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Turning the Art of Karanga Beer Brewing Into a Science: An Example of Humanising Biology Teaching and Learning

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Abstract

South African National Senior Certificate examination reports consistently reflect poor performance in STEM (science, technology, engineering, and mathematics) subjects when compared to other subjects. This has resulted in a decline in the uptake of STEM subjects because many students perceive them as being difficult to learn. This phenomenon is not unique to South Africa, as many other African and developed countries are facing similar difficulties in terms of student participation in STEM subjects. Reasons for the low uptake of STEM subjects include perceived difficulty, perceived lack of ability, classroom experience of STEM subjects, and lack of enjoyment. Thus, STEM educators across the globe are confronted with the challenge of making the subjects attractive, accessible to, and relevant for students. Humanising the teaching of STEM subjects by building on Indigenous knowledges has been suggested as a way that secondary education could deal with these challenges, and turn them into STEM capabilities. The incorporation of Indigenous and other local knowledges into STEM subjects could promote authentic learning experiences, relevance, and inclusivity if teachers were prepared for this, and appropriate resources made available. In Africa, many children enrol in school while they are concurrently engaged in subsistence economic activities rooted in Indigenous practices. Leveraging the insights gained from these activities could humanise and enhance the relevance of school STEM curricula. Karanga beer brewing is one such activity that we participated in as children and, in this paper, we report our exploration of the science related to Karanga beer brewing and how it can be a way of humanising and promoting the relevance of school science and other STEM subjects.

Keywords: Karanga beer brewing, Indigenous knowledges, STEM, humanise, biology

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Introduction and Background

We (the authors) were born and bred in rural communities of Masvingo, Zimbabwe, where Karanga[1] is spoken. Throughout our schooling, we experienced science content that was not contextualised, and thus appeared irrelevant for our everyday rural life. For instance, when Eunice was in secondary school, a full day's trip was paid for, and a bus hired for, her class to go and learn about commercial beer brewing as a way of consolidating knowledge on the practical importance of microorganisms. Ironically, just outside the school grounds, traditional beer brewing was common practice, and a visit to the village would have provided Eunice's class with a more relevant experience of the practical importance of microorganisms. We are also both high school teachers by training, now scholars in science education, and Eunice is a practising science teacher educator. We both work at a South African university. Below, we present how traditional beer (*doro* in Karanga) is brewed by the Karanga people. We use Karanga beer brewing as an example to illustrate the possibilities of how educators can tap into relevant Indigenous knowledges to teach biology. We seek to answer the question: "What knowledge intersections between the Karanga beer brewing process and concepts in school biology content can be drawn upon to humanise science teaching?"

South African National Senior Certificate examination reports consistently reflect poor performance in STEM (science, technology, engineering, and mathematics) subjects when compared to other subjects. This consistent poor performance has seen a decline in the uptake of STEM subjects because many students (and people in general) perceive the subjects as being difficult to learn. This phenomenon is not unique to South Africa, and many African countries (Tikly et al., 2018), and many developed countries face similar difficulties in terms of student participation in STEM subjects (Aikenhead, 2021; Bennett et al., 2014; Morales-Doyle, 2017). A systematic literature review by Tripney et al. (2010) showed that some of the reasons behind a low uptake of STEM subjects include perceived difficulty, perceived lack of ability, classroom experience of STEM subjects, and lack of enjoyment. In Africa, and especially in South Africa, the problem is further complicated by teachers' inadequate content and pedagogic knowledge (Bold et al., 2017; Ramnarain & Fortus, 2013; Tikly et al., 2018), which leads to disengaged and unenthusiastic learners. As a result, STEM educators across the globe continue to be confronted with the challenges of making the subjects attractive, accessible to, and relevant for students (George, 2013; Mensah & Jackson, 2018; Zidny et al., 2022). Building on indigenous knowledges has been suggested as one way that secondary education can deal with these challenges and turn them into STEM capabilities (Avery, 2013; Morris et al., 2021; Tikly et al., 2018). The incorporation of Indigenous and other local knowledges into STEM subjects has been seen to promote authentic learning experiences, relevance, and inclusivity and can humanise the teaching and learning of these subjects. However, for STEM education to build on Indigenous knowledges, teachers need to be prepared for this, and appropriate resources made available. According to Kinyanjui and Khoudari (2013), the infusion of Indigenous knowledge systems into formal schooling has the potential to lay the groundwork for lifelong STEM education. Bringing Indigenous knowledge into the classroom can facilitate the exploration and expansion of STEM concepts derived from students' community experiences. In Africa, a significant portion of children enrol in schools while they are concurrently engaged in subsistence economic activities rooted in Indigenous practices (Khupe, 2014; Khupe et al., 2024; Nyamupangedengu & Nyamupangedengu, 2023; Tikly et al., 2018). Leveraging the insights gained from these subsistence activities has potential to humanise and, in turn, enhance the relevance

[1] Karanga language (known as ChiKaranga) is one of many that have officially been misrepresented as dialects of Shona (a term that was used in colonial Zimbabwe to refer to all languages spoken by Indigenous people who lived in the central and eastern parts of Zimbabwe. Some of the languages collectively known as ChiShona are ChiZezuru, ChiNdau, ChiManyika, ChiToko, and ChiBocha.

of school STEM curricula. Karanga beer brewing is one such activity that we participated in as children. In this paper, we report on our exploration of the science related to Karanga beer brewing, and how this science can be tapped into as a way of humanising and promoting the relevance of school science.

Literature Review

In formerly colonised contexts, although school science is often presented as abstract and context- and culture-free, it is often actually packaged and taught within a Western perspective. And the language of teaching is often not the home language of most learners (Probyn, 2018). This contributes to the well-documented challenges of low uptake, low interest, and poor academic outcomes in STEM subjects (George, 2013; Mensah & Jackson, 2018; Zidny et al., 2022). As argued by Aikenhead (1996), Cameron (2007), Malcolm and Samuel (2008), and Mensah and Jackson (2018), the content and method of teaching are often alienating for non-Western students. Almost three decades ago, Aikenhead (1996) expressed the science learning experience for many non-Western students as a form of cultural border crossing which could be smooth, managed, hazardous, or even impossible, depending on the level of difference that students perceived between their own culture and the culture of science learning. Our own experiences of learning science as Indigenous Karanga students growing up in rural communities have not been different from what the research suggests.

Cognisant of the above challenges, STEM education researchers across the globe have, over the past few decades, come up with suggestions (especially relating to science subjects) of making the subjects attractive, accessible to, and relevant for students (see Avery, 2013; George, 2013; Mensah & Jackson, 2018; Zidny et al., 2022). Suggestions for improved STEM outcomes from the literature include integrating Indigenous knowledge with STEM subject content—what Avery (2013) termed rural science learning—and using culturally relevant pedagogy (e.g. Aikenhead and Elliott, 2010; Khupe, 2014, 2020; Msimanga & Lelliott, 2013; Mosimege, 2020; Sexton, 2024). These suggestions are meant to address issues of social justice and to make STEM subjects more culturally relevant and relatable for students (Morales-Doyle, 2017). The inclusion of Indigenous knowledges in teaching and learning is consistent with situated learning and culturally relevant pedagogy (Khupe, 2020; Sexton, 2024). Despite these recommendations, a survey of the literature shows few practical examples that illustrate the Indigenous knowledges that teachers in Southern Africa can draw upon. As indicated earlier, for teachers to build on Indigenous and local knowledges, there is need for the documentation of more such contextually relevant examples. Our exploration of the science in Karanga beer brewing—a situated practice in our childhood context, seeks to contribute to that literature by providing examples of how Indigenous knowledges can be tapped into as a way of promoting the relevance of, and also humanising, school science.

Conceptual Framework

We draw on aspects of the framework of community-centred research (Khupe 2020; Khupe et al., 2024) as well as notions of learner-centredness as put forward by Malcolm and Samuel (2008) and Malcolm and Keane (2001). Both ideas assume the situated nature of knowledge, knowing, and learning. The socio-cultural attributes of a community (e.g. language and ways of knowledge sharing) are foundational to learning and should be equally foundational in teaching and learning (Vygotsky, 1978; Wertsch, 1985).

Community-Centredness

The elements of community-centredness as put forward by Khupe et al. (2024) include extending knowledge boundaries, relevance to community, and decoloniality. Extending knowledge boundaries is about intentionally valuing and including knowledges that communities hold, in formal education. Bringing in the knowledge that students gain experientially from subsistence activities is one way of extending knowledge boundaries. Such knowledge is currently not common in many prescribed textbooks in Southern Africa, despite persistent calls to decolonise curricula and persistent suggestions for the inclusion of Indigenous knowledges. Knowledges in Indigenous communities are not developed for their own sake, but are relevant for the survival of those communities. If such relevant knowledge is infused in STEM curricula, the more useful those subjects are likely to be perceived. This approach humanises and develops in students an appreciation of local knowledges, contributing to decoloniality.

Learner-Centred Education

According to Malcolm and Samuel (2008), learner-centredness is about acknowledging and connecting learner knowledge and ways of doing and being to the curriculum. We take two elements of learner-centredness from Malcolm and Keane's assertion (2001). The first element is caring for students. This entails the educators believing in their learners' desires and abilities to learn. The second element is learner-centred pedagogy. This is when educators use teaching approaches that take into consideration students' existing knowledge and build on the diversity of experiences within their class. When, during teaching, the teacher draws from learners' experiences, it reflects both levels of learner-centredness identified above. In the Southern African context, this would mean linking STEM (in our case, biology) teaching and learning to relevant Indigenous knowledges. In this paper, we view the basing of teaching of biology concepts on processes found in students' contexts and experiences (such as Karanga beer brewing) as also exemplifying the forms of learner-centredness identified above. In addition, the inclusion of learners' languages, beliefs, interests, and learning strategies in biology teaching and learning aligns with social justice pedagogy (Morales-Doyle, 2017), which is likely to humanise and enhance interest and academic outcomes in the subject. For Malcolm and Samuel (2008), learner-centredness additionally provides opportunities for power-sharing—where the learners contribute to choices of what is worth learning and how. It is our view that such power sharing places the responsibility for learning on the learner and can contribute to more meaningful learning.

Methodology

In this qualitative study we reflected on our childhoods, focusing on Karanga beer brewing, a subsistence economic activity that we participated in and learnt about from our older relatives and the Karanga community at large. We zoomed into the knowledge intersections between Karanga beer brewing process and concepts in school biology content that we know and teach. We drew from elements of participatory research (Jagosh et al., 2012; Vaughn & Jacquez, 2020). We prioritised the knowledge generation in partnership with an Elder who is a custodian of knowledge on Karanga beer brewing. As indicated by Vaughn and Jacquez (2020), we engaged the Elder not as a "subject" but as one with lived expertise in the art of Karanga beer brewing.

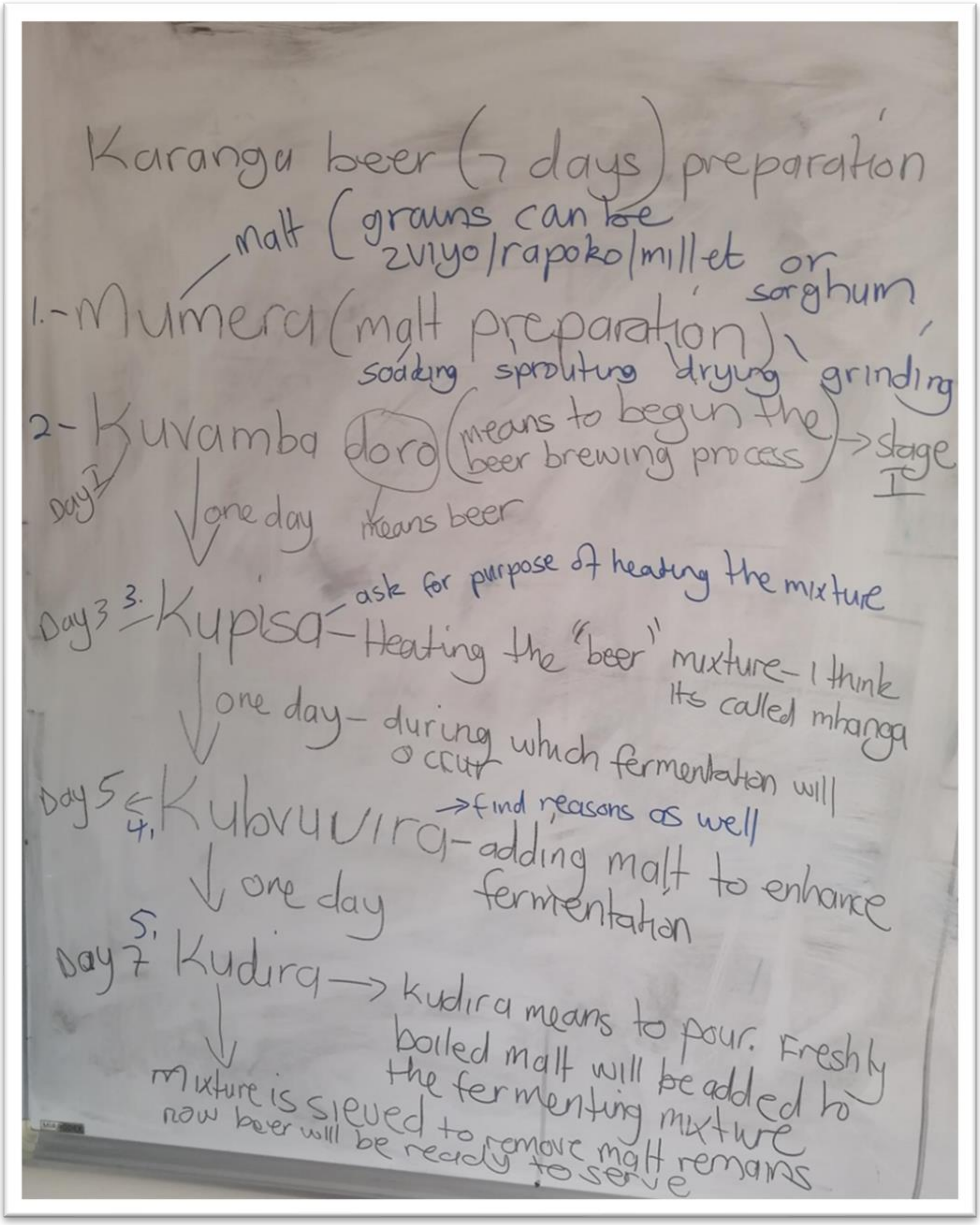
Data Generation

The data generation and analysis developed hermeneutically (Samaras, 2010). The data were generated in stages as follows: 1) researchers brainstorming beer brewing stages from memory, capturing what we could remember, 2) consulting with an Elder, 3) documenting the process, 4) member checking with the Elder, and 5) relating the shared knowledge to biology content.

Brainstorming From Memory

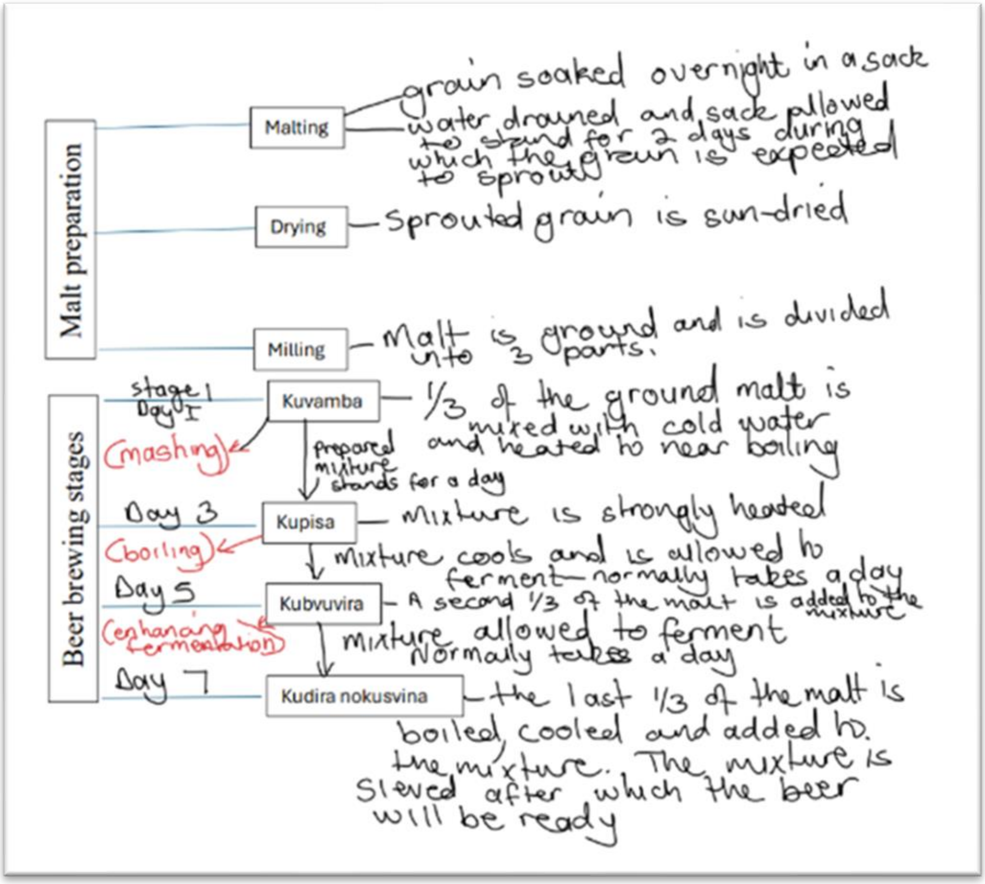
We started off by brainstorming what we could remember about Indigenous Karanga beer brewing from our childhoods. Karanga beer is colloquially known as "seven days," denoting the timeframe for the brewing process. The question that kick-started our brainstorming was: "What do we remember about Karanga beer brewing?" We used the seven days as prompts to jog our memories, therefore, the questions were: "What happens on Day 1, Day 2, Day 3, up to Day 7?" Responding to these questions enlightened us on other aspects that we needed to document. For example, as soon as we started describing what happens on Day 1, Constance immediately added, “How about the grains that are used for beer brewing? We need to describe them.” Then another aspect came to mind: “Malt preparation. We also need to describe how malt is prepared.” We decided to capture what we could remember on a white board in Eunice’s office. The white board became a living space where, for a whole week, more beer brewing steps and aspects were being added (see Figure 1 below).

Figure 1
Brainstorming Karanga Beer Brewing Stages



During the follow-up meeting, which was a week later, we consolidated our ideas. We were able to produce a rough outline of the beer brewing process as well as links with biology concepts (see Figure 2). Our outline had the major stages of the malt preparation and beer brewing process, but we realised there were gaps in the details of the different stages.

Figure 2
Outline of Major Stages of Karanga Beer Brewing



Consulting an Elder

We sought the help of a family Elder and knowledge holder and expert in the Karanga beer brewing trade (Eunice's Mother, *Mbuya*[2] Dhodho). The choice of the Elder was purposive and consistent with Indigenous knowledge practice, where teaching is facilitated through familial and inter-generational relations, rather than mostly by outsiders (as in Western education). This is also consistent with the socio-cultural concept of *more-knowledgeable other* as proposed by Vygotsky (1978). Eunice shared with Mbuya Dhodho our desire to use the process of Karanga beer brewing as a resource for biology teaching and requested that she help us by sharing her knowledge of the process from preparing malt to the finished product. Although traditional research approaches require participant anonymity to rightly protect them from harm, in this study, for purposes of sharing ownership and power, and informed by McMahon and McKnight (2021), we asked Mbuya Dhodho if she wanted us to use her real name. She gladly agreed. From this point, the sharing was within her power, and she shared different aspects over a period of three days. The knowledge was not necessarily shared in chronological order of the beer brewing process, but as it came to the Elder's memory, and in terms of what she felt was important to highlight. Eunice took notes to fill gaps from our brainstormed outline (Figure 2). After each knowledge sharing session, Eunice narrated what she had captured to Mbuya Dhodho to get guidance on accuracy. Eunice used her knowledge of biology content to relate the beer brewing process to biology concepts. She read about the related biology concepts to deepen her

[2] *Mbuya* is a Karanga title for Grandmother.

knowledge and understanding of the biological processes involved in Karanga beer brewing. The knowledge shared by Mbuya Dhodho, together with the knowledge from further reading, gave us deeper insights into the knowledge intersections between the Karanga beer brewing process and concepts in school biology content.

Eunice also took pictures of the rapoko grain (see Figures 3a and 3b) and containers used in the beer brewing process. A limitation to this study was that we could not have a live observation of the beer brewing process. This is because in Karanga tradition, beer is not just brewed without a specific purpose. Beer is only brewed for ceremonial purposes, for example, wedding celebrations and ancestral worship events. Karanga beer may also be brewed by individuals when they need community help for collective work such as weeding the fields, harvesting crops, or thrashing grain—what we call *humwe* in Karanga. In addition, as indicated earlier, Karanga beer brewing is a subsistence economic activity in which the beer can also be brewed for sale. It would therefore have been inappropriate to ask Mbuya Dhodho to brew beer just for the purposes of this study.

Data Analysis

We read through our notes and annotations three times to ensure clear understanding of the process, and to identify possible gaps. As indicated earlier, the knowledge was not shared in chronological order so the readings enabled us to re-organise our notes. We categorised the knowledge that was shared as follows: grain types, preparing malt, role of containers used in beer brewing, and the beer brewing process. Below we present the results, using those categories as sub-headings. We deliberately first present the process of Karanga beer brewing separate from the related biological processes so the reader has opportunity to engage with the Indigenous Karanga knowledge without interference of thinking about school science.

Results

Grain Types

The beer is brewed using various grains such as *zviyo* or *rukweza* (rapoko or finger millet), *mhunga* (bulrush or pearl millet) and *mapfunde* (sorghum) or even maize. In the description that follows, we present how beer is brewed using rapoko, which the Elder mainly uses. Figures 3a and 3b show rapoko grains.

Figure 3a
Harvested Rukweza (Rapoko/Finger Millet) Head

Figure 3b
Rukweza (Rapoko/Finger Millet) Grain in a Winnowing Basket (Musero)

Malt (*Mumera*)[3] Preparation

There are several steps to preparing the malt.

Malting

The rapoko grain is soaked overnight in a large earthenware pot or in a sack. On the next day, the grain is cleaned thoroughly. If it has been soaked in a pot, it must be transferred into a sack and placed in a dark place for two days. Keeping the soaked grain in sacks ensures adequate warmth, moisture, and aeration. Where optimum conditions are not achieved, the germinating grain can rot because of the growth of fungi or moulds promoted by poor aeration. After Day 1, the sack is opened to check if the grain is sprouting and to loosen any grains that may be crumbed together. The second day allows for full sprouting of the grain.

Drying the Malt (Mumera)

The sprouted grain is sun-dried by sparsely spreading it on a flat rock outcrop or on sacks. The grain must be completely dry, and the sprouts shrivelled.

Milling

Firstly, the shrivelled sprouts must be separated from the grain. This is achieved by rubbing the grain between the hands to break off the sprouts and then to winnow (*kupepeta*) to separate the grain and the sprouts using a winnowing basket. The malt is ground coarsely on a traditional grinding stone (*guyo*, see Figure 4).

Figure 4
Grinding Malt on a Grinding Stone

[3] *Mumera* comes from the word *kumera* meaning to germinate

Although modern grinding mills are available, grinding by hand is preferable to achieve the required consistency of the malt. The ground malt is then divided into three parts for use at different stages of brewing.

Containers Used in Beer Brewing Process

Traditionally, clay pots and calabashes are used throughout the beer brewing process. Different containers are used for different functions such as heating, storage, and serving. Figures 5a and 5b show the different containers, and Table 1 shows their functions in the beer brewing process.

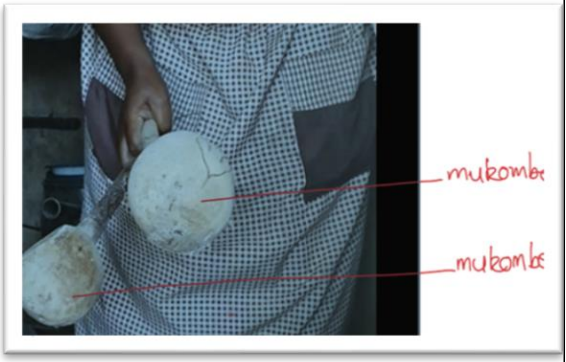
Figure 5a **Containers used in Brewing and Storage of Karanga Beer**	**Figure 5b** **Containers Used in Serving Karanga Beer**
	

Table 1
Containers for Karanga Beer Brewing

Name	Description	Function
Rukambe	Large clay pot	Used for heating at different stages: kuvamba, kupisa, and kubika masvusvu
Gate	Large clay pot	Used for storage of mhanga
Nyengero	Medium size clay pot	Used for storage of beer
Pfuko	Small clay pot	Used for storage and serving the beer
Dende	Calabash	Used for storage and serving beer
Mukombe	Gourd	Serving vessel

The containers are cleaned with clean water before and after use. No detergents are used. This is done to preserve the yeast spores on the surfaces or crevices of the pots to act as inoculant when next the beer is brewed.

Beer Brewing Stages

Mashing (Kuvamba)

The first portion of the malt is mixed with water in a large earthenware (clay) pot (*rukambe*) and heated while continually stirring until just before it boils. The heated mixture is left to cool, and then transferred to a different clay pot (*gate*) and left in a place especially prepared for beer preparation (*bikiro*). The mixture (now called *mhanga*) is left to stand until it ferments. To determine if the fermentation has reached the right level, the brewer looks for signs such as the extent of formation of bubbles and foam, and the colour and taste of the mhanga. The fermentation process can take up to two days, depending on the weather conditions. Fermentation is faster in warm weather.

Boiling (Kupisa)

When the mhanga has adequately fermented, it is transferred back to the rukambe and heated (*kupisa*) until it turns dark brown. It is then left to stand and to cool down completely, after which it is transferred to the gate for fresh fermentation to occur. When the mhanga shows signs of fermenting it is time for the next stage.

Enhancing Fermentation (Kubvuvira)

The second batch of malt is added to the fermenting mhanga and stirred thoroughly. The new mhanga is left to stand until it has fully fermented, and foam has developed, and a certain flavour achieved. Then it is time for the next stage.

Kudira

The last batch of malt is mixed with water and brought to boiling point. The boiled mixture is called *masvusvu*. Masvusvu is very sweet. The pouring consistency of masvusvu depends on the thickness of the mhanga. If mhanga is thick, masvusvu should be thinner. If the mhanga is seen to be thin, masvusvu is made to be thicker. The masvusvu is left to cool to a lukewarm temperature then added to the mhanga in the gate. The mixture is stirred to allow for thorough mixing. This new mhanga-masvusvu mixture is called *madigwa*. Madigwa is freshly brewed beer, sweetish but not yet mature.

Sieving (*Kusvina*)

Throughout the beer brewing process, parts of the malt remain in suspension in the mhanga and madigwa, which necessitates filtration. A large strainer, traditionally made of weaved inner side of bark of young trees or bushes is used to separate the suspension mix (*masese*) from the beer. Nowadays metal sieves are more commonly used. The filtered madigwa is then distributed into smaller clay pots (*nyengero* and *pfuko*) or calabashes (*matende*). The madigwa is allowed to stand for further fermentation to occur and for the beer to mature. The beer maturity is determined by the same indicators of bubbles, foam, colour, and taste, after which the beer will be ready to be served.

Knowledge Intersections Between the Karanga Beer Brewing Process and Concepts in School Biology Content

In this section, we describe the science we identified in the Karanga beer brewing process, thus showing intersections between Indigenous Karanga knowledge of beer brewing and biology content. We make suggestions on how these intersections can be drawn on in biology teaching and learning.

Soaking the dry grain allows it to absorb water and increase in size. This process is called imbibition. Absorbed water activates hormones and the enzymes (amylases and proteinases) in the dormant endosperm of the grain. The teacher can draw on this aspect to show the important role of water in stimulating metabolic activities and why drying food is a common method of preserving food in rural areas where refrigerators cannot be used due to lack of electricity.

Activated amylase converts starch to glucose, and proteinases activate proteins to peptides. This process of conversion of starch to glucose and proteins to peptides is called hydrolysis. The presence of glucose enables respiration to occur which releases energy for germination of the grain. In addition to water and glucose, warmth and oxygen are necessary conditions for successful germination to occur. Keeping the soaked grain in sacks ensures adequate warmth, moisture, and aeration. Where optimum conditions are not achieved, the germinating grain can rot because of the growth of fungi or moulds promoted by poor aeration. The teacher can draw on this knowledge when teaching about germination. Referring to this aspect in malt preparation can help learners to appreciate the importance of water, warmth, and air—specifically, oxygen.

When the grains have sprouted, it is now referred to as malt. Malted grain contains sugars and peptides and oils. Drying the malt stops the germination process thereby conserving the sugars in the seed. The malt is crushed to break open the seeds and expose the sugars. Yeast exists in abundance on surfaces of seeds and of pots used for making beer. That is the reason why all the pots that are used for beer-making are cleaned with clean plain water only, with no detergents. This is done to preserve the yeast spores on the surfaces and crevices of the pots to act as an inoculant when next the beer is brewed. This aspect can help learners to appreciate the effect of detergents on micro-organisms.

Yeast uses the sugars in the crushed grain for its own respiration. Mixing the malt with water and heating it but not bringing it to boil drives out any dissolved oxygen thereby creating anaerobic conditions. This forces the yeast to respire anaerobically. Heating the mixture provides the right temperature for the yeast. The first step in the respiration process is glycolysis, which does not require oxygen. Glycolysis splits glucose into two 3-carbon compounds called pyruvate. In the presence of oxygen, pyruvate is completely broken down into carbon dioxide and water with energy being released. However, in the absence of oxygen, yeast has enzymes that decarboxylate pyruvate, releasing carbon dioxide and forming a 2-carbon compound called acetaldehyde. Nicotinamide adenine dinucleotide (NAD) + hydrogen (H) NADH produced during glycolysis transfers hydrogen atoms to acetaldehyde, reducing it to form ethyl alcohol. The above explanation can be drawn upon when teaching the topic of respiration.

Heating the fermented malt during the kupisa stage sterilises the mixture, and evaporates the alcohol and excess water. Therefore, this kupisa process concentrates the sugars and other intermediate products. The batch is allowed to cool so that it doesn’t kill the yeast in the crevices of the gate when it is returned to this pot. After the batch has completely cooled, it is poured back into the gate and allowed to stand until there is evidence of renewed fermentation. Allowing it to stand allows spontaneous natural fermentation. During this period, yeast will be multiplying in the fermentation pot. Adding a second batch of crushed grain at kubvuvira stage, provides the yeast with more sugars, which allows more fermentation and production of more alcohol. The last stage, which is kudira, requires masvusvu. Preparation of masvusvu releases sugars into the water to form a sweet suspension. Allowing masvusvu temperature to cool to just above lukewarm and then mixing with mhanga allows faster fermentation of the sugars in the masvusvu suspension. Sieving (kusvina) is a filtration process that separates the beer from the suspended seed coat remains (masese). Yeast fermentation involves chemical reactions. The various stages of Karanga beer brewing provide create conditions that are known to increase the rate of reactions, which include a higher concentration of reactants, a moderate temperature, and the physical state of the reactants. The effect of these factors can be explained in terms of the collision theory, which states that reactions occur only when reactants collide. Therefore, the higher concentration of reactants that is achieved at kupisa, kubvuvira, and kudira increases the possibilities of reactants colliding and hence, the rate of fermentation reactions. A warm temperature at kudira increases the kinetic energy of the reactant molecules thereby also increasing the possibilities of them colliding and a reaction taking place. Too high a temperature can however, denature enzymes hence the masvusvu mixture should only be added to mhanga when it has become lukewarm and not when still hot. Grinding the malt grains breaks the grains into smaller pieces thereby opening the grain and exposing the sugars inside. Mixing the ground malt with water and heating the mixture during masvusvu preparation dissolves and concentrates the sugars. Teachers can therefore, draw on this knowledge when teaching about factors that affect the rate of a chemical reactions.

Discussion

The Karanga beer brewing process presented above, and the description of the science related to the process, point to the presence of intersections between Karanga beer brewing and biology education. Our synthesis of the scientific knowledge related to Karanga traditional beer brewing opened our eyes to the numerous possibilities of how this seemingly simple process can be used as a foundation for the teaching of biology concepts. Examples of topics and concepts that can be taught drawing from Karanga beer brewing include seed dormancy, germination, respiration, microbiology, and hydrolysis. In our childhood context, most children had some knowledge of the Karanga beer brewing process, which would have made the process a useful biology teaching resource. Educators could have built on our prior knowledge (Ausubel, 1968) when teaching the listed topics by drawing on this Indigenous knowledge resource. To better facilitate the learning of biology concepts related to Indigenous processes like Karanga beer brewing, and considering that learners in different contexts have different knowledges and lived experiences, educators can draw on their own learners' local knowledges, languages, and lived experiences. This is consistent with learner-centredness as advocated by Malcolm and Keane (2001) and Malcolm and Samuel (2008). In addition, the observation made by many science education researchers (e.g. Aikenhead, 1996; Malcolm and Samuel, 2008; Morales-Doyle, 2017) that the teaching of science is often divorced from context is likely to be resolved through connecting learners to their knowledge and lived experience. Learning that is based on knowledge resources within the local context can create opportunities for learners to construct knowledge from what they already know, making biology more relatable and easier to understand. Such learner-centred teaching is likely to humanise the teaching of these biology concepts, as well as making them less abstract, more relevant, and more interesting. Furthermore, drawing from learners' experiences provides opportunities for power sharing (Malcolm & Samuel, 2008). This power sharing in the science classroom creates space for community-centredness, whereby learners' thinking in science is shaped by their experiences and cultures, rather than only through a Western perspective (Khupe et al., 2024). Science teaching that promotes community-centredness is humanising and is likely to lead to the greater valuing and appreciation of local and Indigenous knowledges and languages.

A commonly cited challenge for learner and community-centred approaches to science teaching is that the approaches are time consuming, considering educators must often rush to complete the syllabus. However, we contend that the benefits of increased learner understanding resulting from learner and community-centred teaching approaches outweigh the challenges. Our experiences as science teacher educators show that many current textbooks do not have examples that are contextualised to the experiences of learners. This dearth of Indigenous science examples and resources has perpetuated a reliance on decontextualised examples, a practice that continues to alienate Indigenous learners from STEM subjects' content. Looking at the biology topics and concepts that manifest at different stages of Indigenous Karanga beer brewing, we identified many examples that could be incorporated in textbooks and fill this gap. The prevalent practice of teaching and learning school science is through the use of published material, which as indicated earlier, does not have Indigenous examples. In this study, the knowledge on Indigenous Karanga brewing was shared by an Elder. Drawing on the knowledge of Elders as resource persons in the teaching of some biology topics or concepts can diversify teaching and learning resources and humanise and promote the valuing and appreciation of STEM-related Indigenous knowledge as well as community and learner-centred pedagogy (Malcolm & Keane, 2001). Most Indigenous knowledge is transmitted orally, which can be a challenge in contexts where such Elders are not easily accessible. It is time that, as educators and scholars, we undertake to acknowledge, document, and use the knowledge within our cultural spaces so that it becomes accessible and more usable for a wider audience.

Conclusion

Our study has illustrated that Karanga beer brewing is a rich resource for biology teaching. However, the value of that resource can only be realised through deliberate exploration. The Elders, who are the traditional knowledge holders, are themselves a resource for science content that if captured and documented can be used to humanise both the content and the teaching of STEM subjects, which is very often ignored. Our study, therefore, points to the need for deliberate efforts to gather and document Indigenous knowledge resources through formal, humanised research processes for this knowledge to be valued for its own sake and for use through formal teaching and learning. Science knowledge is meant to benefit learners and communities and therefore, should be taught with reference to its relevance.

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