERSPECTIVE

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Abstract

This inquiry involved 60 Grade 11 biology students, and 3 teachers from different schools. The students were of Xhosa and Zulu origin in South Africa. After teaching the topic of carbohydrate fermentation to Grade 11 students over the years, two problematic issues recurred year in and year out. The different cohorts of students found this topic abstract as evidenced by their poor scores in given unit tests. The teachers also struggled to teach this topic in ways that are student engaging as they would just narrate the details of the topic and the students would take notes. In a quest to resolve this dilemmatic classroom scenario, two main research questions guided this inquiry: What is the impact of engaging humanising pedagogies in the teaching and learning of science content? How could science content be integrated with South African indigenous knowledge system for enhanced student understanding? A quasi-controlled experiment was used. The control group was taught through the broadcast method and the experimental group was taught through humanising pedagogies. It emerged that teaching and learning that entailed contextualising the content for teaching in the students' everyday knowledge, is a powerful tool for operationalising 'humanising pedagogies.' Engaging humanising pedagogies during teaching and learning decolonised the content for teaching by giving it a 'human face' and 'indigenous smile'. This did not only enhance student comprehension, but it also enhanced the teaching of abstract science concepts that are difficult content to teach. Recommendations are made.

Keywords: *Fermentation, humanising pedagogies, intervention, Indigenous games, home brew beer.*

1. Introduction and background

The world over, the teaching and learning of science ideas have been hailed as a challenging enterprise (Çimer, 2012). Many reasons have been put forward to explain this. These range from the perceived complex nature of science itself and its associated teaching methods (Lazarowitz & Penso, 1992), the science topic in question and the teacher's teaching style (Anderman & Anderman, 2009), the availability of teaching resources and the student's attitudes towards the science discipline (Çimer, 2012). The varied explanations are indicative of the complexities around the teaching and learning of science. This probably further explains why some scholars have viewed this process of teaching and learning from a theoretical and relatively abstract perspectives, e.g. the idea of border crossing (Cobern & Aikenhead, 1998). Furthermore, for biology in particular, many students have been noted to face difficulties with most biology topics (e.g., Özcan, 2003). This has stimulated researchers to investigate why students experience such difficulties and possible ways to overcome such difficulties (Zeidan, 2010). The different and complex biological levels of organization and the abstract nature of most concepts have been found to make learning biology particularly difficult (Zeidan, 2010). In addition to this, the abstract and interdisciplinary nature associated with biological concepts make the teaching and learning of most biology topics difficulty. The challenges students face with particular topics have led to a thrust towards specific research on the challenges associated with the teaching and learning of specific science topics, which in turn has shed insights that leads to the development of topic specific PCK (Mavhunga & Rollnick, 2017). Thus, issues around the teaching and learning of biology topics has been of concern to researchers because, for instance, experiencing difficulties in many biological topics has been found to be negatively affecting students' motivation and performance in this discipline (Özcan, 2003). This inquiry embraces this type of research trajectory.

After teaching the topic of carbohydrate fermentation to Grade 11 students of Xhosa and Zulu origin in South Africa over the years, two problematic issues recurred year in and year out. The different cohorts of students found this topic abstract because they struggled to grasp the content of this topic as

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35106-9-8 © 2024

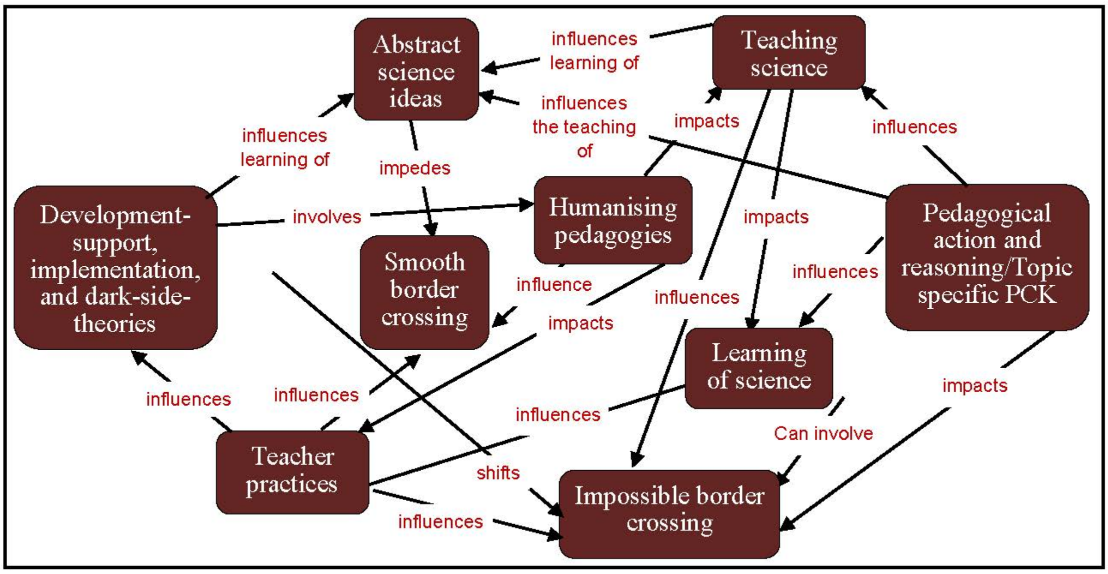
evidenced by their poor scores in unit tests given. Most teachers also struggled to teach this topic in ways that are student-engaging as those investigated in this inquiry would just narrate the details of the topic and the students taking down notes. The concepts which were emerging particularly difficult to teach and also for the student to grasp was the issue of fermentation at physical, chemical and molecular level, especially coming up with the chemical symbols of the reactants and the associated products and then balancing the associated chemical equations. In a quest to provide insights for understanding this dilemmatic classroom scenario, the following research questions guided this inquiry: What is the impact of engaging humanising pedagogies in the teaching and learning of science content? How could science content be integrated with South African indigenous knowledge system for enhanced student understanding?

2. Reviewed literature and the conceptual framework

2.1. Conceptual/Theoretical framework

Each typical social sciences research is seemingly associated with complexity and uniqueness because it involves human subjects whose behaviours in any given context cannot be predicted. Thus, I could not locate a single existing theory to use as a theoretical framework for this inquiry. A framework that is *'home-grown' or a* conceptual framework *(personal integration of concepts)* instead of one that is already there*, i.e. 'off-the-shelf'* (Antonenko, 2014) *was used* to overcome this complexity in this research (see Figure 1 below). The main constructs are discussed below the diagram.

Figure 1. A conceptual framework for the inquiry.



2.1.1. Humanising pedagogy. In this inquiry, pedagogy is seen as a philosophy of education that puts in the spotlight '*the content of what is being taught and the methods of how it is taugh*t'. It also highlights who is being taught and who is teaching, and the purpose (Geduld & Sathorar, 2016. p. 43). In terms of addressing specific learning needs of students (e.g. challenges with grasping abstract content), the quest of this inquiry was to give the textbook content for teaching and learning a human face familiar to the students by using teaching and learning approaches that attempt to contextualise the topic of biological fermentation (use of humanising pedagogies).

2.1.2. Border crossing. The theoretical lens of 'border crossing' views the issue of science teaching and learning in the light of induction into the culture of science (Cobern & Aikenhead, 1998). Thus, teaching is viewed as a form of cultural transmission and science learning as a typical cultural acquisition. This is because science is deemed not as an absolute truth, but as a typical culture where enculturation can occur during the phenomenon of teaching and learning. Thus, the notion of border crossing postulates the existence of borders between distinguishable cultures/subcultures that poses obstacles for individuals to cross. Consequently, the science teachers and students' experiences in the classroom have been theorized in terms of the ease with which they both cross cultural borders into the culture of science. Thus, the notion of border crossing has been used in science education to conceptualize difficulties that students encounter when learning science ideas. This crossing of borders has been categorised by scholars such as Cobern and

Aikenhead (1998) using terms such as *smooth*, *manageable*, *hazardous*, or *virtually impossible*. In addition to this, in this inquiry, the 'development-support-, implementation-, and dark-side-theories (Astleitner, 2020) were the main theoretical lens that scaffold this investigation.

3. Methodology

In my quest to answer this research question, intervention measures that entailed a quasi-controlled experiment were engaged during the teaching of the topic of biological fermentation. The control group was taught using the broadcast method of chalk, board, and talk. The experimental group was taught using 'humanising pedagogies' that involved contextualising the topic of fermentation in relation to the students' indigenous and traditional knowledge systems. The issue of indigenous 'home beer brewing', or what is termed '*umqomboti*' amongst the Zulu/Xhosa indigenous people of South Africa and also playing the African 'Hide and Seek' indigenous game (*umacatshelana*) were used to represent content for teaching. The collected data included unit test scores, which were analysed quantitatively. In-depth group interviews were used to find students' learning experiences from the humanising pedagogy approach used. The students' views were thematic analysed for themes (thematic analysis) through the process of coding from a deductive to an inductive approach.

3.1. Representing the balancing of complex chemical equations content using indigenous traditional games

In terms of the traditional knowledge systems, the balancing of chemical equations entailed incorporating the students' childhood traditional game called "*macatshelana*' (disjoin hands, hide seek find and re-join hands) in the teaching and balancing of the generally perceived complex fermentation chemical equations. The idea of writing and balancing chemical equations has always been a nightmare for the investigated students. We had to engage them in social interactions so that they learn from each other. This was also to address the aspect that some students learn better by interaction with the informed others (Vygotsky, 1978).

The students were exposed to all the stages of the home brewing beer experiment with the help of an elderly woman chosen because of her '*umqhombot*i beer brewing skills in her community. During the traditional game, the students were given different colours of coats, red (representing oxygen atom), black (carbon) and white (hydrogen). The game was about first joining hands into a ring structure of a sugar by a total of 24 students (see Figure 2 below). A whistle was then blown and the 'reaction' began to happen. The other few students wearing blue coats (denoting enzymes) had a role of helping the other students in the ring to break the joining of hands (bond breaking). The 'freed' students then mingled with each other and the rest of the group after dis-joining hands (hiding from each other). The whistle was then blown for the second time. This time students did not form a ring structure, but two in black (Carbon) joined hands with five in white (Hydrogen) with one more in red joining with one in white at the end (ethanol). One of the students in black then joined with two in red to denote carbon dioxide. The total number of students with hands joined were then counted and compared with the initial 24 in the earlier ring. For the students to go add up to the earlier total, the students were asked to discuss how the puzzle could be solved. Whilst this was a bit abstract for most students, the students were probed to form other ethanol and carbon dioxide 'molecules' until all the students had other students to join hands with. The groups of the remaining students who joined to form ethanol groups and carbon dioxide groups were then counted to balance the initial total of 24 students in the ring (balancing the equation). At the end when all the students who were in the initial ring shown in Figure 2 below, also had all their hands joined. If the student was not joining to other students using both hands, then one of the hands was shoved inside the pocket as part of the simple rules of the game (denoting hydrogen atoms that can only bond using a single bond.

4. Results and conclusions

It emerged that most of the students in the experimental group (taught through humanising pedagogies) grasped the fermentation content with ease (smooth border crossing), and their prevalence of inaccurate ideas held was far lower when compared with their counterparts as depicted in Figure 3 and Figure 4 below. However, a few students in the control group grasped the fermentation content but with relatively low scores when compared to the experimental group (manageable border crossing). These students were identified as *talented* students whose marks were always far above average even in different other topics (see Figure 3). Furthermore, during the games and the beer brewing, the students were excited as they played like kindergarten kids and also like real adults during their beer brewing traditional experiment.

Figure 2. The initial single group of 24 students with hands joined.

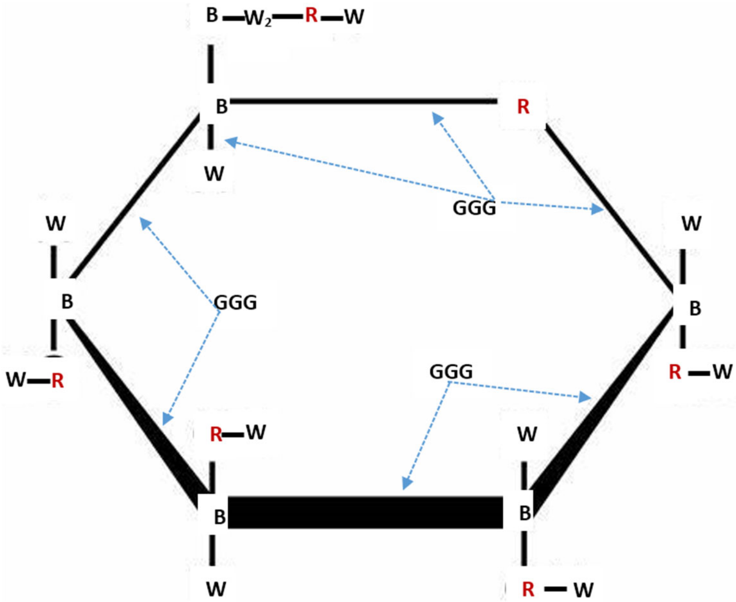
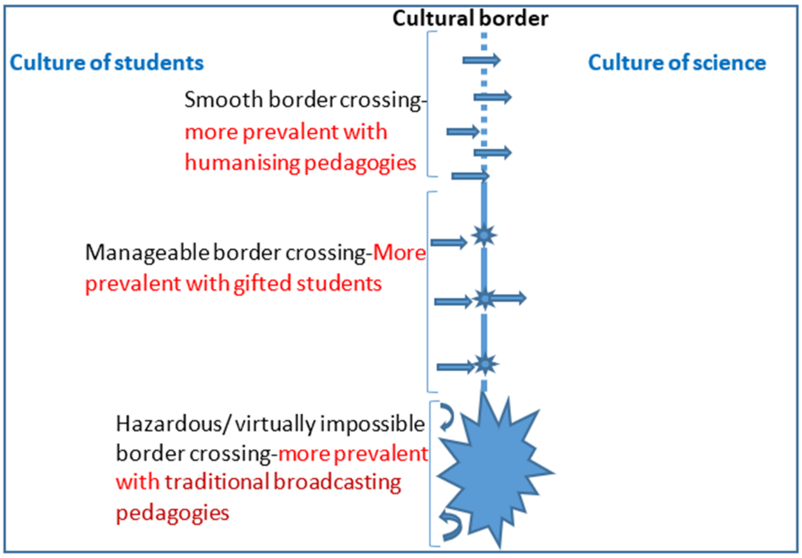
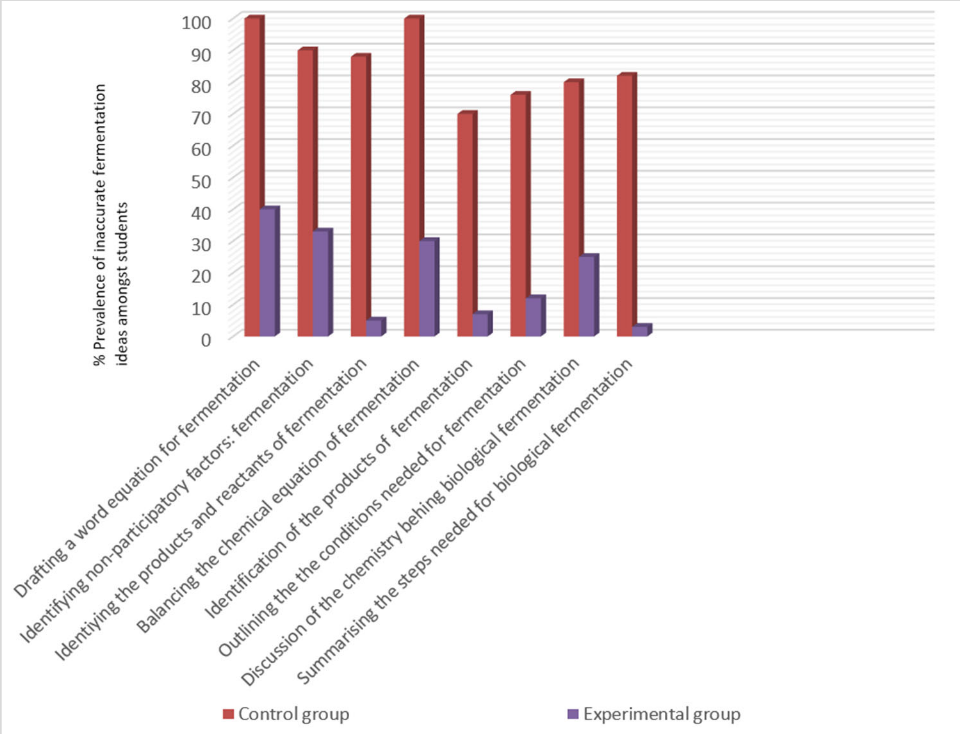


Figure 3. The notion of border crossing as used in this inquiry, based in the ideas by Cobern & Aikenhead (1998).



For instance, when asked about what they liked about the learning activities for this topic, the response by Jack (pseudonym): *I like being outdoors and playing as I learn is pretty awesome. I am excited I now know how to make beer.* This statement is evident that the change from the traditional way of teacher standing in front and the students behind their desks is a welcome development which the student wish to have quite often. Furthermore, the playful hands-on activities in real life and authentic situations empowers the students to learn from what they are doing. This is because there is a kindergarten in every adult (Resnick, 2017), and when that child in us is awakened, then our learning is maximised due to deep childhood innocence concentration that goes with everything.

Figure 4. Students' conceptions of fermentation ideas after teaching.



Thus, from this inquiry, it emerged that teaching and learning which entailed contextualising the content for teaching in the students' playful everyday knowledge, is a powerful tool for operationalising 'humanising pedagogies.' Engaging humanising pedagogies during teaching and learning transformed the content for teaching by giving it a 'human face' and 'indigenous smile'. This not only enhances student comprehension but also enhances the teaching of abstract science concepts through dramatic play. As educators at any level or from whatever part of the globe, it is imperative to contextualise the content for teaching in the relevant everyday life knowledge of the students we teach. Such pedagogical approaches that use dramatic play in our teaching, awakens the child in students, which is crucial for maximum concentration, a powerful precursor for effective learning.

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