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# Primary School Learners' Conceptions of the Role and Function of the Brain

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**ABSTRACT** In many developing countries formal schooling has tended to propagate a Western view of mainstream school science (MSS), almost oblivious to the worldviews learners bring to the classroom. This study reports grade six Zulu children's conceptions of the role and functions of the brain. The survey involved 197 girls and boys from KwaZulu-Natal, South Africa. Data was collected using a paper-pencil instrument consisting of one open-ended task given to the children as homework to enable them to tap into their parents' understanding of the topic being investigated. The study revealed that context was a very strong frame of reference for the children in the way they answered the question. They interpreted the question entirely within the intrigues of their own life worlds-a world dominated by Zulu traditions and culture. The findings reported in this study have far-reaching implications, including triggering national-wide curriculum revisions and reorientations.

## INTRODUCTION

In mainstream school science (MSS), the brain plays the role of controlling all the activities and actions of the body, that is thoughts, moods, memory, emotions, attentiveness, perceptions such as vision, taste, hearing, smell, touch, balance, posture, digestion, heart rate, blood pressure, breathing, bladder function, sexual function, hormone production and balance, immune response, and all others (Jones et al. 2007; Penfield and Roberts 2014; Scott and Fong 2004; Stuss and Knight 2013). In this regard, MSS sees the entire essence of human activity as being controlled and directed from the brain engine room.

Furthermore, according to MSS, one unique attribute of the brain is that it exhibits something known as *localization of function*, which means that different parts of the brain carry out different functions (for example, vision, control of voluntary movement, understanding speech) and, conversely, that not all parts of the brain do the same thing. This may sound rhetorical, but other organs, such as the liver, do not exhibit localization of function, and one part of the liver does exactly the same thing as another. This is how MSS approaches the study of the brain and its functions.

However, research over the past few decades has revealed that children as young as 5 years of age "possess a theory-like knowledge system that can be called *naïve biology*, which involves a set of causal devices enabling children to offer coherent predictions for biological phenomena" (Inagaki and Hatano 2006: 177). Prokop et al. (2007: 62) also report, "ideas about the biological world are developed in early childhood prior to children reaching school age." In this regard, Aikenhead (1996: 8) opines that "the family, peers, the school, the mass media, and the physical, social, and economic environment" are among the "powerful subgroups that influence the students' understanding" of science. However, Jonassen (2009: 20), points out that theory making is just part of human development when he stated that:

*From an early age, humans naturally build simplified and intuitive personal theories to explain their world. Through experience and reflection, they reorganize and add complexity to their theories and conceptual models. The cognitive process of adapting and restructuring those models is conceptual change.*

In concurrence, Hargraves (2014: 30) has the following to say:

*Recent research makes clear that there is a lot more to understand about children's working theory and the way teachers respond to this outcome of learning… Working theories can be seen as tentative and transitionary outcomes of their processes for developing coherent and meaningful knowledge. These theories are subject to modification as the child gains experience and information.*

What is important to note is that from the perspectives of these children "their ideas about the world are not 'wrong'" (Keeley and Sneider 2015: xxii). Therefore, "these commonsense beliefs should be regarded as reasonable hypotheses grounded in everyday experience" (Fadaei and Mora 2015: 38). Thus, through a succession of conceptual change, the human mind develops, and this is a natural progression through life. This natural human development process, through conceptual change, takes place within the context of both biologically determined heredity, as well as environmental forces, as Vygotsky and Luria (1930, quoted in Wells 1999: 5) point out, "in child development, along with processes of organic growth and maturation, a second line of development is clearly distinguished—the cultural growth and thinking." This reference to culture is very important because culture has a very powerful influence on child development as it embodies "a set of values, skills, and ways of life", and also serves as a "toolkit" for thought, sense making, action and communicating (Takaya 2008: 2). Indeed, it has long been "well established that children's learning does not really take place alone, individually, in the sense of a research scientist, but it goes through processes of 'scaffolding', which is helped by peer interactions, and friendly adults, including the teacher" (Raina 2011: 17).

However, alongside this understanding of how child development takes place has been a preponderance of research on the effects of learners' pre-existing knowledge as well as alternative conceptions on subsequent learning (Treagust 1988; Veiga 1989; Wandersee et al. 1994; Akerson et al. 2000; Prokop et al. 2007; Coetzee 2009; Mchunu 2012; Rankhumise 2012; Antwi and Aryeetey 2015). In particular Antwi and Aryeetey (2015: 289) put this point as follows:

*By now, it is well accepted that alternative conceptions or misconceptions are common among students and that these interfere with subsequent learning and are resistant to change. Overcoming misconceptions is crucial to students learning. When misconceptions are changed directly and students are provided with opportunities to reconstruct their worldview, the proportion of students that are able to use science conceptions to explain phenomenon increases significantly.*

The same point was earlier made by Aikenhead (1996: 3) in his remark that "research on personal constructivism has centered around "misconceptions, alternative frameworks, common sense conceptions, untutored beliefs, and preconceptions." Overall, these studies have reported, *inter alia*, "school children can proceed through their school careers and retain misconceptions about many science concepts" (Akerson et al. 2000: 364). In the mind of Akerson et al. (2000: 364) this shows that "in the absence of a teacher who understands and uses knowledge of children's ideas to inform instruction, children are unlikely to develop their ideas towards scientific understanding." To Akerson et al. (2000: 364) this is evidence that "the kinds of science instruction children receive do not seem to be effective in helping students change their conceptions of science" and that "students may be presented with evidence that their ideas are incongruent with an experiment or problem and reject the evidence, or interpret it differently within their own beliefs…"

Zhou (2012: 113) concurs with the views expressed by Akerson and reports that many studies have "documented that preconceptions are apparently changed in school settings but may quickly reassert themselves in the broader context of daily life." This shows that "conceptual changes reported in the literature are not necessarily permanent changes" (Zhou 2012: 113). In concluding the issue of conceptual changes reported by many researchers, Zhou (2012: 113) avows as follows:

*Most of these claimed changes were actually measured right after the instruction. There was no clear distinction about whether these changes reflected the students' profound change in thinking or a process of simply following what teachers instructed in some particular academic contexts, such as exams.*

Views such as these have raised the significance and importance of studying and understanding children's prior knowledge as a vital input into the instructional process. Moreover, when one considers that learning takes place from what someone knows (or purports to know) to what is new then the logical starting point is to establish what the person 'knows' at the start of the learning journey. According to Dede (2008: 50), "people construct new knowledge and understandings based on what they already know and believe, which is shaped by their developmental level, their prior experiences, and their sociocultural background and context". It is

therefore important that for improved classroom practice, teachers take into account the ideas learners bring to the classroom concerning the phenomena to be learned. Indeed, "if only we could understand how students make sense of their natural world, we could design a science curriculum so that science makes sense to all students" (Aikenhead 1996: 2).

**Problem Statement**

The South African government has mandated that indigenous knowledge systems (IKS) be integrated into the teaching of science, whether or not this lends itself to explanation by scientific methods (Department of Basic Education 2011). The call by the South African government to schools to embrace IKS is not an isolated one. In Kenya, IKS has also been fingered as a vehicle through which much of the country's developmental agenda could be achieved (Owuor 2007). One of the reasons for the calls to integrate IKS into MSS is that it has multifaceted benefits, such as "integrating character building, intellectual training, manual activities, and physical education" (Owuor 2007: 24). Furthermore, "it is argued that if African states are to play a central role in directing the goals of education for sustainable development, then there is a need to integrate the African perspectives of knowledge as a reciprocal body of knowledge to Western education in order to ensure relevance and practicality in addressing local problems affecting societies" (Owuor 2007: 26). However, the directive to embrace IKS comes with some challenges, among which is the need to research and document what could be regarded as authentic IKS. At present, work in this area is still at its infancy.

Thus, this study was prefaced on the need to research the knowledge, skills, attitudes and other dispositions, which would be regarded as authentic for integration into MSS. Further, the study was also prefaced on the implications of the literature briefly captured above regarding the importance of ascertaining learners' pre-existing knowledge on a particular subject before instruction can meaningfully start. To the extent that the information to be collected in this study would largely be home-based knowledge, coming from a rural African setting, the researcher was hopeful that some useful insights would emerge from this research. Accordingly, it was envisaged that such information would be useful for curriculum planning and classroom practice.

**Research Objective**

The research objective of this study was to identify and document grade 6 learners' ideas about the role and function of the brain in a living body.

## METHODOLOGY

This was a qualitative survey research, focusing on the respondents' own descriptions of what they considered to be the main roles and functions of the liver in a living body. Data comprised passages written by the respondents in response to the research question. Written passages, as opposed to interviews, were preferred on the basis that this mode of response would accord the respondents the necessary freedom to express themselves without an interviewer interfering with their minds or thinking processes. Furthermore, the learners were asked to express themselves in isiZulu to ensure that language competence and proficiency did not become a hindrance, or limitation, with regard to their ability to express themselves because in these rural areas, grade six learners have not yet attained sufficient competence and proficiency to express themselves in English.

The study used volunteer samples, in the sense that participation was voluntary, and participants were free to withdraw from the study at any time. The learners who participated in the study came from northern KwaZulu Natal, South Africa. For the majority of these learners, exposure to the scientific worldview is very limited and the tenets of mainstream school science (MSS) are encountered mainly through school teaching, while traditional ways of life within the context of Zulu culture remain their dominant sources of both informal and non-formal learning. Altogether, there were 197 participants, comprising 101 girls and 96 boys studying in grade six, and drawn from four primary schools.

Data collection was carried out using a researcher-designed instrument consisting of only one open-ended question, formulated as follows:

*Please, describe what you understand to be the roles and functions of a brain in a living body.*

This was formulated as follows in isiZulu:

*Ngicela, uchaze ngokwakho ukuqonda ukuthi iyini indima nomsebenzi wengqondo emzimbeni ophilayo.*

With regard to data analysis, a first language speaker of isiZulu, holding a degree in English

language served as the translator of the primary data collected. Data analysis involved the identification and coding of emerging themes from the qualitative data gathered. Closely associated with thematic identification is coding of the data. As Taylor and Gibbs (2010: 1) further elaborate:

Looking for themes involves coding. This is the identification of passages of text (or other meaningful phenomena, such as parts of images) and applying labels to them that indicate they are examples of some thematic idea. At its simplest, this labeling or coding process enables researchers quickly to retrieve and collect together all the text and other data that they have associated with some thematic idea so that they can be examined together and different cases can be compared in that respect.

This is precisely what was done in this study, resulting in the three 'codes' used below, namely, the brain is a tool for traditional healing, the brain is the organ for thinking and/or control of all human activities, and brain as mind. However, because the respondents were free to say anything with regard to the role and function of the liver, many of them gave responses, which defied these categories in that a given passage would include aspects of other categories. Thus, the final category under which responses were classified represented the researcher's sense of the dominant attributes of the given passage. It is, therefore, acknowledged that another researcher (or the reader) could have easily placed particular responses under other categories, other than where the researcher placed them.

The emerging themes were defined and redefined into progressively fewer categories under which the various responses were classified, and finally, three main categories were arrived at.

## RESULTS

The results are presented and discussed below under various sub-headings.

### Demographics

The research sample consisted of a total of 197 duly completed responses, and seven "spoilt papers", which were completely unreadable. There were slightly more boys (51%) than girls (49%), with ages ranging from 11 to 18 years, but all studying in the same grade (grade 6) in the four participating primary schools. All respondents indicated that their home language (HL) was isiZulu and their first additional language (FAL) was English. The language of instruction across all subjects at grade 6 level is officially English, although isiZulu is quite dominant in the rural area where this study was conducted. The implication of this was that a language barrier would have been a major limiting factor, had the respondents been asked to express themselves in English. For this reason, they were asked to express themselves in isiZulu, as a way of allowing them to express constructs and notions in ways that would be typical of their culture and social conditions.

The age distribution of the participants is given in Table 1.

For the male participants, the highest cell loadings related to ages 12, 13 and 14, while for female participants the highest cell loadings were ages 11, 12 and 13. Table 1 illustrates these gender variations more clearly across the age range of the participants.

### The Roles and Functions of the Brain

The responses received on the role and function of the brain are summarized in Table 2.

**Table 1: The age distribution of the participants (n= 197)**

| *Age(Years)* | *11* | *12* | *13* | *14* | *15* | *16+* | *Not Given* | *Total* |
|---|---|---|---|---|---|---|---|---|
| Male | 10 | 29 | 24 | 19 | 04 | 07 | 07 | 100 |
| Female | 35 | 28 | 20 | 03 | 03 | 00 | 08 | 097 |

**Table 2: Summary response type and frequency (n=197)**

| *Theme* | *Description* | *Response (%)* |
|---|---|---|
| 1 | Brain is the organ for thinking and/or control of all human activities and actions | 61 |
| 2 | The Brain is a tool for traditional healing | 21 |
| 3 | Brain is Mind | 18 |

Table 2 shows that the most dominant view was that the brain was the human organ for thinking and control of all human activities and actions, followed by the view that it was a tool for traditional healing, and lastly that the brain was the same thing as one's mind.

**Qualitative Data**

In reporting on the actual responses given by the participants, an 'F' or 'M' is given after each response to represent female and male respondents, respectively. This is followed by the age of the respondent.

**Brain as an Organ for Thinking and/or Control of All Human Activities and Actions**

Given below are the actual 'verbatim' statements that the respondents provided.

*To think is to walk. To think is to read. To think is to sell. To think is to repair. To think is to cut, to think is to write, to think is to buy a pen, to think is to be supported, to think is to clean the yard, to think is to buy electricity. [M, 14]*

In attempting to understand and interpret the statements that the respondents gave, the researcher experienced some difficulties. His first reading of the statements suggested to the researcher that there was a problem, and that the respondents had not understood the question. Most of the responses struck the researcher as largely meaningless. The researcher even held discussions with the teacher who served as the research assistant to establish whether, in fact, she had given these learners clear instructions about the task. She confirmed that she had given the children clear instructions in the learners' home language (isiZulu), since they were all expected to respond in their home language. She further explained that she had written the instructions on the chalkboard, in addition to the fact that they were also clearly set out in the questionnaire.

The researcher then went back and read the responses several times, before it dawned on him that these learners had approached the task with their "rural home mentality" of answering questions circuitously. Having been raised in a rural area, himself, he recalled that in those parts of the world time is an abundant resource. People take their time to explain things, always building an elaborate *context* for their explanations, no matter how small the task. The researcher felt ashamed for having lost this perspective, and for failing to understand the nature of these responses the first time he read them. This is when it struck the researcher that he may have stumbled on something quite profound and fundamental to the community from which the respondents were drawn, than what he initially expected from this investigation, that is, not prior knowledge or IKS, but a much bigger characteristic of the research sample, a whole cognitive style attribute that was typical of a way of life of the communities from which the research sample was drawn, how they approach questions, their way of conceptualizing issues, their way of perceiving things, their whole manner of speaking and answering questions.

To rural African people context is everything. Even when you ask a simple question like "what is the meaning of my name?" the old man will sit you down and give you a very long story, which only after much ado, will culminate in what could have been a straightforward response taking five seconds in Western culture. But by the end of that story, the listener will have been exposed to a lot of contextualized information and knowledge about their family, going back to the first family member who bore that name, and what its meaning and significance in the family has been, and therefore, how one is expected to live up to the family standard and expectation of someone bearing that name. However, sometimes the old man will just tell the story and then leave the listeners to work out their own answer from the context he has so laboriously set down. In big measure, the findings of this study have demonstrated this phenomenon. As demonstrated by most respondents, if not all, the best way to answer the simple question of "what is the function of a brain in a living human body?" was to explain how people in different situations use their brains to get things done. This, of course, was limited to their sociocultural environment, full of the African intrigue of traditional healing and spiritual divination. Further reading on the importance of 'context' led the researcher to the field of 'cognitive styles' and the theory of attribution. This was the academic 'context' in which he felt the results reported here could meaningfully be discussed.

So, looking at the response, "*To think is to walk. To think is to read...*" at first, appears nonsensical. However, after due reflection, it

becomes clear that the respondent is giving an answer, which is couched in a number of contexts. In this regard, the context is that for anything one does, one has to think, *and this is the function of the brain*. So, in answering the question, the respondent lists as many human activities as possible where the brain is required to perform its function to enable the person to carry out the stated activities. This contextual way of responding to the question was typical and a characteristic of all other responses that were received.

Given below is one statement falling under this response category:

*The function of the brain, if you want to build a house you go and buy blocks, door and window frames, windowpanes, cement, doors and you go and fetch sand from the mountain. The other one is to study, improve your grades, go to the university and ask your father to pay for you, if you are lucky you pass, then go and get a job from companies. When you get paid you must go and pay your father. Buy a lounge suite for your house and the DVD or decorate your house and buy a car. To think about the work of traditional healers is fair, because they speak about something, which is going to happen, and it really happens because they communicate with the ancestors. The brain has blood because it is clear like flowing water carelessness… [M, 13]*

The other point that one picks from this statement is that most responses were long-winded, and presented more than one idea. The researcher felt that separating these ideas would not correctly and completely represent the input of a particular respondent. For instance, although this respondent also talked about traditional healers, the researcher simply categorized this response under this section. The theme of traditional healers was very common, and was used promiscuously by most respondents. The other sampled responses were as follows:

*With the brain you think. You do the washing, with the mind you think of anything that you like to do, or you think of going to Fotini (a place called Fourteen in Richards Bay) with your children. Mother is ill you think when or if to go to hospital. You think of what to do today. You think of phoning your relatives. You think of making yourself beautiful. When you write a test at school, or build a house, you think of how it should look. You also think of going to visit your uncle. Also think what we writing tomorrow and that on Friday we are cleaning at school. [M, 14]*

*Many people use their brains. Some plan to build houses, others use it to build furniture, the others to build cars, the others make clothes for us, they use the brain to do that. They use their brains to make baby toys. The others sell building material, the others fell trees to manufacture exercise books, pencils, wooden spoons, and they had used their brain to do that. Even doctors use their brain to heal us when we are ill, they give us medicine, and then we get better. The spiritual healers pray and give us holy water. The brain is used to manufacture jewelry and things for water sanitation and waste disposal, they also manufacture shoes, and the others plant their crop by using their brain. The others repair phones, stoves and electricity. They build roads where cars can travel properly, and swimming pools. [F, 12]*

*The function of the brain is very important to a person because if you have a brain you respect and listen to people. You can recognize a person who does not have a brain because of the behavior s/he does not listen and does not respect other people. [F, 12]*

From this statement, one could say that there is one misconception that comes out, that is, the respondent thinks that there are some people who do not have brains. However, in isiZulu to say that someone has no brains does not necessarily carry the literal meaning. If you're stubborn, disrespectful towards elders, or poor in schoolwork, it may be said that you have no brains, and one never gets the impression that the speaker means to say that the person in question will not present a physical structure called brain, if one were to open his/her skull.

**The Brain as a Tool for Traditional Healing**

This sub-category could be seen as an elaboration of the first category, which indicated that the 'brain is for thinking and control of all human activities'. Some of the respondents gave a list of 'trades', 'professions' and other activities, which characterize other human 'walks of life', including traditional healing. However, the issue of traditional healing was so pervasive and promiscuously used by the respondents that the researcher felt that it would be justified to create this as a subcategory of responses.

In most parts of rural KwaZulu-Natal province, as is the case in most African communities across the African continent, the main role players in traditional healing are *izangoma* (the diviners/fortunetellers), *spiritual healers*, and *herbalists* (*izinyanga*). The *izangoma* typically carry out two main functions of divination and diagnosis, although there are some who also carry out healing. The spiritual healers heal mainly through prayers, which usually involve appealing to the gods, ancestors, and God. The *izinyanga* use herbs and other traditional medicinal paraphernalia to heal their patients. These various types of traditional healers are ever-present in the communities from which the research sample was drawn. As is quite evident from the responses, the importance, influence and impact of the activities of these traditional medicine people in the lives of the respondents were quite significant, as judged by the extent of elaborations in the responses. Given below are a few examples of the pattern of responses under this response category.

One respondent gave the following response:

*The function of the brain is to go there and ask for medicine to help him/her. The other person who has come for the bones to be thrown is ill and maybe there is something that the person has lost. If the other one is ill the spiritual healer will pray for that person, if he gets better he will go back and thank the spiritual healer, and the spiritual healer will ask, did you go well, he will say yes or no and the spiritual healer will say I will give holy water to bathe in and drink, will also ask the spiritual healer to pray for the sins and criminal cases to be removed. The spiritual healer will help with prayer and you get well; will greet and ask how are you feeling now? And you will say yes I am better. She will pray so that you will get better. The traditional healer helps if you have come for herbs or bones to be thrown or the rope that you put around your waist. Also when people are bewitching you, you will go to the traditional healer to find out who has bewitched you. Maybe if there is someone who is ill he will go to the traditional healer for help so that he will be well like every other person if he wants help. [F, 12]*

Three other respondents had the following to say:

*The brain is there so that when you are ill you know how to look for help from traditional healers and fortunetellers. The fortunetellers are able to help you when you are ill, they give you herbs and medicines, and they are also able to tell you about spiritual things. Their herbal mixtures help a lot, and they sometimes ask you to use the enema. They also go to traditional and spiritual healers to ask for holy water. The traditional/spiritual healer performs their rituals in the special house, specially built for this. [F, 13]*

*The brain is used by people if they want help or the herbalist or the sangomas. It also helps those who are not sangomas. If you have a headache they take you to the clinic. If given work at school you have to do it because you are going to get help. You need to use your brain because you are going to have a problem if you do not listen. The brain has a lot of work. [M, 12]*

*The brain helps people who are ill. When something has happened they go the fortune-teller (sangoma) to throw bones. Other people believe in ancestors, when ancestors are angry people encounter problems, so they go to the sangoma to ask for forgiveness. The traditional healers help by giving people remedies for their ailments. The sangoma helps by revealing the secrets behind the illness, whether it is because of the ancestors that you have become ill or have the problems you cannot solve. [F, 12]*

**Interplay between Brain and Mind**

The direct substitution of 'mind' for 'brain' was unexpected. In isiZulu there are two separate words for mind (*umqondo*) and brain (*ingqondo*), although sounding somewhat similar. Conceptually, the term 'brain' refers to the physical object protected by one's skull, whereas the term 'mind' refers to the human capacity to think, sense, and process information. Ciborra and Willcocks (2006: 129) conceive of 'mind' as referring to "disposition, mood, affectedness and emotion", while Pinker (1997: 24) simply states that "the mind is what the brain does."

However, at the level of these respondents the researcher seriously doubts that they are aware of the philosophical debates regarding the distinction between 'mind' and 'brain'. Perhaps, therefore, one could say that the one main conception found was thinking that 'mind' is the same thing as 'brain'. The following state-

ments were some of the responses that typified this response category:

*With my mind, when the teacher gives me work, I go and do that work, the work of the mind, you think with your mind. [F, 11]*

*If you have the right mind you are able to do right and important things. [F, 12]*

*To think psychologically, if the teacher teaches us anything, we must have the right mind at school, when we are learning mathematics. We must listen to what the teacher is saying. In my mind I am thinking of grilling meat, and then people come and I may be able to recognize them without looking at them, and tell the community that so and so has been here, by thinking although I did not see them but they were there. Also my mind is thinking about many people in my heart and mind, I am also thinking of the month school is closing on September 30. It is also God who gave us our brains, all of us who are remaining on earth. The brain that does not work well, it makes them mad. We do not see God who is above, we only see the clouds. If you know somebody's number, someone that you know, you have it in your mind. Also there are people who like God and there are others who do not like Him. I wish to respect my teachers at school and not miss classes because my mother loves me, I also love them all at home. I think with the helping mind, also my home belongs to God, but we've never seen Him. [F, 12]*

*The function of the brain is for working or when you are learning you keep everything in the mind, so that when you start writing you write something you know that you have memorized. [F, 14]*

*The function of the brain comes from the mind, because they want to make something beautiful, and that you can praise. [F, 11]*

*If you play football you must use your mind. [M, 14]*

*The brain is the one, which creates the mind. [M, 14]*

Ordinarily, the Life Science curriculum does not go into the discussions of mind versus brain. Typically, what is covered is the physical structure of the brain and the functions performed by its various sections. However, this response category goes to exemplify the point about the holistic nature of the cognitive framework of rural (African?) people. As will be pointed out under discussion, the Western way is to truncate phenomena into constituent parts, whereas the African way is to integrate at the bigger picture level. Accordingly, the African indigenous ways of both cognition and perception are more holistic while for Western cultures they tend to be focused on specific attributes of a given concept or phenomenon.

As pointed out earlier, the striking aspect of these results is the respondents' proclivity for context, which may be seen as unnecessary 'rambling' if one looks at it from the MSS point of view. It was typical for a respondent to start with one idea. For instance, that the brain helps a person to think, but then soon drift in another direction, and then another. The following passage is an example of this, and it was extremely difficult to categorize such responses:

*The function of the brain is for you to think, go to the spiritual healer or the traditional healer; think when you have to go to many places; think about where can I go today, should I stay home or should I visit a friend. Satan says I must not go to my friend, God says I must go to my friend and not succumb to Satan. At last I fell ill hearing a voice saying I should go to the spiritual healer or the traditional healer, it says I must not go, Satan will kill me. God says I must go, Satan will really kill me, I must go to my traditional healer, He will help me, said God. If you need to be helped, you think of someone you can trust to help you and in return help other people. When you are ill the spiritual healer helps you. Even the traditional healer helps you. Satan, also when you write you think, the brain helps you if you want to study, Satan is saying you must not study, God says study, the voice saying write also read, I wish you a bright future. [F, 11]*

These types of responses cut across the two categories of 'brain for thinking' and brain for 'traditional healing'. However, the issue of context still remains the common denominator in all cases.

## DISCUSSION

The research objective of this study was to identify and document grade 6 learners' ideas about the role and function of the brain in a living body. Table 2 shows that the highest single response was that the brain's main function was to enable the individual to think and direct all the human activities and actions. The other

responses that fell under the other two categories did not carry much by way of stating the role and function of the brain from the MSS point of view. Instead, what came out was a very clear exhibition of a context-based learning framework, which will form the central focus of this discussion. This was an unexpected but a significant finding, and deserves a little more explication.

In MSS contexts, questions are typically answered in a very direct way, and teachers expect their students to give answers which are 'exact and to the point', where applicable in an itemized manner so that the points stand out. On the other hand, anybody familiar with rural African people knows that a lot of their wisdom and knowledge is 'hidden' in riddles, proverbs and many circuitous ways of expression. Thus, with regard to the responses that came out of this study, it is striking to see how early this 'mentality' of the importance of context was embraced and adopted by these children. It is much more sophisticated to give the types of responses obtained in this study than to give very direct (usually memorized answers) as one commonly finds in MSS situations. In great measure, these responses reflect what constructivists refer to as "situated learning" (Tobias and Duffy 2009: 4).

The question of situated cognition is very important and quite useful in explaining the results of this study. According to Han et al. (2013: 352), "the human brain develops in a specific sociocultural context during interactions with others." For her part, Bang (2015: 230) uses the term 'situative perspectives' to refer to the notion that knowledge and the act of knowing take place at a particular time, and within a particular, place, space and context. In Bang's view, the acknowledgement and adoption of 'situative perspectives' "have enabled significant advances in understanding culture, learning, and development broadly by focusing on the ways in which people in all communities explore, narrate, and build knowledge about their worlds", that in doing so, they "not solely in their minds but also in varied ways that are dynamically and inextricably connected to particular contexts and interactions." (Bang 2015: 230-231).

Therefore, with the current emphasis on constructivist approaches to teaching and learning, one would want to encourage learners to think their answers through within authentic contexts. This is what the respondents in this study have shown, by attempting to build context to illustrate their understanding of the role and function of the brain. This calls for contextual teaching and learning, which are exalted by Berns and Erickson (2001: 3) as constituting help to teachers so that they can relate the "subject matter content to real world situations, and motivate students to make connections between knowledge and its applications to their lives as family members, citizens, and workers and engage in the hard work that learning requires." Quite clearly, if all the learners learned in this manner, not only would learning be interesting and relevant, but it would also hold great potential for critical thinking, reflection and innovation.

Historically, the term 'cognitive style' was used to refer "to a psychological dimension representing consistencies in an individual's manner of cognitive functioning, particularly with respect to acquiring and processing information" (Kozhevnikov 2007: 464). Further, Kozhevnikov reports that cognitive style may also refer to "stable attitudes, preferences, or habitual strategies that determine the individuals' modes of perceiving, remembering, thinking, and problem solving." Different people have different ways of thinking, and research around cognitive styles addresses this issue by attempting to unpack how people's different overall patterns of thinking or approaching problems (Akerson et al. 2015; Fadaei and Mora 2015; Keeley and Sneider 2015). This is contrary to the assumption, historically held by many, that human cognition and perception are universal among people of all cultures. Nisbett and Mitamoto (2005: 472) express this point in the following manner:

*One of the basic assumptions about human cognition and perception has been that information-processing machinery is fixed and universal. However, the evidence we have reviewed suggests that cognitive and perceptual processes are constructed in part through participation in cultural practices. The cultural environment, both social and physical, shapes perceptual processes.*

One of the most common distinctions in the literature on cognitive style is between *analytic* and *holistic* styles, where the former involves understanding a system by thinking about its parts and how they work together to produce larger-scale effects, and the latter refers to proclivity to understand a system by sensing its large-scale patterns and reacting to them. Ac-

cording to Lin et al. (2013: 4), it has generally long been established "that individuals of individualistic cultures tend to think analytically when engaging in cognitive activities whilst individuals of collectivistic cultures engage in holistic thinking."

Varnum et al. (in Lin et al. 2013: 4) define analytic thinking as the ability to "focus on a single dimension or aspect (that is, categorizing objects or evaluating arguments) and to disentangle phenomena from the contexts in which they are embedded (that is, focusing on the individual as a causal agent or attending to focal objects in visual scenes)" and holistic thinking as the ability to focus broadly on the "context and relationships in visual attention, categorizing objects, and explaining social behaviors".

Accordingly, Lin et al. (2013: 4) explain, "While analytic thinkers view the world as composed of separate elements that can be understood independently, focusing on objects and dispositions, holistic thinkers focus on the relationships among different elements and context". As such, "analytic thinkers focus on dispositions while overlooking situational causes, while holistic thinkers focus on both dispositions and situational causes when they search for explanations" (Lin et al. 2013: 5). Regarding tolerance for ambiguity, Lin et al point out that analytic thinkers are low in tolerance for contradiction and therefore differentiate and contrast information to choose the best goal while holistic thinkers integrate divergent information and are able to assimilate contradictory positions.

The analytic cognitive style is closely aligned with the notion of intelligence that is dominant in the Western culture. Whimbey and Whimbey (1975: 120) define intelligence as follows.

Intelligence is an attentional/processing skill used in analyzing and mentally reconstructing relations. The distinguishing feature of this skill is breaking complex relations (or problems) into small steps that can be dealt with fully. The major components of the skill are extensive search and careful apprehension of all details relevant to the relation, thorough utilization of all available information including prior knowledge, accurate comparisons, and sequential, step-by-step analysis and construction.

Not surprisingly, one finds that analytic knowledge tends to be the main type of knowledge espoused by most school curricula, not only in Western countries, but also in most post-colonial African countries. In addition, analytic understanding is also required in many outside-of-school situations when confronted with problems involving physical or natural systems. This is so, mainly because most day-to-day systems and devices are founded on school knowledge. For example, a good car repairperson must be able to analyze the difficulties of a car brought in for repair by demonstrating his/her understanding of how the components of the system function and work together. Likewise, most experts in many other fields of life use analytic intelligence to executive their duties and resolve challenges that they encounter.

However, quite important to this study is the other type of intelligence, whereby a person goes for the overall idea or the bigger picture, and not so much worry about or pay attention to the finer details. This type of intelligence is about holistic abilities. A holistically intelligent person does not tear things apart mentally, to understand them. Instead, s/he tends to approach a subject by trying to understand its 'gist' or general meaning.

Overall, the underlying distinguishing feature of these Analytic-Holistic (A-H) studies is "the importance of context" (Lin 2009: 19). According to Lin (2009: 19), research describing A-H differences has found that people from Western nations differ from those of Eastern Asia, for instance, in analytic versus holistic modes of thinking. Westerners exhibit analytic thought whereby, typically, they detach objects from their contexts, focus on attributes of objects, avoid contradictions and use rules to explain and predict behavior. In contrast, East Asians show holistic thought by orientating "to the context or field as a whole, attend to relationships between focal object and the field, and also explain and predict events based on such relationships" (Lin 2009: 19). In concurrence, Iliev (2015: 1) points out as follows:

*Using this East-West framework as the comparative lens, researchers found that Easterners use a holistic mode of thinking while Westerners use an analytic mode. Holistic thinking relies less on formal rules, attends to the whole field, and is more open to dialectic contradiction than analytic thinking.*

From cultural neuroscience research, the role of the social and physical environments in shaping cognitive development has emerged as a

major factor. This point is made quite succinctly by Han et al. (2013: 337) who aver that from cultural neuroscience research "theoretical frameworks such as individualistic versus collectivistic values, independent self-construals versus interdependent self-construals, and holistic versus analytic cognitive tendencies have emerged to guide empirical studies of cultural discrepancy in human cognition and emotion." These contrasts typically represent the dialectics between Western and indigenous outlooks and dispositions. Characteristically, "holistic thinkers prefer to use experience-based knowledge rather than abstract logic…reason dialectically…and make situational attribution" (Lin 2009: 19).

In a similar vein, Fu et al. (2013: 1) report that "generally, East Asians are more sensitive to context and relations among objects or events and hence, view the world on a global scale, that is, have a holistic cognitive style, whereas Westerners are more focused on focal objects and hence view the world on a local scale, that is, have an analytic cognitive style." Another way of putting this is that Westerners tend to engage in *context-independent* and analytic perceptual processes by focusing on a salient object independently of its context, whereas Asians tend to engage in *context-dependent* and holistic perceptual processes by attending to the relationship between the object and the context in which the object is located.

In concurrence, Nisbett and Mitamoto (2005: 469) content that "there is considerable evidence that shows that Asians are inclined to attend to, perceive and remember contexts and relationships whereas Westerners are more likely to attend to, perceive and remember the attributes of salient objects and their category memberships." In explaining these dispositions, Nisbett and Mitamoto (2005: 469) opine as follows:

*If one lives in a complex, interdependent social world with many role prescriptions, one needs to attend to relationships and to the context. On the other hand, if one lives in relatively independent, individualistic social circumstances, one might attend primarily to objects and one's goals with respect to those objects without being overly constrained by other people's demands and needs. Asian societies are more interdependent and thus attend more to context.*

At a broader level, A-H thinking explains cultural differences in attribution, which is "defined as the process by which people describe causes in their world" (Lin 2009: 20). In this regard, attribution may be 'dispositional' or 'situational'. According to Lin (2009: 20), "dispositional attribution identifies internal causes such as competence, personality, and beliefs as most explanatory, whereas situational attribution also looks to external causal factors such as task demands, environmental barriers, and surrounding people." In this regard, Lin reports that many researchers using Western samples have found a tendency towards dispositional attribution while ignoring situational causes correspondingly aligned with analytic versus holistic cognitive thinking styles.

According to Lin (2009: 20), "the pattern of attributing to dispositional causes is not universal", just as it was observed earlier that human cognitive style is not universal in that it is a function of the environment and culture, amongst others. Thus, when you have a curriculum predicated upon dispositional attribution, powered by analytic cognition, then from the start learners with a situational attribution inclination (holistic cognition) are at a disadvantage. So, with reference to the present study, if the researcher wants a "straightforward answer" to the question regarding the role and function of the brain, as he initially did, but then a respondent gives a circuitous response, as most of them did, then a cognitive style dissonance or clash arises. Likewise, when the teacher in similar circumstances marks the learner wrong for "waffling" and not getting to the point, the learner is confused. Yet, because situational attribution is integrated, this is what the teacher should be rewarding because it represents a higher order learning achievement. At home, the same learner would be praised for 'situating' his/her understanding of concepts within appropriate contexts. On the other hand, because most African schools are Western-orientated, they fail to capitalize on this asset that the learners bring with them from home. Little wonder, therefore, that rural learners, in particular, take time to acclimatize to these 'strange' curricula because the whole process involves embracing a totally new cognitive mindset. At best, they have to be bicultural to survive, as Nisbett and Mitamoto (2005: 470) point out, "If people have been exposed to two different kinds of social systems, they might be expected to reason and perceive either holistically or analytically, depending on

the cues prompting one cultural orientation or another." Nisbett and Mitamoto (2005: 471) express this point further as follows:

*In everyday life, people are constantly exposed to particular cultural practices and environments that encourage culturally specific patterns of attention. Under normal circumstances, these practices and environments contribute to the 'default' patterns of perception that are characteristic of a given culture. But changing the environment might be expected to produce at least a temporary change in default patterns of perception.*

This is what happens to many learners. When they are in school they adapt to the culture of analytical cognition, and in out-of-school contexts they fall back on their holistic cognitive thinking patterns. However, with regard to the implications of this for classroom practice, what it means is that people belonging to the two cognitive thinking styles will require different learning environments in the kinds of information that is provided in order to learn optimally. Learners with a holistic cognitive style will prefer a learning environment that is rich with information that shows relationships among concepts or concepts connected into a meaningful whole, whereas analytic thinkers will prefer focused and categorized information. Another approach, according to Takaya (2008: 2), is that the teachers' efforts should center around helping students to "experience various modes of meaning-making and communicating and to create a community in which multiple ways of learning take place as opposed to the largely cultureless mode of learning, which dominates schools." In this regard, Takaya exalts "the importance of understanding culture as a *context* in which values and meanings of students' experience may be interpreted."

## CONCLUSION

This study has brought about a realization of the importance of context in the Zulu children's understanding of their world, and concept formation, generally. In undertaking this study, the researcher had a different expectation regarding its outcome. His focus was on documenting misconceptions or alternative conceptions that the respondents might have had, within the context of IKS. Nonetheless, the primacy of context exhibited by the respondents within the aegis of a holistic cognitive style has been a very significant outcome of this research. It is, therefore, important to understand how cognitive style differences affect sense making for the respective types of thinkers. Understanding how this takes place among people of different cognitive styles would improve instruction. Indeed, as classrooms become increasingly culturally diverse, attention to cognitive differences can go a long way in making instruction both relevant and more appropriate.

## RECOMMENDATIONS

This study has taken a step towards sensitizing educators on how cognitive differences, such as AH thinking, influence information processing and, therefore, learning. This could be crucial for adapting curricula and classroom practice. The reality of rural African life is that the knowledge of the people's life worlds is not neatly packaged into school-like subjects, or learning areas, such as physics, life sciences, accounting, history, and others. People live an integrated life, a life in which religion, physics, chemistry, language studies, and others, are all fused into one 'learning area'. Thus, when learners are tested with specific reference to a researcher's narrowly defined subject matter area in mind, for instance, biology, as was the case in this study, the researcher is making assumptions about knowledge and understanding that may be totally out-of-phase with the realm of knowledge and understanding in which the learners were based. It is, therefore, small wonder that the participants in this study interpreted the question put to them entirely within the intrigues of their own life worlds, a world dominated by African traditions and culture.

The issue of the research sample having a cognition, which is not aligned with MSS, has been the major outcome of this study and suggests a very serious look at the pedagogy in use in the school system as a whole. However, in order to ensure that the findings of this study do not represent a very specific view from a particular research area within the country, it is important to recommend that this study be extended to cover a wider geographical area within the Kwazulu Natal province, as well as other parts of the country. In the meantime, however, it would be proactive thinking if teachers and education

officials embraced the findings of this study and start to exercise sensitivity to the learners' cognitive styles, as well as to the differences in the cognitive styles of learners.

Quite important is the implied need for profound curricular revisions, which would give the primacy of place to holistic cognitive reasoning, that is, a shift from the current focus based on the analytic cognitive reasoning style, or at least evolve ones, which would reflect an equitable balance between the two cognitive reasoning styles. This is not to say that analytic reasoning is undesirable, rather it is merely a matter of recognizing that this is not the dominant tool that the learners use in interpreting their environment, they promiscuously use holistic reasoning, and context-dependent and make situational attribution. To achieve this, it appears important to sensitize various important stakeholders about the current incongruity between the learners' dominant cognition vis-à-vis the school curriculum. This could be addressed by way of in-service interventions for office-based educators (education administrators, curriculum specialists and planners), field workers (for example, subject advisors), and school-based educators (school principals, heads of department and classroom practitioners). Failure to do this will result in these rural school children continuing to be subjected to a Western worldview, of which they'll never be an integral part, and to curricular tasks that do not reflect their lived worlds. Inevitably this leads to underachievement for those learners who will be slow to make the switch from their home-based worldviews to the Western worldview. In big measure then, it is not surprising that many learners find it difficult to abandon their home knowledge, which works for them outside the classroom, in favor of classroom-based knowledge, which only serves the purpose of passing examinations. Thus, they walk about with two worldviews, which may never blend. They will use home knowledge for the most part, and school knowledge in examinations and when looking for employment.

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