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## **10. TEACHING GENETICS TO PRE-SERVICE TEACHERS FROM DIVERSE BACKGROUNDS**

*A South African Self-Study*

I am a teacher educator at a university in South Africa. I joined the institution in 2007, straight from a high school classroom. I had been a high school biology teacher for 14 years in the neighbouring country of Zimbabwe. At the time of my employment, I was already an MSc (Science Education) student and I was hired on the basis of being a successful high school teacher and a successful post graduate student. I was employed to teach a content course (genetics) to pre-service teachers. I did not expect to face any challenges in moving from high school to teacher education. As a confident high school subject specialist, I anticipated that I could easily teach the content of genetics. My assumption was that the subject matter the preservice teachers needed to know was what I had been teaching for 14 years.

At the university, I found myself experiencing challenges that I had not anticipated. The student population in my classes represented diversity in all its many forms: race, class, culture and schooling background. In other words, it was multiracial and multicultural. Observations from some of the activities that I was doing with the students began to show me that students had different levels of content knowledge and for some of them their cultural beliefs and practices and their limited proficiency in the language of learning and teaching (English) hindered meaningful learning. The observations about culture and language became a catalyst for reflection. In my reflections, I began to recall my own experiences of learning genetics. I remembered a day when our biology teacher gave us a genetics problem to solve which referred to blonde hair and blue eyes. We had no idea what that was because as black rural children, what we were familiar with were brown eyes and black hair. Even our teacher could not help us because he also didn't seem to know what blonde hair looked like. It was a question that he had just pulled out of our biology textbook which was Eurocentric. Even though we succeeded in solving the problem, the exercise was meaningless to our lives.

Recalling this incident helped me to see that I had been doing the same thing to my high school learners and then to the pre-service teachers in my university classes: not using *culturally relevant* genetics content and pedagogy (Ladson-Billings, 1995). It dawned on me then that some of the biology, especially the genetics, that I had

been teaching could have been alien to my African high school learners and could be alien to some of the preservice teachers. This awareness of the possible influence of culture and language on the learning of genetics motivated me to consider what I now understand as *multicultural education* in my teaching of genetics. The challenge however was what to do. I had not been trained to practice multicultural education. The need to respond to this challenge became one of the motivations for my doctoral self-study research focusing on how I teach genetics to pre-service teachers. In this chapter, I examine how I have addressed some of the challenges of teaching genetics to a multicultural class. The focus of this study was through answering the question, How do I teach genetics to pre-service teachers? The data sources included video recordings of my lectures, course materials, and interviews with students, which were conducted at the end of the course.

MY CLASSROOM CONTEXT:  
PERSPECTIVES ON MULTICULTURAL EDUCATION

Multicultural education is about the teaching of diverse student populations (Téllez, 2008). According to Banks (2010), multicultural education means at least three things: it is an idea that all students irrespective of their gender, social class and ethnic, racial or cultural characteristics should have an equal opportunity in school. It is also a reform movement that is trying to change the schools and other educational institutions so that students from all social class, gender, racial, language and cultural groups will have an equal opportunity to learn. Banks also sees multicultural education as “a process whose goals will never be fully realized” (p. 4) but which should continue in order to increase educational equality for all students. However, the term multicultural education is used differently by different people implementing a wide variety of programmes and practices addressing different needs, such as equity of women, ethnic groups, language minorities, low income groups and people with disabilities (Banks, 2010). Teachers in Téllez’s (2008) study described multicultural education as “a curriculum that draws upon and affirms language, culture and experiences that includes (SIC) class, race, poverty, and language” (p. 49). Banks (2010) uses multicultural education to mean a total school reform effort designed to increase educational equity for a range of cultural, ethnic and economic groups. Hassard (2005) describes multicultural education as “a way of teaching and learning” (p. 45) in which cultural diversity is respected and teachers in their lesson presentations draw upon the cultural diversity implicit in the content being presented. When I look at the different perspectives on multicultural education outlined above, I can see that there are many aspects of multicultural education other than the differences in cultures. The different aspects, however, all relate to measures that can be taken to achieve educational equity for groups that are disadvantaged in one way or another. If the measures are at classroom level, I agree with teachers in Téllez’s (2008) study who preferred to use the term “equity pedagogy” (p. 49) instead of multicultural education. In my case, I am implementing various pedagogic

measures at the classroom level. As such, what I am doing also can be described as equity pedagogy.

In my study, I am using Hassard's (2005) definition of multicultural education as a way of teaching and learning for two reasons. The first reason is that I am looking at multicultural education at the classroom level within my own classroom, and the description of multicultural education that was given by Hassard describes accurately the type of multicultural education I am trying to implement. The second reason is that I am specifically looking at my pedagogical efforts to address the ideas about genetic phenomena that African students bring to class, which, as described by Hassard, is a look at my way of teaching.

### *Challenges of Teaching Genetics in a Multicultural Classroom*

One of the challenges that is associated with the teaching of science in general are the ideas that students bring to class about science phenomena. These ideas include misunderstandings, misconceptions, or intuitive ideas. I define a misunderstanding as an incorrect meaning or explanation of a concept or phenomenon that students hold, which they may have acquired from textbooks or from teachers during instruction (Cho, Kahle, & Nordland, 1985; Sanders, 1993). A misconception is an idea or ideas that students strongly and persistently hold, that they would have constructed in response to their everyday experiences (Abimbola, 1988; Sanders, 1993). Intuitive ideas are ones that students formulate because they have not been able to access scientifically correct explanations. I will use the term *alternative ideas* to refer to all the different categories of ideas (intuitive, misconceptions, and misunderstandings) that students bring to class. Effective teaching of science is achieved when the alternative ideas that students bring to class are elicited and addressed during the teaching and learning process (Cimer, 2007). While students' alternative ideas are a challenge that manifests itself across all science disciplines, I have found alternative ideas about genetic phenomena the most challenging to address. Firstly, this is because the concepts that students need to understand in order to deal with their alternative ideas are abstract and therefore difficult to teach and to learn. Secondly, it is because some of the ideas that students bring to class relate to cultural meanings and beliefs. And lastly, it is because for some of these beliefs, there is no genetic explanation to validate or disprove them.

Genetics is a field in which phenomena are experienced but are not always accessible to the senses to aid in understanding. This being the case, different cultures and individuals use intuition to explain their experiences about genetic phenomena. The use of intuition results in the development of explanations that are built on cultural beliefs, cultural values, and superstition; ultimately, these culturally-laden explanations are brought by the students to the classroom. What makes genetics difficult to teach and to learn, then, is that some of the concepts that are taught are contrary to the students' cultural beliefs about these concepts and if not dealt with in the teaching process, these beliefs may hinder the development of scientifically

acceptable explanations. To effectively teach genetics, therefore, a teacher or a teacher educator has to be aware of and address the ideas and cultural beliefs that students bring to class about genetic phenomena. This is a huge challenge in a multicultural classroom where students from different cultures may bring different beliefs about genetic phenomena to the classroom. This challenge is compounded when teaching pre-service teachers. Not only is the teacher educator expected to make the content comprehensible, but also to teach it in such a way that pre-service teachers develop “the skills, confidence and competence to teach learners with different needs and abilities” (Garbett, 2012, p. 38).

#### *Locating Multicultural Education in the Context of My Classroom*

As explained earlier, the student population in my classes represents diversity in many forms: race, class, culture, and schooling background. When I began my self-study, I decided that I had to relook at my whole enterprise of teaching genetics in the context of the experiences that I had regarding the multicultural context of my classes. The first question that I asked myself was, Does the content that I teach cater to the multicultural nature of my classes? To answer this question, I revisited my course module. The course module describes the content of the course in detail, including the activities that will be done in the course. My conscious awareness of the multicultural context of my class made me realize that the content of genetics that I was teaching was based in what can be termed *Western culture*. Here culture is taken to mean an ordered system of meaning and symbols for the purposes of social interaction (Aikenhead, 1996). Taking into account the argument by Aikenhead (1996), that Western science is a subculture of Euro-American society, I came to realize that the genetics that I was teaching catered more for one group of students in my genetics class, those with the Western cultural background. I needed to restructure the content of my course module and also my teaching of that content to make it more comprehensible to students from other cultures especially Black African students. I decided to focus on Black African students for a number of reasons. Firstly, Black African cultures are replete with beliefs and myths about genetic phenomena. It was therefore important to address these beliefs in addition to addressing misunderstandings and the misconceptions that all students bring to class. Secondly, the majority of the students in my classes are black South Africans and traditionally, the school science that they are taught in high school does not cater for the knowledge and beliefs that they bring to class from their own cultures about genetic phenomena.

In addition, I am familiar with some of the cultural beliefs about genetic phenomena that Black people in Southern Africa hold and I understand how important it is to deal with these beliefs not only because they may interfere with learning of correct genetics concepts but also because some of these beliefs cause a lot of suffering in Black African communities. For example, in some South African and Zimbabwean communities, because of the stigma and superstition associated with albinism, some

#### TEACHING GENETICS TO PRE-SERVICE TEACHERS FROM DIVERSE BACKGROUNDS

mothers keep their children with albinism hidden indoors because they are ashamed of them and because they cannot explain their children's condition to others. In some cases, a woman is divorced for giving birth to an albino child or at worst, the baby is left to die (Baker, Lund, Nyathi, & Taylor, 2010). The last reason why I chose to focus on the cultures of Black Africans is that the majority of learners in many South African classrooms are Black. Therefore exposing student teachers to some of the beliefs about genetic phenomena African learners are likely to bring to class, and a discussion about them, should empower them with some skills and ways of addressing these beliefs.

#### SOME OBSERVATIONS FROM TEACHING GENETICS TO PRE-SERVICE TEACHERS

Below is a description of some of the observations that I have made in the past five years from teaching genetics to pre-service teachers. I describe these observations here because they are influencing my pedagogy in the classroom. Although all students know that a child is a product of sexual relations between a male and a female, many of them cannot explain the role of sexual reproduction beyond the production of new offspring. Some students cannot explain the link between sexual reproduction and processes such as meiosis and fertilization. As a result, they are not able to explain why children resemble but are not identical to their parents or siblings. They may also have difficulties in explaining why sometimes a child shows only remote resemblance to his or her parents. Some students cannot explain phenomena like albinism and as a result they bring to class many cultural beliefs and explanations about the birth of an albino child in a family. Some students do not know how sex is determined and so they bring ideas to class that a woman is to blame if girls only are born in a family. When I reflected and thought deeply about these observations, I came to the conclusion that what students lack is a fundamental understanding of genetics. Therefore, the most important thing that I needed to do was to help students to understand these fundamentals.

#### *The Content of Genetics that I Teach to Pre-Service Teachers*

It is important to note that while genetic phenomena occur in all living organisms and that in the genetics course I also teach genetics in other living organisms, in this chapter I focus on genetic phenomena with reference to humans because the genetic phenomena we experience affects us in our day to day lives. In my genetics course, I firstly establish the connection between genetic inheritance and sexual reproduction; that genetic inheritance is the passing of genetic material from parents to offspring and that reproduction is the mechanism by which inheritance is achieved. I do this to help students to understand the role of reproduction especially sexual reproduction in genetic inheritance. Next, I explain to students what genetics is all about and why it is important for the students to know and to understand genetic phenomena. I then

E. NYAMUPANGEDENGU

teach students about the nature of genetic material (DNA, chromosomes, genes and genetic information). This content is important so that students know exactly what determines the characteristics of individuals and in what form that information is passed on to the next generation and why in that particular form.

I then teach about meiosis. Meiosis brings about the formation of gametes which are important in sexual reproduction. Meiosis is also the mechanism that explains some of the variation that we see between parents and their children and between siblings. Students therefore need to understand this process so that they can understand and explain the variation that we see in sexually reproducing organisms. I then teach about mutations and genetic disorders with a particular focus on albinism. The reason why I focus on albinism is that there are many beliefs and myths associated with giving birth to a child with albinism. The rest of the course then looks at inheritance patterns including monohybrid inheritance, codominance, multiple alleles and sex determination. Sex determination is an important concept to teach as some students hold alternative ideas about how sex is determined.

*Some Cultural Beliefs about Genetic Phenomena That Some African Students Bring to Class*

In some cultures like mine, people hold a belief that if you are fond of someone in the family during pregnancy (e.g., your brother-in-law, sister-in-law, mother-in-law etc.), your child will have some similarities to that person in one way or another. It is also believed that if you dislike things that you see people do like finger sucking, your child may also have these mannerisms or habits. They also believe that if you stare at people for whatever reason during pregnancy, your child will show some physical or behavioural similarities to that person. Some cultures believe that an unborn child can *catch* albinism through the mother touching a child with albinism during pregnancy. The blame for the birth of a baby with albinism is often placed on the mother. As a result of beliefs like these, if a woman gives birth to a child who has albinism or is disabled, she is blamed and sometimes she actually blames herself. For example, in a study about the myths surrounding people with albinism in South Africa and Zimbabwe, Baker et al. (2010), described a case of a mother who believed that she gave birth to an albino child as a direct result of touching a child with albinism when she was pregnant. An assumption of infidelity is also a common belief that is associated with the birth of a baby with albinism in Black Africans mainly because the child will be visibly distinct from other members of the family (Baker et al., 2010).

THE CHALLENGES OF A MULTICULTURAL CLASSROOM  
AND OF TEACHING HOW TO TEACH

As a teacher educator, I have a dual role of teaching content to, and at the same time developing in pre-service teachers the competence to teach that content

(Garbett, 2012). In addition to fulfilling the dual role of a teacher educator in my teaching of the genetics course, I also have to consider the multicultural nature of my class. In order to achieve the teaching of content and at the same time teaching about how to teach that content, I have decided to model good teaching in my classrooms, i.e., to incorporate in my teaching features of teaching that work for particular settings or situations with implications for contextual awareness (Fitzgerald, Dawson, & Hackling, 2013). Modelling good teaching in my case (as a teacher educator) has therefore involved using pedagogic strategies that are meant to assist and enable students to understand content and at the same time to acquire skills and competencies for teaching that content. Modelling good teaching also means using pedagogic strategies that cater for the multicultural nature of my class: the different levels of content knowledge the students bring to class, their prior ideas about the subject matter, and level of proficiency in the language of instruction (in this case English) and also different cultural and schooling backgrounds. I describe below the pedagogic strategies that I have employed in order to model good teaching.

#### *Accommodating Students with Different Levels of English Language Proficiency*

I use PowerPoint presentations as a way of helping students to overcome the challenge of learning in an additional language. One of the problems that I have to deal with concerns English, which is the official language of instruction. Not all students are proficient in English. I come from Zimbabwe and I cannot speak any of the South African languages. This puts the non-English speaking students at a disadvantage as all communication and teaching has to be done in English. There is not the luxury of code switching to help students to understand concepts. In addition, all students, including English First language speakers, may struggle to hear what I say because my accent is different to theirs. So in order to meet the language needs of all my students, I make it a point that I prepare a PowerPoint presentation for every lecture. This I do so that both groups of students, i.e., students whose first language is not English and English First Language speakers who may struggle to understand my accent, are catered for. Students can relate what they hear me saying to the actual words and if they cannot understand what I am saying because of my accent, they can at least see what I am saying.

#### *Accommodating Students with Different Levels of Content Knowledge*

To cater for different levels of content knowledge, I now start with the basics. I use strategies that bring about new learning even for those students who may be familiar with the content. An example is when I use the string analogy to teach about the relationship between DNA and chromosomes. The content about information molecules—DNA, genes, chromosomes—is very difficult to understand as it is abstract. In my class, I may have students who have been taught this content and understood it well. I also may have students who were taught this content but

found it very difficult to understand. Then there will be students who have never encountered this content. In order to accommodate everyone in my class, I model to the pre-service teachers how they can teach the basics about the information molecules by enacting a particular pedagogic strategy. By enacting this strategy, I am actually teaching students in a way that will help them to understand the content and at the same time show them ways of teaching that content. For example in the photograph below, I was teaching about the relationship between a DNA molecule and a chromosome. So instead of simply telling student teachers that they could use an analogy of string, I used string myself. The loose string represents a DNA molecule and the ball of string represents a chromosome.



*Figure 1. Here I am using an analogy of loose string and a ball of string to explain the relationship between DNA and a chromosome*

#### *Choosing Examples in a Multicultural Classroom*

The type of examples that one uses in a multicultural classroom is crucial if they are to be effective in helping students to understand concepts and to prepare them to teach those concepts in different contexts. The examples must be meaningful to each and every student and the students should be able to use those examples in a variety of teaching contexts. Thus, I represent diverse teaching situations in my choice of examples. Below is an extract from a lecture in which I used examples to help students to understand the concepts of gene and allele. I considered context in terms of where students come from and where they may teach after completing their teacher education qualification.

Lecturer: Trait is determined by a gene. And then variation of that trait is determined by alleles. So now let's look at what we mean by gene and allele, because with this one there's a huge misconception. Textbooks, teachers use

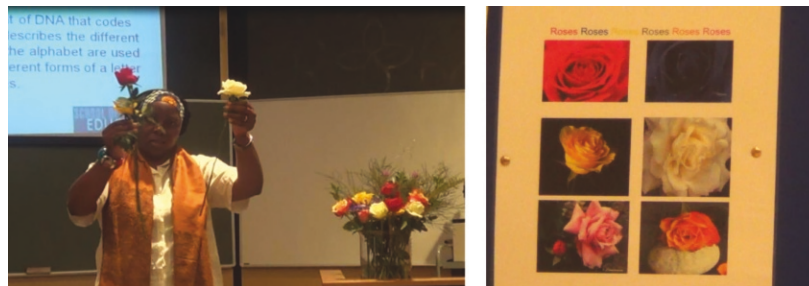


these two terms as if they mean the same thing. So I was trying to figure out how these two terms can be explained. So the first thing I thought of was ice-cream, different flavours of ice-cream. What are the different flavours?

Students: Strawberry, chocolate, vanilla

Lecturer: So we have strawberry ice-cream, we have chocolate ice-cream, we have raspberry ice-cream, vanilla ice-cream. All those are ice-creams. Okay, so that's what you can use to explain, so ice-cream represents the gene and the flavours are the alleles. So it's still ice-cream but now we are seeing different flavours. But then I thought, I grew up in rural areas, and all I knew was ice-cream, I didn't know about flavours. So if my teacher had used that example it was not going to make sense to me. So being a rural child what would make sense to me is colour of hair of cattle. Because I knew a lot about cattle. And so depending on the context, you need to use something that your learners can understand. So if we look at colour of cattle there (pointing at pictures of cattle printed and laminated), we have black colour of hair, we have brown colour of hair, we have white. So there's a gene that determines that a cow or a bull has hair colour. But then we have different alleles, that determine different forms of colour, we have brown, we have black. Yes?

Lecturer: If your school can afford, you can also use fresh roses to explain the same concept.



Figures 2 and 3. Here I display fresh roses and images of roses from a textbook

If your school cannot afford a fresh roses, you can use pictures from the internet for your learners to see. You can use pictures in a textbook, or you can make a chart like this one and then you can use it all over again.

Right, so the reason why I have used a variety of visuals to explain to you, the same concept of allele was to represent different school contexts that you may find yourself in. So different contexts and the availability of resources call for one to think of different ways of explaining concepts, in this case the concepts of gene and allele.

E. NYAMUPANGEDENGU

*Using Case Scenarios to Deal with Beliefs and Alternative Ideas That Pre-Service Teachers Bring to Class*

I use case scenarios that are aimed at making students aware of some of the ideas that they bring to class about genetic phenomena especially cultural beliefs. I focus a lot on beliefs that are found in African communities for reasons outlined earlier. By focusing on such beliefs, in a way, I will be incorporating the issues that the beliefs raise into the genetics curriculum. After presenting each case to students, I allow them to discuss in small groups first then I hold a whole class discussion. No answer is right or wrong at this point. I take note of students' ideas as we will revisit them during and at the end of the course. The reason why I ask students to discuss in groups first is to make sure that students don't hold back their ideas when it is whole class discussion as the ideas will be presented as coming from a group not an individual. Sometimes the discussions do not yield much. Some Black students hold back their own beliefs about genetic phenomena as they are not sure how their peers would view them. So to encourage them, I make reference to cultural beliefs from my own rural community first. In most cases, students then open up and share the beliefs they know of. Below are two examples of scenarios that I present to students as a way of eliciting their ideas about genetic phenomena.

*Case 1: Eliciting Students' Ideas about Albinism*

In my rural village, there is a couple who after getting married the wife got pregnant and gave birth to an albino child. The husband's relatives 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. In small groups discuss a possible explanation to this incident.

*Case 2: Eliciting Students' Ideas about Sex Determination*

A relative of mine has four children, all girls. They desperately want to have a baby boy. They are however afraid that if they try again, they may get another girl child. How come this couple is giving birth to girls only? Is there anything they can do to have a boy child? How is the sex of a child determined and when is it determined?

The presentation and discussion of a case is followed by the teaching of content linked to what is contained in the cases. The teaching of content is then followed by genetics problems that students have to solve. The problems that I prepare are linked to the genetics ideas discussed and content covered in such a way that they combine the cultural beliefs and the genetics that they would have learnt. I give an example below based on albinism.

A couple in the rural village of Nyanga has three children. Two children, a boy and a girl are normal. The third one, a girl named Chipo, has albinism. Albinism is a recessive genetic disorder. People with albinism do not produce melanin. Melanin is a pigment that gives the skin, hair, eyes their colour. Because people with albinism lack melanin, they have very pale skin, white or sand coloured hair. People affected with albinism have very poor eyesight and must avoid the sun as much as possible because of their high risk of getting skin cancer. When Chipo was born, family members accused the mother of infidelity. A social worker at a local clinic then suggested that the family go for genetic counselling and DNA tests. The genetic tests showed that both parents and the normal boy were all carriers of albinism but the girl was not.

I ask my students questions to both assess their understanding and to encourage their thinking and explanation of genetics.

- Question one assesses students' understanding of a genetic term which is purely genetics content: Albinism is a *recessive* genetic disorder. *Define* the term *recessive*
- Question two seeks to indirectly elicit the students' own thinking about albinism: Can you think of any possible reasons why the family thinks that the wife cheated on her husband?
- Question three seeks to find out what type of explanations the student is going to use. Will the explanations be scientific or cultural?: If you were a member of this family, how would you respond to the family's accusation of infidelity?

Questions four to seven are based on genetics content covered in class. The questions seek to assess students' understanding of the content of genetics.

- *Suggest* any two issues that are likely to be discussed during the counseling sessions.
- *Identify* from the passage, the benefits of going for genetic counseling.
- *Explain* what it means to say that the normal boy and both parents were *carriers*.
- *Use* a full genetic diagram to show how this couple ended up with an albino child.

The last question below focuses on a scenario about genetic phenomena that some students in my class will very likely experience in their teaching lives or in their lives outside the classroom

- Chipo is a learner in your class. *Discuss* some of the things you should do to improve the quality of Chipo's learning experiences in your classroom.

I also use a variety of learning activities and teaching approaches as a way of meeting the needs of students from diverse backgrounds. For example; I use a lot of whole class discussions as it is important for students to verbalize their thinking. I use a combination of explanations, models and analogies in my lesson presentations. Oral

explanations cater for learners whose preference is for the auditory. Explanation on a PowerPoint presentation, models and other visual materials cater for learners whose preference is for the concrete and the visual. I also use role playing and practical work to expose issues that are difficult to put across to students in form a lecture. Examples of role playing activities that students do are explained below:

- Role playing a family in which a happy young couple in a rural community gives birth to an albino child. Some family members think it's a curse for something this couple did. Others accuse the young mother of infidelity. The couple is devastated and they don't know what to do. A respected biology teacher at a local school offers to meet the family and explain how this could have happened.
- Role playing a once happy and close family of six in which the father has developed Alzheimer's disease, a dominant genetic disorder which is characterized by severe memory loss. In the play, the mother shares with her children the experiences of caring for their father and why she thinks that it may be a good idea for the children to know their status. Each child explains why they do or do not want to know their risk status. (The source was an organization that supported science teachers to exchange activities, Access Excellence, but it is not a currently active website).

I also incorporate student presentations in my teaching especially when teaching meiosis. I like to use presentations as a way of consolidating students' understanding of meiosis. I divide students into groups. Each group is assigned a stage of meiosis. They are expected to prepare a poster showing the events of their stage. When they present in class, each group needs to make links to the preceding presentation to show their understanding. Each member of a group contributes orally during the presentation.

#### FINDINGS AND DISCUSSION

In the preceding section, I have described how I teach genetics to a multicultural class. The findings that I present and discuss below come from an analysis of what students said about my teaching when they were interviewed at the end of the course. The interviewer was a Bachelor of Education Honours student whom I asked to do the interviews so that students would remain anonymous as I had indicated in the letters of consent that they had signed. I gave the interviewer the names of the students who had signed the consent forms. She then approached the students and organized the interviews. Of the 13 students interviewed, 7 were females (four Black Africans, one Indian, one Coloured and one White) and 6 males (four Black Africans, one Indian and one Coloured). See Appendix 1 for more details about the students. Below, I present the findings in terms of the impact that the pedagogy that I implemented that focused on the multicultural context of my classroom had on the personal outcomes of students who were interviewed.

*Using a Variety of Teaching Strategies in My Teaching*

In order to provide for different learning preferences of students in my class, I planned lectures, tutorials and practicals that provided for a variety of ways of learning such as concrete, abstract, visual or auditory (Hassard, 2005). The use of a variety of teaching strategies and teaching and learning activities accommodated student diversity as reflected in interviews with the students at the end of the course. Comments made by the students suggest that by incorporating a variety of activities in my teaching, I have not only catered for the needs of students from different cultures and backgrounds but I have also increased their motivation to learn and provided them with a range of experiences necessary for understanding concepts and for promoting their growth as teachers.

*Student 4:* I love the fact that she uses a variety of teaching styles. That I think will suit everybody, because if you didn't understand on the first teaching style, you'll catch up on the next and definitely on the third one, so, ja, you participate, you put your whole heart there because you feel like, "yes, she's doing her job and she's going the extra mile at the end of the day."

*Student 7:* She used multiple ways of teaching the same concepts, so she didn't just rely on a definition, she elaborated on it, she showed us visual examples; she didn't just brush over everything, just to give us the knowledge. She actually prepared and made it specific for us as learners and not just us as a class.

The comment by student 4 indicates that the use of different teaching strategies in my teaching motivated her to participate whole heartedly in my classes. What was significant about her comment was that it was not the use of a variety of teaching styles that actually motivated her but rather the effort made by the lecturer to use a range of different teaching strategies: you participate, you put your whole heart there because you feel like, "yes, she's doing her job and she's going the extra mile at the end of the day." Student 7 also felt that my teaching catered for students as individuals not as a class and just like student 4, she also saw beyond what was happening in the classroom: "she actually prepared and made it specific for us as learners and not just us as a class." It was not just what was happening in class that had enabled the teaching to be specific to them as students, it was the preparation that I had done before the lecture.

The use of role playing and presentations in my teaching also impacted positively on students.

*Student 3:* For me, like, science is not very creative, if you don't do tutorials, you do practicals or experiments, but then the teaching styles that I learned from her was presenting role-playing and like interacting children in groups, because in most cases we, in science, children just do work individually, "do

this on your own” and that’s the way. I think interaction for me is the major point and the major style...

Similarly to students 4 and 7, student 3 saw more than just a variety of teaching styles. She saw creativity in the way I used role playing and in the presentations that students made; creativity that promoted interaction and participation of all students regardless of race, culture or schooling background. In addition, the role playing and presentations created a platform that allowed them to get feedback and to share knowledge among themselves:

*Student 3:* She was the first one for me, since I was here, from first year and second year; she was the first one to introduce presentation in science. Like, I haven’t talked for two years in science, so like, everybody got the chance to say something about genetics, so if you didn’t understand then there will be a platform to show that you don’t understand and then the misconception you have will be corrected.

These students have done physical science and biology modules in their first and second years. I have actually taught these students a biology course in their first year and another one in their second year. What the student’s comment is saying then is that no science lecturer including me in those two years did anything in the science or biology classroom that could encourage her to talk and hence the comment “she was the first one for me.” It’s only now in third year in this genetics course that everybody according to student 3 “got a chance to say something” in a science classroom. This ability to bring in to my lectures something that encouraged students to participate was a result of my sensitivity to the student diversity in my class. The experiences that student 4 got from role playing and presentation were similar to those of student 3:

*Student 4:* Some of us hardly speak in class, hardly participate, but this year and because we had to role-play and do presentations, we were taken out of our comfort zones to say, “you know what, you are a teacher, you have to own your content.”

In addition to expressing the view that role playing and presentations encouraged her to participate in class, student 4’s comment also foregrounded how she interpreted my use of role playing and students’ presentations. According to her, by asking the class to role play and make presentations, I was saying to them you are teachers, you must know your content, you must own it. While it is true that students were required to know about the genetic phenomena that they had to role play and present and therefore in a way, I was directing them to go and do research, my aim for using these two forms of teaching and learning was to provide variety in my teaching. So here again, I have a student seeing beyond the use of a variety of teaching styles to something deeper and more powerful: a way of using role play to encourage students as teachers to know their content and show that they own this content.

*Using Case Scenarios in My Teaching*

The use of cases promoted the engagement of students in the teaching and learning process and also raised interesting questions about science in general and genetics in particular. An exemplar case is described below.

*Lecturer:* In our culture, we believe that when you are pregnant and there is something that you don't like about a family member or something a family member does that attracts your attention (a mannerism for example) there is a chance that your unborn child will show that mannerism when s/he is born. What is your comment about this belief?

*Student:* That is true ma'am. It happened to me. When I was pregnant with my second child, I was living with my step daughter. Every time when she slept, she would curl her whole body and would sleep in a very distinctive position sucking her thumb. This sleeping habit of my step daughter though it didn't affect me in anyway was a very striking observation that registered in my mind especially that she would sleep in that same position every night. Then I got the shock of my life. When my little boy was born and was old enough to change sides when sleeping he started to sleep in exactly the same peculiar way as his step sister. So tell me ma'am, is this genetic? If not how else can you explain it?

I didn't have and I still don't have a genetic/scientific answer to that question. I challenged students to go and find out from the internet what researchers say about thumb sucking. Students' feedback indicated that scientists agree that thumb sucking runs in families but not one of them said it is genetic because no gene has been found that is responsible for the thumb sucking phenomenon. So we came to a conclusion that at the moment, genetics does not have an explanation for the phenomenon that had been experienced by the student above about thumb sucking in a specific sleeping position.

Then one student commented, "Though inadequate, at least these guys from your culture have an explanation for their observations." Some students nodded in agreement. The case was a powerful moment of teaching and learning for me as a lecturer and for students too firstly, because it opened up contributions from students from different cultural backgrounds sharing their own experiences. Secondly, the case shows that in a genetics class descriptions of cultural beliefs can be powerful discursive resources and ways of addressing conflicts between scientific claims and students' cultural beliefs. Lastly, the descriptions can give a voice to African beliefs about genetic phenomena in the teaching and learning of science and by using such descriptions, African knowledge and beliefs can be acknowledged in the genetics classroom. While in some cases, a few students from one cultural group will participate in class discussions, in this instance, students from diverse cultural backgrounds participated especially when reference was made to thumb

sucking which is a phenomenon familiar to all racial and cultural groups. The case exemplified how choice of appropriate teaching materials and texts can generate excitement and dialogue in a multicultural classroom. On a personal level, from that day, I have wondered whether the genetic make-up of parents is solely the cause of some of the things that we observe in children.

*Using Content with Which Students Could Identify*

The use of cases in my teaching also helped students to identify with the content of genetics.

*Interviewer:* Can you describe the kind of questions she asked?

*Student 3:* Okay the questions were... some of the questions we had were based on our everyday life, like linking genetics to our everyday life, and then giving examples of how we would use our situations in genetics.

Students could also see themselves applying the knowledge they had gained to their lives.

*Student 7:* As well as by doing this course it's also taught me how to differentiate between genetic disorders and we can, if we encounter one of our friends or family members to have certain genetic disorders, by doing this course we know how to interact and how to treat them and stuff like that, so by that I know as a student, I'm taking it as I'm learning about this disorder so I can, if I encounter it in real life, I know how to deal with it.

*Student 2:* I think what I also grasped was that, we were [inaudible], we need to then define empathy versus sympathy. Yes, have empathy for people with genetic disorders but don't have sympathy for them, don't feel sorry for them because, don't treat them as different people, you know, they might have a genetic disorder, it's something they cannot help, but they themselves have found a way to live with it, so who are you to try look down on them, type thing. That's what I really got from the course and the Alzheimer's thing as well, it was good to see because I myself have a grandmother with Alzheimer's, and there is a lot of people who don't know what it is and what it's about and it's a good approach, it's something that I would use especially to get people to just know more about these disorders so that if they do come across someone they can treat them with respect, you know.

Students' comments, as reflected in the interview excerpts above, show that there was something in my teaching that met the needs of diverse students in my classroom as individuals but also of them as members of a family or of a community. Students felt catered for in many different ways and I argue that this is what multicultural education should achieve.



A surface look at my teaching shows what can be described as daily routine activities and teaching strategies, or what the administrators, the teachers and the teacher educators in Ladson-Billings' study saw as "just good teaching" (1995, p. 159). However, according to student 5, my teaching reflected "more than just learning genetics." With a critical friend (CK), we decided to read through, and examine further, students' comments to find out what else could have been reflected in my teaching. This further examination of students' comments helped us to see beyond the surface features of the routine activities of good teaching that were happening in my classroom. As mentioned above, it was not just the use of a variety of teaching strategies that helped me to reach out to the diverse students in my class; it was also the manner in which I was doing my teaching that implicitly communicated that I was valuing each one of them.

*Student 5:* I personally really enjoyed the fact that she was always prepared. It makes a big difference, and that she put so much effort into making us understand, because she didn't have to get flowers and she didn't have to do any of those things because, I mean, she's a lecturer, and she said that this is the textbook, do it, that she could have quite easily have done that. But the fact that she always tried to get us to learn and that she was showing us more than just learning genetics; that she was actually being a good example of a teacher. I think that was very helpful.

*CK:* Student 5's comment shows your enthusiasm beyond their expectation: "she didn't have to get flowers and she didn't have to do any of those things because, I mean, she's a lecturer." You care enough to do more than what is expected of you as a lecturer.

Students noticed that I was working very hard from the way the lectures, the practicals and the tutorials were going: she's going the extra mile at the end of the day. Students also noticed that I was thoroughly preparing for my lectures:

*Student 7:* She seemed well prepared, she always had enough notes and she always had either the posters or something to refer to or hands-on materials like the strings and so forth, always just to give us concrete examples or something that we could see.

Preparing thoroughly for lectures is a reflection of caring for the students that I teach.

*Student 13:* I enjoyed the way she applied her teaching strategies and to make sure that we as students we understand as much as possible to that at least even if we can get our own feedback, at least we can see I did not do well because of this and this and this, so at least, even when we write our exams now, I think everyone will manage to write and pass Nyamupa's section, because the way she was presenting the content actually it was okay.

*CK:* You're teaching has helped student 13 to understand the genetics subject matter to such an extent that he is confident that "everyone will manage to write and pass." So, according to student 13, your teaching made the content of genetics accessible not only to him but to all the diverse students in your class.

The student's comment reflects an ability to develop in students a conceptual understanding of science subject matter.

*Student 7:* She started off from the basics, she started off finding out what do we know, what don't we know (sic). And then she build (sic) from that, and she went from genes to... and she moved on... just she gave us scaffolding and she built on that for us

*CK:* Student 7's comment shows that you considered in your teaching what students bring to class. You did not make assumptions about their prior knowledge. You cared about what their gaps are and building on them. Student 7 is also confirming that you did not assume that being at university; students would know the basics of genetics. You did not only find out what they knew about genetics concepts but also what they did not know and by so doing, you were showing sensitivity to students' possible different schooling and social backgrounds which is a consideration of the multicultural context of your classroom. The use of the vocabulary such as "build on" and "scaffolding" is fascinating to me. These are concepts that they learn about in methodology courses when learning about theories such as constructivism. Using them to describe your teaching means that students were able to witness in your teaching, concepts that they had learnt elsewhere. You are passionate about your work and hence you do not tell students how it is done, you show them by doing it yourself.

Student 2 has gained knowledge that he feels is going to be useful in his life.

*Student 2:* I think what I also grasped was that, we were [inaudible], we need to then define empathy versus sympathy. Yes, have empathy for people with genetic disorders but don't have sympathy for them, don't feel sorry for them because, don't treat them as different people, you know, they might have a genetic disorder, it's something they cannot help, but they themselves have found a way to live with it, so who are you to try look down on them, type thing. That's what I really got from the course and the Alzheimer's thing as well, it was good to see because I myself have a grandmother with Alzheimer's, and there is a lot of people who don't know what it is and what it's about and it's a good approach, it's something that I would use especially to get people to just know more about these disorders so that if they do come across someone they can treat them with respect, you know.

Student 2 was able to see the usefulness of the knowledge that he had gained and could even see where and when he would make use of that knowledge. An ability

to consider the usefulness of the knowledge that students gain in their lives is an important value in the teaching and learning of science (Berry, Loughran, & Mulhall, 2007). I also modeled in my teaching the value of constructivism seen in organizing learning experiences that create conditions for students to construct their knowledge.

*Student 2:* From a theoretical point of view, Mrs. Nyamupa based a lot on teaching from a constructivist point of view where we had a lot of group work; we had a lot of tasks where we had to construct our own understanding and information

Student 2's comment shows that he is familiar with the theory of constructivism and just like student 7 has witnessed its application in my teaching. By preparing thoroughly for my lectures, by choosing content that is useful in the students' lives and by being able to assist students to develop an understanding of the content, I showed them that I cared for them.

#### CONCLUDING REMARKS

The responses of the student teachers to the kind of teaching that I enacted in my genetics course, with the aim of achieving multicultural education suggests that effective teaching was realized. Students, irrespective of class, gender, culture, and race, seemed to have valued my teaching and to have learned from it in terms of both the genetics content and the skills and competences of teaching that content. My initial thinking that the deliberate use of specific teaching strategies tailored for a multicultural pre-service classroom would lead to successful learning for diverse students has however been challenged. This self-study has shown me that it is not only the use of a variety of teaching and learning strategies that achieves effective teaching and learning in a multicultural class; it is also the human values and the values about teaching that you embody as a lecturer that make a difference. In my lectures, students did not just see a good PowerPoint presentation; they saw the thorough preparation behind the PowerPoint presentation and the teaching and that's what motivated them to learn. Students did not only see a lecture presentation that catered for their different contexts, they saw a lecturer who was thinking of their contexts when she was preparing the lectures, a lecturer who saw them as individuals not a class, a lecturer who was creative enough to draw them out of their comfort zones and encouraged them to participate in the learning process.

All these experiences that students highlighted in the interviews reflect the universal values of caring, compassion, hard work, enthusiasm and passion about one's work. It was these values that were embodied in my multicultural pedagogy and it was these values that appear to have made a difference in my multicultural classroom. By focusing on these values in my practice, I will actually be practicing multicultural education because an examination of students' interviews has revealed that these values are a language and a pedagogy that can be understood by any student from any racial category, culture and class.

## APPENDIX 1

*Details of students who were interviewed*

<i>Code</i>	<i>Gender</i>	<i>Race</i>	<i>Performance level in the genetics course</i>
1	F	Indian	2+
2	M	Coloured	2
3	F	African	2
4	F	African	2
5	F	White	3
6	M	African	2+
7	F	Coloured	2
8	F	African	2
9	M	African	2
10	F	African	3
11	M	Indian	2-
12	M	African	3
13	M	African	2-

*7 females (4 Africans, 1 Indian, 1 Coloured, 1 White)*

*6 males (4 Africans, 1 Indian, 1 Coloured)*

**Key to performance coding:**

*0 – 50% average = 1*

*50 – 59% average = 2-*

*60 – 69% average = 2*

*70 – 75% average = 2+*

*75 – 100% average = 3*

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#### TEACHING GENETICS TO PRE-SERVICE TEACHERS FROM DIVERSE BACKGROUNDS

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