# Proceedings of the Nineteenth Annual Meeting of the

# SOUTHERN AFRICAN ASSOCIATION FOR RESEARCH IN MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION (SAARMSTE)

Mathematics, Science & Technology Education – A bridge to the future

**18 - 21 JANUARY 2011**

**Hosted by the North-West University- Mafikeng Campus**

# Long Papers

**Edited by Thapelo Mamiala and Frederick Kwayisi**

2011 North-West University- Mafikeng Campus, Republic of South Africa

ISBN # 978-0-9869800-0-8

# SAARMSTE COMMITTEES 2011

## SAARMSTE EXECUTIVE COMMITTEE

| | |
|---|---|
| **President:** | Prof Marc Schäfer (Rhodes University) |
| **Past President:** | Mr Chipo Fumhanda (New Zealand) |
| **Secretary – Treasurer:** | Prof Marie Botha (University of Pretoria) |
| **Regional Representatives:** | Dr Emilia Afonso -Mozambique Chapter (Universidade Pedagogica) |
| | Prof. Helen Drummond – North West Chapter (North-West University) |
| **Research Capacity Rep:** | Dr Tulsi Morar (Nelson Mandela Metropolitan University) |
| **AJRMSTE Editor:** | Prof Fred Lubben (CPUT & University of York) |
| **Secretariat (ex-officio):** | Ms Caryn McNamara (Rhodes University) |

## SAARMSTE LOCAL ORGANISING COMMITTEE (LOC) 2011

| | |
|---|---|
| **Chairperson:** | Prof Thapelo Mamiala (North-West University) |
| **Treasurer:** | Prof Helen Drummond (North-West University) |
| **Secretary:** | Dr Jacob Tholo (North West Department of Education) |
| **Organiser:** | Dr Frederick Kwayisi (North-West University) |
| **Members:** | Ms Sophy Mangope (North West Department of Education) |
| | Ms Helen Thomas (North-West University) |
| | Ms G Poti (North West Department of Education) |
| | Mr Noorullah Shaikhnag (North-West University) |
| | Ms V Leketi (North West Department of Education) |
| | Mr Andrew Mutsvangwa (North-West University) |
| | Mr Nkosana Mavuso (North-West University) |

## SAARMSTE PROGRAMME COMMITTEE 2011

| | |
|---|---|
| Programme Chair: | Dr Frederick Kwayisi (North-West University) |
| Proceedings Editors: | Ms Helen Thomas (North-West University) |
| | Prof Thapelo Mamiala (North-West University) |
| Mathematics Coordinator: | Prof Thapelo Mamiala (North-West University) |
| Science Coordinator: | Prof Helen Drummond (North-West University) |
| Technology: | Dr G.M.Reitsma (North-West University) |
| Members: | Dr Jacob Tholo (North West Department of Education) |
| | Ms Sophy Mangope (North West Department of Education) |
| | Ms Brenda Mokotedi (North West Department of Education) |
| | Mr K. Maletsoa (North West Department of Education) |

# Using food science concepts to enact science-indigenous knowledge systems classroom based discourses

**Samuel Kwofie [1] Meshach Ogunniyi [2]**

[1] *South African National Bioinformatics Institute.* [2] *School of Science and Mathematics Education, University of the Western Cape, South Africa.*

[1] samuel@sanbi.ac.za, [2] mogunniyi@uwc.ac.za

## ABSTRACT

According to the World Bank and United Nations Educational, Scientific and Cultural Organization (UNESCO), Indigenous knowledge systems (IKS) could serve as leverage for augmenting policy formulation regarding health, environment and education. By exploring the appropriate pedagogic approaches, the potential exist for integrating IKS into the conventional western based science classroom environment. This study is part of the Science and Indigenous Knowledge Systems Project (SIKSP) at the University of the Western Cape. In response to the new South African curriculum to integrate school science with IKS, the reported study involving science teachers used food science based concepts as part of an instructional model to enhance the teachers' ability to engage in science-IKS classroom based discourses. The study involved 13 primary and secondary science teachers who attended bi-weekly science-IKS workshops for two consecutive six months. The teachers demonstrated the potential to: (1) enact science-IKS teaching and learning discourses, (2) articulate coherently the link between science and IKS concepts (3) discern science concepts embedded in traditional food processing techniques (4) unravel the wisdom in IKS and (5) value IKS as a useful body of "owned" knowledge.

## Introduction

The National Curriculum Statement formulated by the South African government encourages the indigenization of school science. Educators (teachers) are called upon to incorporate Indigenous Knowledge Systems (IKS) into school science discourses. The curriculum entreats educators to decontextualize school science by adopting IKS-science based lesson activities. Since school science is essentially based on a mechanistic worldview and the western model of education, educators must be well equipped to effectively implement IKS based largely on anthropomorphic and metaphysical worldview in their classrooms. By the same token, it was our view that any attempt to relate the two distinct worldviews together implies the provision of an intellectual space for dialogue or what Bhabha (1994) calls third hybrid space to reflect on classroom context. Our view was that a classroom based on a dialogical argumentation instructional model could provide such a space. Hence we have adopted Toulmin's (1958) Argumentation Pattern (TAP) as a pedagogical framework for implementing a science/IKS-based curriculum. Also, because IKS are embedded within a metaphysical framework, the Contiguity Argumentation Theory (Ogunniyi, 1997) approach was adopted in this research, where IKS and science are considered as equipollent or complimentary cosmologies in need of a form of dialogue that would result in meaningful learning.

Educators are currently being trained as facilitators for effective implementation of the new IKS educational policy. Video and audio archives from focus group discussions, workshops and classroom-based activities serve as guide in implementing science/IKS- based lessons. Already exemplary materials have been developed and piloted on indigenous food systems such as gari, fufu powder, lafun and

**Proceedings of the 19th Annual meeting of the Southern African Association for Research in Mathematics, Science and Technology (SAARMSTE), 18-21 January 2011 at North-West University, pages 387-397**

umqombothi. Gari, fufu powder and lafun are food products processed from cassava tubers and these are popular in western, eastern, certain parts of southern Africa as well as Asia and the West Indies. Umqombothi is a traditional beer prepared by various ethnic groups in South Africa and is consumed during ceremonies such as marriages and home coming after circumcision initiations. The dialogical argumentation discursive worksheets based on earlier studies (e.g. Ogunniyi, 2004, 2007a &b) being used in the workshops have been developed around the nutritional values of indigenous foods, health implications and their traditional methods of preparation. Indigenous knowledge embedded in the various stages of the traditional food processing techniques is linked to the ethnographic narratives from local people.

In this research food science concept such as Hazard Analysis Critical Control Point (HACCP) system was employed to identify critical control points in indigenous food processing flow charts, and sensory analysis was used to evaluate the gari. HACCP system is used as a guide to identify critical control points in the food processing chain, especially where potential food safety hazards could be introduced as contamination (Fletcher et al, 2009). Proximate analysis concept and testing for the nutritional components give insight into the nutritional efficacy of food (Kolapo et al, 2007). Sensory analysis techniques (Seo et al, 2007) are also used to evaluate food products by using human senses such as taste, smell, touch and sight. The scientific knowledge derived from these food quality assurance processes is mapped unto indigenous knowledge to generate discourses for dialogical argumentation. This research does not intend to compare separately the pedagogic outcomes of IKS and science. The aim of this study is therefore to explore how to equip teachers with the essential pedagogic skills necessary to enact science-IKS classroom discourses.

## Purpose of study

The need to promote IKS as leverage to augment school science curricula appears to have taken a snail pace. Therefore robust pedagogic approaches need to be exploited in the development of science-IKS curricula materials. The purpose of the study therefore, was to determine the effects of food science based instructional model on teachers' ability to: enact appropriate science-IKS based classroom discourses; articulate coherently the link between science and IKS; realize the worth of IKS concepts; and discern science concepts embedded in traditional food processing techniques.

## Methodology

As stated earlier, a Dialogical and Argumentation Instructional Model (DAIM) was employed as the pedagogic framework together with the Contiguity Argumentation Theory (CAT), a philosophical model for integrating science with IKS concepts. For the purpose of this discourse, science and IKS were considered as complementary and equipollent even though IKS could be situated within a metaphysical context. The worksheets and workshop discourses are based on a pedagogical framework consisting of individual and small group tasks, and whole class discussions. The role of the facilitator is to mediate the whole class discussions and co-constructs the knowledge of the teachers to enhance their conceptual understanding of both IKS and scientific phenomena. During the course of dialogical argumentation, individuals may realize their disagreement on scientific claims and grounds and this may lead to cognitive conflict. Although certain claims and grounds may be rebutted at each stage of the argumentation processes (individual task, small group task and whole class discussions), individuals and groups are encouraged to reach a consensus on claims and grounds pertaining to IKS-science phenomena. The IKS-science dialogical argumentation may involve inductive, deductive and analogical logical reasoning strategies. Once cognitive harmonization has been attained, the individual could achieve cognitive optima. The levels of argumentations are determined at each stage of argumentation (individual, group and whole class) to ascertain whether the educators are developing high-level argumentations skills. Higher incidences of rebuttal of claims and grounds by colleagues involved in the argumentation discourses could lead to the attainment of high level of argumentation (e.g. Simon et al, 2006; Ogunniyi, 2007a &b). This research reported here involved 13 primary and secondary school teachers with different pedagogic skills who attended the IKS- Science workshops for a three-hour bi-weekly for two consecutive six months. The teachers were divided into 4 groups and were denoted as T1 to T13. The teachers were expected to gain pedagogic skills necessary for the implementation of science-IKS classroom discourse. The teachers were assigned the following task: (1) perform sensory analysis on gari, (2) identify the critical control points in the provided process flow charts (A, B and C) for indigenous processing of food, and (3) identify the process flow chart for production of gari from cassava out of the 3 charts (A, B and C) provided. The process flow charts employed in this study were designed by modifying the charts originally produced by the International Institute of Tropical Agriculture (2005).

## Results and Discussions

The results reported here were obtained from the transcribed video archive and discursive worksheets designed for the purpose of this study. For lack of space, the details on the effectiveness of DAIM and the various levels of argumentation traversed by the teachers during this discourse will be reported elsewhere. Here we are focusing on the effectiveness of using food science concepts such as sensory analysis, HACCP system and indigenous preparation of African foods to enact science-IKS based discourses. In addition, we also explored the ease or otherwise with which the teachers critically interrogated coupling of both western-based scientific and non-western based IKS concepts in the context of CAT.

### Evaluating the effectiveness of sensory analysis

The teachers carried out sensory evaluation on gari as directed in the worksheet. This task was done individually. Sensory analysis can be combined with other detection methods to identify or authenticate food products (Arvanitoyannis & Vlachos A, 2007) as well as used in the experimentally determination of food product shelf-life (Koutsoumanis, 2001). Sensory analysis is therefore the ultimate in evaluating the quality or otherwise the success of food products (Drake, 2007). Sometimes trained expert are used to gather data for both qualitative and quantitative analysis. For the purpose of this research, the teachers involved are not trained experts and we adapted the consumer testing as well as the affective testing approaches. The teachers were allowed to use their individual subjective judgments so as to determine if they will appreciate the gari and the IKS embedded in its preparation. The obtained results were not quantitatively analysed but rather qualitatively. The knowledge obtained at this stage was used to enhance the discussions at later stages. We present a summary of the results here focusing on four teachers, one from each group (Tables 1a-d). In addition, we analysed the overall discourses with the aim of identifying potential emerging insights during the activities.

**Table 1a**. Sensory analysis report of T1 also in group 1

| | |
|---|---|
| Flavour and taste: | Slightly flavour after it has been in the mouth for a few seconds, slightly bitter taste, [and] slight sting on the tongue |
| Texture: | Rough |
| Smell/Aroma: | No smell |
| Appearance (colour): | "Creamish" [cream like], yellow |
| Appearance (shape): | Small fibres, granular, irregular in shape |
| Appearance (size): | Granules range in size- small to medium |
| What is your overall evaluation of gari (use your own discretion) and is there a competitive product in South Africa? | No competitive product available. An adaptable product that can be used in variety of dishes |

Dry gari is granular flour with creamy-white appearance, and has a slightly fermented flavour as well as slightly sour taste. The teachers though not trained experts could evaluate gari to certain extent. The sensory analysis results of the remaining eight teachers did not differ substantially from the reported results. At the end of this exercise they appreciated the product and the IKS associated with. From the reported snapshots, T1 suggested that since there was no competitive product to gari produced in South Africa, it could be adapted in a variety of ways. Furthermore, T8 suggested that the roughages in gari could have nutritional value. T11 and T8 also proposed maize meal and wheat meal (T8 only) as competitive products in South Africa. "Competitive product" mentioned here does not mean nutritional alternative but rather a staple food alternative that consumers can turn to.

**Table 1b.** Sensory analysis report of T4 also in group 2

| | |
|---|---|
| Flavour and taste: | Bland, slightly acidic with fermented taste |
| Texture: | Rough, granular, dehydrated |
| Smell/Aroma: | Odourless, slightly acidic, garlic and sour |
| Appearance (colour): | Cream, very light yellow |
| Appearance (shape): | Dry granules, flakes, crystal like, fibrous |
| Appearance (size): | Small, big granules fibrous, grated, milled |
| What is your overall evaluation of gari (use your own discretion) and is there a competitive product in South Africa? | Processed tuber which has been possibly grated, grinded, fermented, slightly baked |

**Table 1c.** Sensory analysis report of T8 also in group 3

| | |
|---|---|
| Flavour and taste: | Starch, tasteless initially and with time tastes like breadcrumbs |
| Texture: | Dry, hard, can't break individual crystals with hands, only the wheaty [wheat like] flakes are breakable |
| Smell/Aroma: | It's got a sour-like smell |
| Appearance (colour): | Cream |
| Appearance (shape): | Granular (different shapes to irregular) |
| Appearance (size): | Small crystals, flakes |
| What is your overall evaluation of gari (use your own discretion) and is there a competitive product in South Africa? | It looks as though it consists of starch. There are tiny small flakes and roughage that could be cassava. This roughage could be vital for digestive system (utilized as fibre). The competitive product could be wheat bix or maize meal |

**Table 1d.** Sensory analysis report of T11 also in group 4

| | |
|---|---|
| Flavour and taste: | Taste like milk powder |
| Texture: | Course |
| Smell/Aroma: | No smell |
| Appearance (colour): | Cream |
| Appearance (shape): | Amorphous |
| Appearance (size): | Small granules |
| What is your overall evaluation of gari (use your own discretion) and is there a competitive product in South Africa? | Yes, we have mealie meal [maize meal] as a staple food |

Although gari is an indigenous food, the evaluation method they employed was scientific. They also realized sensory analysis was not that different from the local way of evaluating food. It is a well-known fact that food is evaluated in the traditional homes by tasting and smelling. Unlike the traditional homes where familiarity with the product serve as evaluating criteria, sensory analysis combines both statistical methods and biochemical characterizations. From these discourses the teachers were able to link the scientific concepts in sensory analysis to the IKS associated with gari. They also saw the suitability for adoption as potential introductory activity in food science and nutrition classrooms discourses. Teachers therefore can exploit the possibility of blending their pedagogic content with the approach reported here to decontextualize the science curricula.

**Evaluating the effectiveness of HACCP concepts**

Each group was required to carefully study the process flow chart and identify the critical control points essential for product quality, safety and storability according to the HACCP system. According to the Food and Agricultural Organization's Food Quality and Safety Systems Manual (1998), Hazard Analysis and Critical Control Point (HACCP) System: "is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing and inspection." HCCP system therefore identifies, evaluates, and controls hazards that are significant for food safety. Critical Control Point (CCP) is also defined as: "A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level." A typical HACCP system has been established by the Food and Nutrition Service (FNS), USDA (2009), FNS require that school food safety program must comply with HACCP system established by the Secretary of Agriculture. We present here a summary of the results and explanations given for the critical control points chosen.

Group 1

> In identifying the critical control points essential for product quality, group 1 identified sorting, peeling and washing. They went further to explain that sorting produces "fresh product with no rot", "peeling removes woody tips", whilst "washing cleans the product". Concerning product safety, they identified steeping, fermentation and pressing as the critical control points. They explained that, "steeping removes cyanide content", "fermentation removes cyanide and regulate microorganism activity", whilst "pressing removes liquids with cyanide content". They further identified drying, packaging and storing as essential for product storability. They posited their claims that, "drying removes micro-organisms and moisture", "packing reduces exposure to air", whilst "storing increases shelf-life"

Group 2

> In identifying critical control points essential for product quality, group 2 identified pressing, grating and fermentation. Even though they did not assign any specific reasons to their chosen control points, they went further to speculate that these processes contributed to the properties of the product. Concerning product safety, they identified fermentation and pressing. They posited their claim that, "within product B [referring to process flow chart B] fermentation is followed by pressing which results in the removal of cyanide. They identified roasting stage as the critical control point essential for product quality even though they did not assign any reason. They went further to contend that, "…B more of indigenous process, C industrial…"

Group 3

> In identifying critical control points essential for product quality, group 3 identified washing, crushing, steeping and dewatering. They contended that, "washing removes insecticide and micro organisms [for hygienic purposes]", "crushing increase flavour", "steeping removes toxic or virulent cyanide", whilst "drying decrease moisture in product, may prevent processes of moulding, and increase in shelf-life." They did not assign any specific benefits attributed to dewatering. For the product safety, they identified washing, steeping and drying and attributed the same reasons as assigned earlier. They also identified drying as essential for product storability contending that it extended the product expiry.

The critical control points identified by the last group (4) and assigned reasons followed the same trend as the reported groups. It emerged that group 2 critically compared all the 3 provided indigenous methodologies for food processing to identify instances where both traditional and improvised “mechanized” technologies were incorporated together. Method C involves grating using motorized grater and drying using rotary dryer. These two methods (i.e. motorized grating and rotary drying) may have influenced their decision to consider method C as industrial. This appeared to have been confirmed in later stages where each teacher was supposed to identify the process flow chart for the production of Gari. T4 also the group 2 leader began by making the following assertion that process flow chart C could be industrial, and further made a counterclaim by suggesting process flow chart C could be used to produce gari and her grounds were “…because of the rotary dryer, … to produce a dry product.” They seemed to have identified how “mechanized” technologies arising out of the need for mass production of food are integrated with traditional way of food processing. Nowadays it is a common practice to see local people in Africa incorporating “semi-mechanized” technologies in the way they do things. For example instead of pressing fermented food paste in sacks with heavy stones, simple hydraulic presses are sometimes used to speed the process. Nevertheless, local people sometimes consider these semi-mechanized technologies as their “own’ since they have been around for decades. In process flow chart B, roasting is done in large, shallow cast-iron pan over a fire, with constant stirring, usually with a broken piece of calabash (gourd) or wooden paddle for 20-30minutes or alternatively use rotary dryer. Group 2 was able to identify scientific alternative to indigenous way of food processing. From the aforementioned, the group appears to have appreciated how science can be integrated with IKS to attain meaningful discourses. They also discovered there was so much scientific knowledge embedded in the indigenous way of food processing. The essence of the discourses was not for the teachers to accurately predict the critical control points and substantiate their choice with valid reasons; they were rather expected to demonstrate their understanding of scientific knowledge embedded in IKS by unraveling the link between the two philosophical concepts. The reasons all the groups assigned to the critical control points selected were scientifically reasonable. They were able to identify roasting as one of the critical control point and essential for the storability of the gari. They contended that roasting and drying decreased the moisture content thereby inhibiting microbial growth. The teachers were also able to identify the fermentation stage as a critical control point in the processing of cassava to produce gari. They went on further to explain that fermentation removed cyanide and also impact on the taste and flavour of gari. Fermentation has been reported to reduce the cyanide content in or the bitterness of cassava (Akullo et al, 2007).

Biochemically, the cyanogenic glucosides contained in cassava are hydrolyzed by linamarase to cyanohydrins, which in turn breakdown to cyanide. Cyanide intoxication seems to be a major health problem in some cassava growing areas in Ethiopia; acute cyanide intoxication in children from high cassava consumption area was reported (Abuye, Berhane & Ersumo, 2008). Cyanide ingested from cassava has also been implicated in konzo, an irreversible paralysis of the legs predominant in children and young women from Mozambique and Tanzania (Cliff et al, 2010; Bradbury, Cliff & Denton, 2010). Affected communities need to be educated on processing techniques to remove the toxic cyanide in the cassava. The pedagogic approach used in our research could complement other training programs for rural health personnel to combat cyanide intoxication. We are not proposing our approach as an alternative solution but we believe that it could serves as a useful resource for education pertaining to cassava intoxication. This demonstrates the need to place emphasis on IKS not only in the school science curricula but also on health policy formulation.

**Evaluating the effectiveness of DAIM and CAT**

Here we demonstrate how the teachers used DAIM and CAT to facilitate the epistemology of science and of IKS. We present snapshots of activities in some of the group. Each teacher in group 3 was supposed to identify the process flow chart for gari from the 3 different process flow charts provided in the discursive worksheet. The identified process chart was considered as the claim, whilst the reasons, evidence or data used to substantiate the claim were considered as the grounds. The verbatim dialogical argumentation discourses in group 3 is presented below:

T8 chose process flow chart A as the chart for gari production, to substantiate the claim, T8 contended that, “because I felt sorting of the cassava, peeling as well as dewatering and drying and storing are the most important things to get the final product.” T8 supported her claim by identifying unique processes in the chart A which could results in the final product. Nevertheless, T7 also the group leader of group 3, demanded further evidence from T8 by contending that, “T8 how different is your B from A according to your claim?” T8 then provided backings to augment the evidence provided that, “B does not have a steeping process of which is important to remove the cyanide which is poisonous from the cassava and C does not have the dewatering but steeping is there”. T8 used the absence of steeping in process chart B and dewatering in C respectively to reject both as potential process charts for production of gari, even though C involved dewatering. T8 provided extra grounds for rejecting B that, “Drying is not in method B, so is very important”. T8 considered drying as very critical in achieving the final gari food characteristics. T10 like T8 chose process chart A as the claim but did not provide any concrete evidence to support the claim. T10 posited the claim to the colleagues by saying, “can I tell you why I selected A? A safe product fits for use can be produced by local people still using all the production processes”. It seems T10 seemed to believe the use of entirely indigenous approach with no blending of “mechanized” technology was reasonable enough to predict A. As indicated earlier, there is no semi-mechanized technology employed in chart A.

T9 selected process flow chat B as the claim. T7 demanded evidence for the claim that, “T9, why did you choose B then? T9 supported the claim with the following grounds, “Chose B, I followed the three methods and saw that the methodology A and C will not give us the final product that we have, the dry gari. Only B will give. So I follow each one sequentially, the steps.” T9 seemed to have considered the effect of each process in the three different process flow charts could impact on the characteristics of the dry gari. T9 used a step-by-step approach and demonstrated this in method A by contending that, “If you look at A, you when you peel, which is common in all, the third step in A you reduce the size, either chop it or break it down…. Then you steep when sizes are reduced, then crushing is after you have steeped”. T9 further supported the claim made that, “in each sequence I noticed that there were some sequence that will not result in the dry process that we will have. Some will results in different products other than gari”.

T7 argued that, “chose C because of fermentation. In A there is no fermentation… Size reduction is important but is not in B though in A.” T7 used the absence of size reduction in B and fermentation in A respectively to reject these process charts. T7 further provided backings for the claims that, “chose method C, if you look at it in a chronology way, the point of settling is very important but not in others. Decanting is very important… It is like a separation method”. T10 later during the argument expressed the desire to rebut some of the claims made but did not rebut following further explanations and conversation within the group.

The dialogical argumentation pedagogic approach seem to have enhanced the quality of dialogue and appeared to have provided space for the teachers to critically analyze the science-IKS discourses. DAIM also provided platform for effective scaffolding of knowledge, since the teachers exhibited the potential to articulate coherent discourses. According to T7 continuous argumentation appeared to have augmented their understanding about the scientific concepts embedded in indigenous way of food processing. This assertion could be corroborated by the statement made by T7 that “as we arguing we getting more sense”. The essence of these activities was not accurate prediction of claims but rather to engage in critical argumentation using the problem solving approach. Although the arguments proposed by the other teachers in this group were reasonable to certain extent, T9 was able to propose correctly chart B as the potential methodology for the production of gari by identifying roasting as the vital process that could result in the low moisture content of gari. From the epistemic interactions the teachers appeared to have engaged in quality argumentation. Although not reported here, during the whole class discussions, the group leaders presented their respective arguments and the workshop facilitator mediated the discourses to reach a consensus using knowledge co-construction.

In order to gain insight into the trajectory of science and IKS concepts experienced by the teachers we reviewed their discourses using CAT categories. It should be noted that the teachers have been exposed to the Nature of Science (NOS) and Characteristics of IKS (CIKS) through their weekly attendance of the workshops for about six months period, so they are not naive in terms of NOS and CIKS. Since some of the teachers were not familiar with cassava processed food products such as gari, they were keen and enthusiastic to participate in the activities but others were initially concerned about tasting the gari during the sensory analysis. After the facilitator had made an analogical comparison between cassava and sweet potato, the teachers gladly tasted the gari since they were familiar with sweet potato. In designing science-IKS curricula, researchers are advised to explore the use of resources with IKS concepts that are "owned" by the teachers or students. This assertion appears to have been corroborated during the subsequent activities using Umqombothi, a traditional beer that the teachers were familiar with. Before the activities the teachers were enthusiastic and keen to participate. The details of the Umqombothi science-IKS research will be reported elsewhere. In *Pedagogy of the Oppressed* Paulo Friere (1993) suggested the use of knowledge "owned" by people as the foundation for development of curricula by integrating the sociocultural attribute of their daily lives. Before the gari activities the conceptions held by most teachers were dominated by science with IKS being emergent. According to CAT two distinct cosmologies or school of thoughts (i.e. science and IKS) can co-exist harmoniously by recalling each other. In an earlier study reported (Ogunniyi & Hewson, 2008), science was the dominant conception held by the teachers whilst IKS was suppressed before the supposed activities. After the discourses most teachers considered science and IKS concepts as equipollent since they were able to unravel the inherent wisdom embedded in IKS.

> For example, similar to the conceptions held by other teachers, T3 in group 1 contended that, "…naturally prepared foods have got a higher quality. This is the assumption we have. Is it really true? Then you use scientific knowledge to verify that". T3 further consolidated IKS views held by contending that, "You can put the IKS and scientific knowledge on par". T3 also explained that both science and IKS employed intuitive approaches during investigation by saying, "Some people take faith as knowledge systems, gut feelings as valid as scientific knowledge and sometimes have used it too. If I do it this way, this is going to work. And every scientist has used this method to make short cut. This intuitive knowledge then becomes the bedrock of IKS. Then it becomes established…."

## Conclusion

This study based on a dialogical argumentation model has used a topic in food science as an exemplar for science teachers to enact a science-IKS curriculum in their classroom. Although the focus of this paper was to provide a snapshot of the workshops, our experience in the larger study (not reported here) showed that the instructional model research was effective in enhancing the teachers' ability to implement the curriculum in their classrooms. Further, the teachers consolidated their conceptual understanding of both science and IKS. They were motivated and also exhibited keen interest and positive attitudes towards IKS-science based lessons. The teachers engaged in critical and analytical thinking and also relied on prior knowledge to construct concepts. When developing science-IKS curricula materials, teachers need to consider incorporating IKS concepts "owned" by the students. We have also illustrated how this approach could be used to supplement public health education efforts especially in eliminating cyanide related cassava intoxication as well as adapted for other pedagogic purposes.

## References

Abuye, C., Berhane, Y. & Ersumo, T. (2008). The role of changing diet and altitude on goitre prevalence in five regional states in Ethiopia. *East Afr J Public Health, 5*(3), 163-168.

Akullo, D., Kanzikwera R., Birungi, P., Alum, W., Aliguma, L. & Barwogeza, M. 73RD IFLA GENERAL CONFERENCE AND COUNCIL 19-23 August 2007, Durban, South Africa, Retrieved August 13, Retrieved from http://www.ifla.org/iv/ifla73/index.htm.

Arvanitoyannis, I. S. & Vlachos, A. (2007). Implementation of physicochemical and sensory analysis in conjunction with multivariate analysis towards assessing olive oil authentication/adulteration. *Crit Rev Food Sci Nutr, 47*(5), 441-498.

Bhabha, H. (1994). *The location of culture*. New York: Routlege.

Bradbury, J. H., Cliff, J. & Denton, I. C. (2010). Uptake of wetting method in Africa to reduce cyanide poisoning and konzo from cassava. *Food Chem Toxicol*.

Cliff, J., Muquingue, H., Nhassico, D., Nzwalo, H., & Bradbury, J. H. (2010). Konzo and continuing cyanide intoxication from cassava in Mozambique. *Food Chem Toxicol*.

Drake, M. A. (2007). Invited review: Sensory analysis of dairy foods. *J Dairy Sci, 90*(11), 4925-4937.

Fletcher, S.M; Maharaj, S.R. & James, K. (2009). Description of the food safety system in hotels and how it compares with HACCP standards. *Journal of Travel Medicine, 16*(1), 135-41

Food and Agricultural Organization of the United Nations (1998). *Food Quality and Safety Systems - A Training Manual on Food Hygiene and the Hazard Analysis and Critical Control Point (HACCP) System*. 1998 Retrieved August 13, 2010, from http://fao.org/docrep/W8088E/w8088e05.html.

Freire, Paulo. (1993). *Pedagogy of the oppressed*. New rev. 20th-Anniversary ed. New York: Continuum.

International Institute of Tropical Agriculture. (2005). *Integrated Cassava Project*. Retrieved October 20, 2009, from http://www.cassavabiz.org/postharvest/Gari01.htm

Kolapo, A.L. & Sanni, M.O. (2007). A comparative evaluation of the macronutrient and micronutrient profiles of soybean-fortified gari and tapioca. *Food and Nutrition Bulletin, 30*(1), 90-4

Koutsoumanis, K. (2001). Predictive modeling of the shelf life of fish under nonisothermal conditions. *Appl Environ Microbiol, 67*(4), 1821-1829.

Matsha, T., Brink, L., van Rensburg, S., Hon, D., Lombard, C. & Erasmus, R. (2006). Traditional home-brewed beer consumption and iron status in patients with esophageal cancer and healthy control subjects from Transkei, South Africa. *Nutrition and Cancer, 56*(1), 67-73

Ogunniyi, M.B. (1997). Science education in a multi-cultural South Africa. In M. Ogawa (Ed.). Report of an international research program on the effects of traditional culture on science education (pp. 84-95). Mito: Ibaraki University Press

Ogunniyi, M.B. (2004). The challenge of preparing and equipping science teachers in higher education to integrate scientific and indigenous knowledge systems for their learners. *South African Journal of Higher Education, 18* (3): 289-304.

Ogunniyi, M. B. (2007a). Teachers' stances and practical arguments regarding a science-indigenous knowledge curriculum, paper 1. *International Journal of Science Education, 29*(8), 963-985.

Ogunniyi, M. B. (2007b). Teachers' stances and practical arguments regarding a science-indigenous knowledge curriculum, paper 2. *International Journal of Science Education, 29*(10), 1189-1207.

Ogunniyi, M. B. (2008). An argumentation-based package on the nature of science and indigenous knowledge systems, Book 2. Developed through Science and Indigenous Knowledge Systems Project (SIKSP), University o f the Western Cape.

Ogunniyi, M.B. & Hewson, M.G. (2008). Effect of an Argumentation-Based Course on Teachers' Disposition towards a Science-Indigenous Knowledge Curriculum. *International Journal of Environmental & Science Education* Vol. 3, No. 4, 159-177

Rheeder, J. P., Marasas, W. F. O., Thiel, P. G., Sydenham, E. W., Shephard, G. S. & Van Schalkwyk, D. J. (1992). Fusarium moniliforme and fumonisins in corn in relation to human esophageal cancer in Transkei. *Phytopathology, 82*, 353−357

School food safety program based on hazard analysis and critical control point principles. Final rule. (2009). *Fed Regist, 74*(239), 66213-66217.

Shephard, GS., van der Westhuizen, L., Gatyeni, P.M., Somdyala, N.I., Burger, H.M. & Marasas, WF. (2005). Fumonisin mycotoxins in traditional Xhosa maize beer in South Africa. *Journal of Agricultural and food Chemistry, 53*(24), 9634–9637

Shephard, G. S., Thiel, P. G., Stockenström, S. & Sydenham, E. W. (1996). Worldwide survey of fumonisin contamination of corn and corn-based products. *Journal of AOAC International, 79*(3), 671−687.

Simon, S., Erduran, S. & Osborne, J. (2006). Learning to teach argumentation: Research and development in the science classroom. *International Journal of Science Education, 28*(2-3), 248

Seo, H.S., Hwang, I.K., Han, T.R. & Kim, I.S. (2007) Sensory and Instrumental Analysis for Slipperiness and Compliance of Food during Swallowing. *Journal of Food Science*, *72*(9), 707-713

Toulmin, S., (1958). *The uses of argument*. Cambridge University Press, Cambridge.

## Acknowledgements

This project was kindly funded by NRF of South Africa. We would also like to thank all the teachers and members of the Science and Indigenous Knowledge Systems Project (SIKSP) at the University of the Western Cape.