

# LOCAL TECHNOLOGICAL KNOWLEDGE FOR TEACHING AND LEARNING BIOLOGY IN SENIOR HIGH SCHOOLS IN THE SISSALA EAST MUNICIPALITY, GHANA

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**Abstract:** The use of indigenous or local technological knowledge in teaching and learning can anchor the study of subjects including Biology on the principle of learning from the known to the unknown. Therefore the aim of this study was to ascertain the existing local technological knowledge of the Sissala East Municipality and how to integrate them into teaching and learning of Biology in Senior High Schools in the Municipality. Cross-sectional survey was used to collect data from six Biology teachers and 30 local technological knowledge experts. The study revealed that majority of the teachers (83.3%) were of the opinion that it is difficult integrating local knowledge into teaching and learning of Biology. The challenges among others include poor teacher background knowledge in local technological knowledge (mean of 3.7) and unsupportive government policies (mean of 4.2). Some of the existing local technological knowledge that could be used in teaching and learning Biology are local conservation techniques and sustainable use of natural resources (mean of 4.15) as well as totems and taboos (mean of 4.99). Strategies that could be used to integrate local technological knowledge in the teaching and learning of Biology include invitation of local craftsmen to schools during Biology lessons to assist teachers (mean of 3.8) and incorporating indigenous technologies into national curriculum (mean of 4.2). It was recommended that educational authorities in senior high schools in Sissala East Municipality should encourage Biology teachers to utilize local technological knowledge in teaching and learning of Biology.

**Keywords:** Local, technology, knowledge system, teaching, Biology, conventional concepts, strategies, Sissala East Municipality.

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## 1. INTRODUCTION

Ghana places a lot of emphasis on science education to the extent that the school curriculum from the basic school up to tertiary level includes a lot of science concepts. This includes either Biology concepts to be taught or full-fledged programmes for Biology to be studied. Over the years, Biology has remained the most popular subject in the senior high school curriculum in Ghana (Anamuah-Mensah, 2000) because of high enrolment figures. However, the teaching and learning of Biology at various levels, especially at the pre-tertiary level depends largely on the strategies adopted by the teacher in generating and sustaining the interest of the learners. The methodologies are varied and depend on the complexity and characteristic nature of the content, the abilities and potentials of the learners, as well as factors such as

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the learning environment. Teachers have to manage their overall classroom practice as pedagogical leaders (Soares, 2020). As free agents in the classroom, teachers can accept or reject the changes in the teaching process (Julie, 2015) by adopting or adapting existing knowledge systems.

One basic component of a country's knowledge system includes indigenous knowledge otherwise known as local knowledge. Local knowledge indicates the knowledge of any individual who had resided in an area for long duration (Khatri et al., 2021). It includes the skills, experiences and insights of the people, which are applied to maintain or improve their livelihood (Ellen & Harris, 1997). Indigenous or local technological knowledge is knowledge that is specific and serves as source of identity to particular culture or society (Warren, 1989). It includes the cultural traditions, values, beliefs and views of local people (Agrawal, 1995). They can also be ideas and practices of indigenous community that are advanced over a long period of time (Devi et al., 2014). Such knowledge are transferred from generation to generation through folk songs, proverbs, myths, stories, culture, puppetry and traditional methods (Lekshmi, 2009). Useful local or indigenous knowledge can help to balance biodiversity by maintaining soil purely organic, gene pools, conservation of indigenous varieties etc.(Sharma et al., 2020). This implies that local knowledge systems can be effectively employed for the teaching and learning of Biology. The difficulty however is that, such local knowledge has not been adequately documented over the years and therefore, their basis and principles are shrouded in secrecy, or as it were, myths. This calls for more research to be carried out on relevant local knowledge and technologies to be considered by educational experts including Biology Education experts for consideration in teaching and learning.

In the actual fact the classroom didactic processes involving Biology are influenced by different factors such as students' and teachers' beliefs, orientations, prior knowledge, and experiences within certain contexts, which play important role in students' outcomes (Caleon et al., 2018; Julie, 2015; Tufail & Mahmood, 2020). The science teachers are able to create situations that support and stimulate students' learning through an amalgam of different teaching knowledge (Shulman, 1986). They encourage students to learn, develop interests, concepts, to impact realistic knowledge and practical experiences (Davis & Arend, 2023; Wang, 2020) through existing knowledge systems. Meanwhile, conventional methods of teaching Biology have over the years generated varied outcomes, and have had serious implications for the attainment of national goals. Many teachers have had challenges explaining certain concepts in Biology to the understanding of students. The basis of some of these concepts are quite alien to them, having no relationship with the immediate environment of the learners. The result of this conventional approach to the teaching of Biology is that, students only end up memorizing what they are taught. If some topics are taught out of the context of the learner, the learner is less motivated and it ends up killing the interest of the learner in Biology.

A major strategy in motivating students to develop interest in Biology is relating conventional concepts to the everyday experiences of local environment. After all, a major role of science education is to prepare students to think responsibly, critically, and creatively in responding to societal issues caused by the impact of science and technology on life and society (Hofstein et al., 2011; Holbrook & Rannikmae, 2007; Sjöström & Eilks, 2018; Stuckey et al., 2013). However, the teaching and learning of Biology in Senior High Schools (SHS) within the Sissala East Municipality of the Upper West Region of Ghana faces a critical challenge in integration of indigenous or local technological knowledge into the curriculum. This leads to a disconnect between the content taught and the immediate environment of the learners resulting in the situation where students merely memorize concepts without developing a deeper understanding (Weimer, 2003). If this problem is allowed to persist, it will continue to hinder the effective learning of Biology, limiting students' interests and engagement with the subject. This could lead to a continued decline in academic performance, hindering the development of critical thinking and practical skills necessary for future scientific endeavours. Integration of local technological knowledge into the teaching and learning of Biology has the potential to enhance students' interest and higher performance in the subject. By connecting Biology concepts to the local environment and cultural context, students would be more likely to find the subject relevant and engaging. This approach would not only improve academic performance but also foster a holistic understanding and higher performance in Biology and its applications in the community. Hence, this study aimed at identify various forms of local technological knowledge within the Sissala East Municipality that could be effectively incorporated into the teaching and learning of Biology at the SHS level.

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The purpose of the study was to identify the local technologies of the people of Sissala East Municipality in the Upper West Region of Ghana, for teaching and learning Biology. The specific objectives were to:

1. examine challenges in incorporating local technological knowledge into Biology lessons at the SHS level in Sissala East Municipality,
2. identify various forms of local technological knowledge of the people of Sissala East Municipality that could be used in the teaching and learning Biology at the SHS level in the Municipality,
3. explore the strategies for the integration of local technological knowledge into Biology lessons at the SHS level in Sissala East Municipality.

The research questions that the study answered were:

1. What challenges hinder the effective use of local technological knowledge for teaching and learning Biology at the SHS level in Sissala East Municipality?
2. Which forms of local technological knowledge of the people of Sissala East Municipality, can be used in teaching and learning Biology?
3. How can the challenges be overcome for an effective integration of local technological knowledge in the teaching and learning of Biology at the SHS in Sissala East Municipality?

## 2. THEORETICAL BASES OF THE STUDY

This study is anchored on the behaviourist and constructivist theories of learning. Behaviourists are focused on behaviours that could be empirically observed, such as actions that could be measured and tested, rather than on internal states such as emotions (McLeod, 2007). They believe that learning is dependent on a person's interactions with his/her external environment. Thus, as people experience consequences from their interactions with the environment, they modify their behaviours in reaction to those consequences (Maddux & Rogers (1983)..This means that behaviour can be changed by manipulating the environment in order to encourage certain behaviours and discouraging others, which is a process known as conditioning (Chambliss, 2013). This means that with the use of local technological knowledge behaviour can be reinforced through interaction with the materials that students are familiar with. This would lead to the development of skills, and transfer of knowledge.

Constructivism proposes that individuals create knowledge and meaning through their interactions with the world. Constructivism recognizes the role of prior knowledge in learning and believes that individuals interpret what they experience within the framework of what they already know (Kretchmar, 2019) Constructivist teachers act as guides or coaches, facilitating learning by developing supportive activities and environments, and building on what students already know (Kretchmar, 2019). This study fits into the constructivist theory because learners would construct knowledge from what they are already familiar with from the immediate environment.

In this study, technology is considered as the study or mastery of the use of tools in the manufacturing and industrial sectors (Grace, 2010). Here, we are looking at local knowledge as the knowledge of any individual who resides in the area for long duration (Sillitoe, 1998). This will serve as a base for the construction of reality by linking culture to advance scientific knowledge (Abonyi *et al.*, 2014) in Biology. This may help to reflect the different intellectual traditions of various cultures adjoined with scientific knowledge to solve relevant problems in the context of ecological, societal, and economic ramifications (Abonyi *et al.*, 2014) of the Municipality.

### Setting

The study was carried out in the Sissala East Municipality located in the North- Eastern part of the Upper West Region of Ghana. It falls between Longitudes 1.300 W and Latitude 10.000 N and 11.000 N. It shares boundary on the North with Burkina Faso, on the East with Kassena Nankana West District and Builsa District, to the South-east with West Mamprusi District, South-west with Wa East and Daffiama-Bussie-Issah districts and to the West by Sissala West District (Ghana Statistical Service, 2022).

### Research design

The mixed method approach was used for this study. The mixed methods approach is a methodology for conducting research that involves collecting, analyzing and integrating quantitative (e.g., Experiments, surveys) and qualitative (e.g., focus groups, interviews) research (Creswell, 2009). Descriptive survey was used for this study because it helped in gathering information from a large number of respondents at less cost and at relatively short time (Fraenkel & Wallen, 1990).

### Population

The target population was all Biology teachers in the two Senior High Schools in the Sissala East Municipality and all custodians of local knowledge systems from the six clans in the District in 2023. The accessible population was all the 6 Biology teachers in the two Senior High Schools and three selected clans in the Sissala East Municipality.

### Sample and sampling

The six (6) Biology teachers in the two public senior high schools were conveniently selected. Three out of the six clans were randomly selected. With the help of community leaders in the three selected communities 10 custodians of local technological knowledge were purposively selected from each community. Thus, in all 30 local technology system practitioners were selected as respondents. Their expertise covered traditional birth attendants, artisans, local industry players, traditional herbal practitioners, farmers, and fishermen/hunters. Another condition was that the experts selected were people who could read and write English.

### Instrument

The main instruments used were questionnaires. Two different questionnaires, one for Biology teachers and the other for local technology knowledge experts were designed by the researchers.

The questionnaire for biology teachers was made up of ten (10) closed-ended items under various thematic areas. Nine (9) of the items were of Likert-Scale type with five levels of response ranging from scale of one being highly disagreed to five being highly agreed. One of the questions was simple yes or no answer item. The teachers' questionnaire was used to elicit responses on the challenges involved in incorporating local technological knowledge in teaching and learning of Biology as well as strategies that can be adopted to integrate local technological knowledge into teaching and learning of Biology in the SHS level.

Content and face validity of the questionnaire were done by two Biology teachers from another school from a nearby District. Test-retest method was employed to pilot-test the instrument by using six Biology teachers from two schools in a nearby District. The reliability co-efficient was 0.9.

The questionnaire for local technological knowledge experts also contained 10 items. Eight of the items were Likert-scales just as that of the teachers and two were open-ended items. The items covered known local technology existing in the Municipality, herbs and their medicinal uses, as well as totems and taboos existing in the Municipality. Content and face validity were ensured by two local technology knowledge experts who were from communities not involved in the study. Again, test-retest was used to pilot the instrument by using 10 local technology knowledge experts from one of the communities not involved in the study. The reliability co-efficient obtained was 0.95.

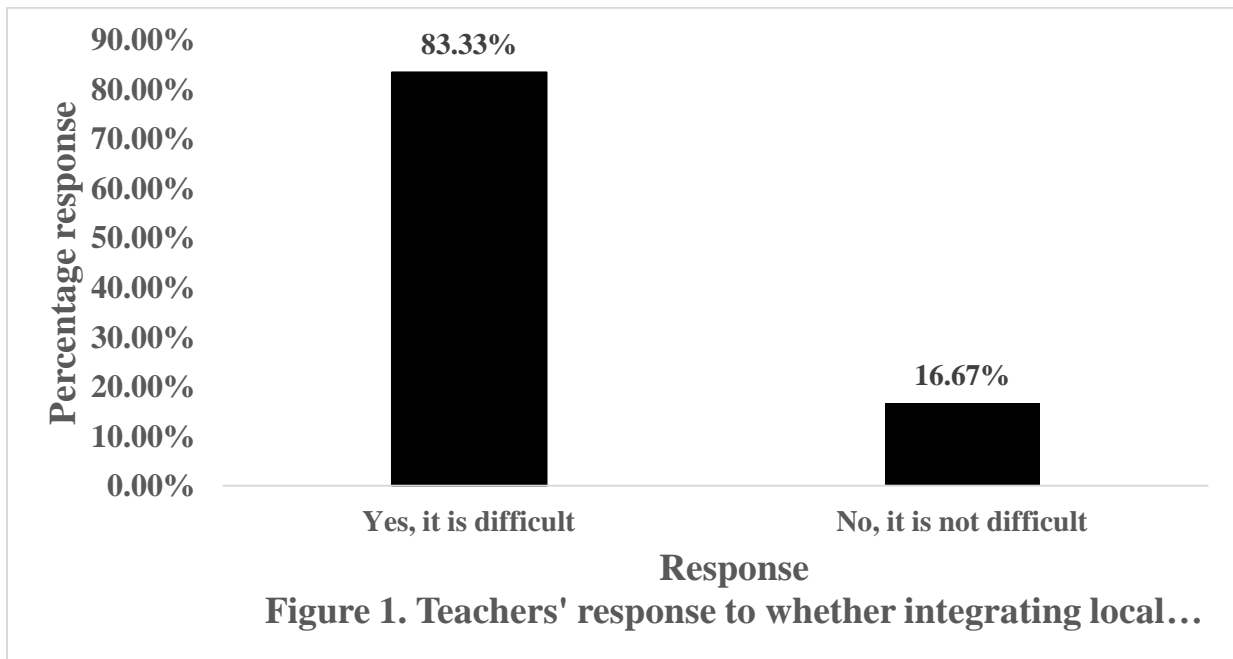
### Data collection procedure and analysis

The selected respondents were visited and the questionnaires administered to them to complete and collected back from them on the same day. Data collected were coded using Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics in the form of frequencies, percentage frequencies and rated means were calculated for the quantitative data and interpreted. Qualitative data were analyzed by using words, names, phrases and sentences.

### Ethical considerations

Participants were briefed on the objectives of the study, procedure and its purpose (solely academic). Participants were assured of complete confidentiality. This was done by ensuring that data obtained from participants were not under any circumstance made available to a third party or anybody who was not directly involved in the study. Participants were informed of their right to choose to participate and withdraw at any time they deemed necessary without any repercussion. Participants' identity was also not revealed to the public. Therefore, participants were not required to write their names, communities or school's names on the questionnaire.

3. RESULTS AND DISCUSSIONS



The results in Figure 1 illustrate that majority (83.3%) of biology teachers agreed that it was difficult linking LTK into biology lessons in schools, while 16.7% disagreed. This finding indicates that the majority of biology teachers face challenges in incorporating LTK into their lessons

**Research question 1. What challenges hinder the effective use of local technological knowledge for teaching and learning Biology at the SHS level in Sissala East Municipality?**

The responses to challenges teachers face in incorporating LTK into Biology lessons have been presented in Table 1. Fifty percent (50%) of the respondents disagreed with the statement that students possess poor background knowledge in LTKs. This has been confirmed by the rated mean of 2.50. However, 16.7% were undecided. This finding implies that while majority of respondents (67.7%) perceived students to have a reasonable background knowledge of LTK, there existed undecided as well as disagreeing teachers. According to Green and Raygorodentsky (2010) as well as Onwu and Mosimege (2004) there is the need for teachers to consider leveraging students' existing knowledge and gradually build upon it to facilitate a smoother integration of LTK. Therefore, since the teachers largely agreed that the students did not have poor background knowledge in the local technological knowledge that could be used in teaching Biology in the Municipality, the onus lies on them to take advantage of such students' knowledge to integrate it into the teaching and learning process. This would go a long way to take students from the known to the unknown and link what they learn to the environment.

**Table 1. Teachers' response to challenges in incorporating LTK into Biology lessons**

Item	Percentage response					Mean	Decision
	SD	D	U	A	SA		
Poor student background knowledge in LTK	16.7	50.0	16.7	0.0	16.7	2.50	Disagree
Poor teacher background knowledge in LTK	0.0	16.7	0.0	83.3	0.0	3.7	Agree
Inadequate literature on LTK	0.0	0.0	0.0	83.3	16.7	4.2	Agree
Unsupportive government policy	0.0	0.0	16.7	50.0	33.3	4.2	Agree
Unavailable LTK teaching and learning resources	0.0	0.0	0.0	83.3	16.7	4.2	Agree

**Decision points:** Strongly disagree (SD) = 1.0 – 1.4; Disagree (D) = 1.5 - 2.4; Undecided (U) = 2.5 – 3.4; Agree (A) = 3.5 – 4.4; strongly agree (SA) = 4.5 – 5.0.

**Source: Field data 2023**

Interestingly, 83.3% of the teachers (Table 1) agreed that they had poor background knowledge in LTK. This finding confirmed by a mean of 3.7, points finger at the teachers as those whose lack of knowledge in LTK for teaching and learning Biology is responsible for the poor integration of LTK into teaching and learning of Biology in the Sissala East Municipality. This echoes the argument that when teachers lack adequate knowledge of LTK, they may struggle to effectively integrate it into Biology lessons. Therefore, teacher expert knowledge in LTK in teaching and learning is very important in successfully incorporating such knowledge into education (Hart et al., 2012; Veintie, 2013). This lacuna can be taken care of by professional development programs for teachers. This could enhance teachers' knowledge in the use of LTK in teaching and learning. One important way to ameliorate this problem is to ensure collaboration between educators and local communities to bridge this knowledge gap.

Concerning lack of literature on LTK, 83.3% of the teachers agreed while 16.75 highly agreed. This shows that all the teachers were affirmative proved by mean of 4.2. In the actual fact, insufficient reference materials can impede teachers' ability to integrate local knowledge into biology lessons. This challenge emphasizes the importance of relevant literature to support the incorporation of LTK in teaching and learning. This was underscored by Demssie *et al.* (2020); as well as Druker-Ibanz and Caceres-Jensen (2022) that there is the need for a robust knowledge base to facilitate effective integration of local knowledge into education. In any case, lack of adequate literature hampers teacher preparation and limits the availability of diverse instructional materials for students. Such materials can be in the form of textbooks illustrating local technological knowledge that could be used in teaching and learning Biology. Textbooks are indispensable educational tools that make knowledge available to learners (Palló, 2006). They greatly influence the achievement of the curriculum goals (Hadar, 2017) and thus enhance the teaching-learning process (Mithans & Grmek, 2020). Therefore, educational authorities in Ghana should consider developing textbooks for SHSs specifically focused on LTK that could be used in teaching science including Biology.

Again, 50.0% of the teachers agreed while 33.30% strongly agreed that unsupportive Government Policy on LTK is responsible for not being able to integrate LTK into teaching and learning of Biology in the Municipality. This emphatic 83.3% affirmation is supported by a mean of 4.2 which stands for agree. Meanwhile, supportive policies significantly influence the successful integration of local knowledge in education (Assefa, 2022). Therefore, a serious effort is required from the Government of Ghana to enact and implement policies related to deliberate use of local technological knowledge (LTK) in teaching and learning of Biology in the Country which will affect Sissala East Municipality. This will promote the inclusion of LTK in the curriculum.

About unavailability of LTK Teaching and Learning Resources, majority (83.3%) of the teachers (Table 1) agreed and 16.7 strongly agreed that the unavailability of LTK teaching and learning resources poses a challenge. This underscores the importance of having appropriate materials to facilitate effective integration of LTK in teaching and learning of Biology. Insufficient resources may limit teachers' ability to design engaging lessons, hindering the practical application of LTK concepts in Biology classroom. This finding buttresses the position of Assefa, 2022), which emphasized the significance of culturally relevant teaching materials in enhancing the incorporation of local knowledge into teaching and learning. Thus, there is the need for increased investment in the development and dissemination of LTK resources for Biology education in the Municipality.

### **Research question 2. Which forms of local technological knowledge of the people of Sissala East Municipality, can be used in teaching and learning Biology?**

The results of forms of local technological knowledge of the people of Sissala East Municipality that could be used in teaching and learning Biology have been presented in Table 2. Majority (72.7%) of the respondents strongly agreed and 20.9% agreed that food processing (fish processing and preservation) activities exist in the Municipality. The mean score of 4.88 indicates a high level of agreement among the respondents. This suggests that food processing is a common and important form of LTK in the Sissala East Municipality. Such LTK is useful for teaching of biological concepts such as nutrition, digestion, metabolism, enzymes, fermentation, microorganisms, food safety, and food security. This aligns with the research work of Zindy and Eilks (2020) who argued that food processing is a form of indigenous science that can foster intercultural learning and education for sustainability. They provided examples of how food processing could be used to teach chemical and biological processes involved in food production and consumption, as well as the cultural and environmental aspects of food systems. Similarly, Patchen and Cox-Peterson (2008) suggest that food processing can be integrated into science learning to make it more relevant and meaningful for students from different cultural backgrounds.

**Table 2. Local technological experts’ response about existing local technological knowledge in study area**

Item	Percentage response					Mean	Decision
	SD	D	U	A	SA		
Food processing (fish processing and preservation)	0.0	0.0	6.3	20.9	72.7	4.88	Strongly agree
Beverage/ distillation (Pito brewing; fermentation using yeast).	3.8	15.2	10.6	60.6	6.1	3.56	Agree
Agriculture (farming systems; crop and animal production)	0.0	0.0	0.0	0.0	100.0	5.00	Strongly agree
Conservation and sustainable use of natural resources	3.0	4.5	14.4	30.3	47.0	4.15	Agree
Local post-harvest management/ storage (use of ash to preserve cereals and legumes, locally made silos for storing grains)	7.6	13.6	39.4	30.3	8.3	3.18	Neutral
Healthcare (traditional bone setting: using local herbs, straw and fiber threads, traditional birth attendance: using herbs)	3.8	8.3	9.8	40.9	36.4	3.98	Agree
Agricultural by-products utilization (Use of cowpea; <i>Vigna unguiculata</i> husks for the preparation of animal feed).	0.8	4.5	5.3	43.9	44.7	4.28	Agree
Totems and taboos	0.0	0.0	0.0	0.5	99.5	4.99	

**Decision points:** Strongly disagree (SD) = 1.0 – 1.4; Disagree (D) = 1.5 - 2.4; Undecided (U) = 2.5 – 3.4; Agree (A) = 3.5 – 4.4; strongly agree (SA) = 4.5 – 5.0.

**Source: Field data 2023**

Concerning beverage/ distillation (Pito brewing; fermentation using yeast), 60.6% agreed and 6.1% strongly agreed. The mean score of 3.56 shows that majority agreed, suggesting that beverage/ distillation is also a common LTK but less common than food processing. Tamang (2010) argued that beverage/ distillation is a form of indigenous technology that can reflect the diversity and complexity of indigenous cultures, but also warned that it could be subjected to misrepresentation and appropriation by outsiders. However, beverage or distillation can be used to illustrate topics of fermentation, respiration, ethanol, yeast, microorganisms, pH, and energy. For example, the fermentation and brewing of a drink brewed from fermented cereal known as pito using yeast can be used to explain anaerobic respiration, the production of ethanol and carbon dioxide, the effects of pH and temperature on fermentation, and the energy content and uses of ethanol. This is a local technological knowledge that Biology teachers in the Municipality can exploit for teaching.

The results show that all respondents (100%) strongly agree (mean of 5.0) that agriculture, especially farming systems including crop and animal husbandry exists in the Municipality. This suggests that agriculture is a very common and very important form of LTK in the Sissala East Municipality. This outcome is not surprising at all since the study area is largely an agrarian community. The major crops cultivated include maize, cowpea, yam and sorghum. The people also engage in rearing of animals such as cattle, sheep, pigs as well as poultry including the guinea fowl, domestic fowl, turkeys and ducks. Agriculture is a well-established and widely accepted form of LTK that can enrich Biology education in the fields of plant and animal diversity, reproduction, genetics, ecology, evolution, biotechnology, and sustainability. This finding resonates with that of Avery (2013) whose study covering rural science indicates that knowledge gained from agricultural engagements can provide students with practical and relevant knowledge and skills for their future careers and personal lives. Similarly, Sumida (2017) advocates that agriculture is a form of indigenous technology that can foster students’ interest and motivation in learning Biology.

A large majority of the participants (77.3%) agree or strongly agree that conservation and sustainable utilization of natural resources is practiced in the Municipality. This agrees with the high mean score of 4.15 which signifies a high level of consensus among the respondents. This is an indication that conservation and sustainable use of natural resources is an essential and prevalent form of LTK in the area. This has the potential to be incorporated into Biology education to cover topics such as ecology, biodiversity, natural resources, environmental issues, and sustainability. For example, sustainable fishing and land utilization can be used to explain concepts such as ecosystem structure and function, population

dynamics, carrying capacity, resource management, environmental impact, and sustainable development. Various studies have shown that conservation and sustainable use can serve as a form of LTK that promotes environmental awareness and action in Biology education. For instance, Nelson and Shilling (2018) argued that local knowledge in this area can enhance students' understanding and appreciation of the natural environment and their role in protecting it. According to them, ecological and cultural values of biodiversity, threats and challenges of environmental degradation, strategies and solutions for environmental conservation can be taught using local knowledge of conservation.

There was a low level of agreement among respondents regarding the use of post-harvest management/storage, including ash preservation of cereals and legumes and grain silos in the Municipality as indicated by mean score of 3.18 which depicts neutral position. This suggests that post-harvest management/storage may not be a common or important aspect of Indigenous or Local Traditional Knowledge (LTK) experts in the Sissala East Municipality. This suggests that it may have limited potential for integration into teaching and learning Biology in the Municipality. Though the use of such knowledge is associated with low efficiency, low sanitation and high health risks (Ngubo, 2021) they can still be used to explain the methods and mechanisms of preventing or delaying the growth of microorganisms that cause food spoilage and contamination, the factors and conditions that affect the quality and safety of food, and the importance of food security for human health and well-being. However, only 38.6% of respondents agree to its existence in the Municipality. Ngubo (2021) posits that post-harvest management/storage is a form of indigenous technology that can provide students with practical and useful knowledge and skills for food preservation and security. However, it has some drawbacks and disadvantages such as low efficiency, high losses, poor quality, and health risks (Ngubo, 2021). However, it can still be used in teaching and learning of Biology with caution.

Most respondents (77.3%) agree or strongly agree (mean of 3.98) that traditional healthcare practices are operational in the Sissela East Municipality. This suggests that traditional healthcare is a common and important form of LTK in the Sissala East Municipality. This has potential for integrating into teaching and learning Biology. Traditional healthcare as LTK can facilitate the teaching of human anatomy, physiology, pathology, pharmacology, and immunology. For example, experts in traditional bone setting and traditional birth attendance can serve as resource persons to explain the structure and function of the skeletal and muscular systems, the causes and effects of bone fractures and dislocations, the methods and principles of bone healing and alignment.

Additional information provided by the local technology knowledge experts related to herbs of medicinal value, especially, native plants that are used in first aid and the treatment of various conditions. These medicinal plants have been presented in Table 3.

**Table 3: Herbs and their Medicinal Uses by the people**

Native herb/plant		Medicinal uses
Scientific name	Common name	
<i>Azadirachta indica</i>	Neem tree	Treatment of fever
<i>Parkia biglobosa</i>	African locust bean tree	The bark is used in treating Pneumonia in babies.
<i>Calatropis procera</i>	Sodom apple	The leaves are used in treating epilepsy, wounds/sores and various skin diseases
<i>Veronia amygdalina</i>	Bitter leaf	The 'siwaaka' leaves are used in the treatment of various conditions including diarrhea, general body weakness, malaria etc
<i>Mitragyna stipulosa</i>	African linden	Locally called 'veke' and the leaves are used in treating skin conditions such as chicken pox, eczema rashes etc
<i>Mikania scandens</i>	Climbing hempweed	Locally called 'betu-luobi'. The bitter roots are used for the treatment of stomach upsets and hernia.

**Source: Field data 2023**

*Azadirachta indica* is reported to have numerous medicinal values. For example, different parts of the tree is used for treating diseases such as cancer, dental diseases, stress, ulcers, heart diseases, malaria, skin diseases, viral diseases, AIDS, oral diseases, and sexually transmitted diseases. The phytochemicals in *A. indica*, serve anti-diabetic, antiviral, anti-oxidant, anti-microbial, anti-parasitic, anti-malarial, anti-cancer, anti-ulcer, hepatoprotective and gastro-protective purposes (Oli & Gautam, 2022). The traditional experts stated that *A. indica* is used for the treatment of fever in the Sissela East Municipality.



*Parkia biglobosa* (Family Fabaceae) commonly known as African locust bean tree (dawadawa in Hausa language and Kolgo in Frafra (Gurune) language) is traditionally used as food and medicine in West Africa. It contains carbohydrates, proteins, fats, minerals, vitamins, tannins and flavonoids. The plant also possesses antimalarial, anti-helminthic, antibacterial, antivenom, antidiabetic, and antihypertensive and antioxidant properties (Builders, 2014; Musara *et al.*, 2020). In this study it was said that the bark is used in treating pneumonia in babies.

Murti *et al.* (2010) intimated that the leaves of *Calotropis procera* (Family Asclepidaceae) serve as antidote for snake bite, sinus fistula, rheumatism, mumps, burn injuries, body pain, and treatment of jaundice (Murti *et al.*, 2010). In this study the respondents submitted that the leaves are used in treating epilepsy, wounds/sores and various skin diseases. They also stated that the leaves of *Veronia amygdalina* are used in the treatment of various conditions including diarrhea, general body weakness, malaria and others. Meanwhile, Adedapo *et al.* (2014) reported that the fresh leaves of *Vernonia amygdalina* are rich in vitamins and salt and thus used in human diet. The leaves possess anti-oxidant, anti-inflammatory and analgesic properties. Extracts have been reported to cause appreciable reduction in oedema (Adedapo *et al.*, 2014).

Toklo *et al.* (2020) stated some known ethnopharmacological properties of *Mitragyna inermis* to include antibacterial, antiviral, antiparasitic properties. In the current research area the leaves are used in treating skin conditions such as chicken pox, eczema rashes etc. Similarly, the bitter roots of *Mikania scandens* are used for the treatment of stomach upsets and hernia in the research area. On the other hand, Kar and Mahanty (2017), reported that, traditionally, the leaves of *Mikania scandens* are used as agents for protecting ulcer and in healing wounds; as an antimicrobial, antipyretic and anti-inflammatory agent as well as an anti-cold used as decoction for coughs. In Africa, it is also used for treatment of snake and scorpion bites, used as an antispasmodic and pain-reliever for rheumatism, arthritis, and intestinal inflammation.

All these medicinal plants found in the research area could be used in teaching health issues, especially treatment of diseases, nutrition, ecology and biodiversity of plants. In similar work,

Rankoana (2012) opined that traditional healthcare systems can provide students with practical and relevant knowledge and skills for their health and hygiene. Cited examples are teaching of human health and diseases, the use and efficacy of medicinal plants and herbs, and the ethical and social issues of healthcare. Similarly, Dansu (2021) suggest that healthcare is a form of indigenous health knowledge that can foster students' interest and curiosity in learning Biology.

In Table 2, the survey revealed that most respondents (88.6%) agree or strongly agree that agricultural by-products utilization, especially the use of cowpea husks for the preparation of animal feed, could be used in the teaching and learning of Biology in schools. The mean score of 4.28 indicates a high level of agreement among the respondents. This suggests that utilization of agricultural by-products is a common and important form of LTK in the Sissala East Municipality. This has the potential for integrating into Biology education. The use of cowpea husks for the preparation of animal feed as an LTK can be used to explain the nutritional and chemical composition of cowpea and its by-products, the digestive and metabolic processes and mechanisms of animals, the role and function of enzymes in breaking down carbohydrates, proteins, and fats, the applications and implications of biotechnology in enhancing the quality and quantity of animal feed, and the challenges and solutions for sustainable agriculture and animal production. This finding corroborates the findings of Matsekoleng *et al* (2024) that agricultural by-products utilization is a form of indigenous technology that can provide students with practical and useful knowledge and skills for reducing waste and increasing productivity. Others like Valenti *et al.* (2017) advocate that agricultural by-products utilization could stimulate students' creativity and innovation in the field of Biology.

One other important local or indigenous technological knowledge stated by respondents as being practiced in Sissala East Municipality are totems and taboos (Table 4). All the respondents were affirmative about this practice in the municipality.

A totem is sacred or spiritual object or symbol or emblem of a group of people in the form of family, clan, lineage or tribe, which is having a special significance in the tribal life of the people (Goswami, 2018). Such symbolic items take the form of animals, part of an animal, a plant or part of a plant or an association between a plant and an animal. Totems serve as reminder of the ancestry or mythic past of a group of people. It represents a spiritual, religious, social and cultural association between a clan or lineage and a bird, animal or a natural phenomenon (Goswami, 2018). In Ghana, totems are very commonly used to depict importance, wisdom, power or philosophical underpinnings. In many cases, they take the form of animals or animals on plants or plant parts. All these demonstrate relationships in one form or the other and effectively be used to teach ecology.

In a specific society, the list of behavioural guidelines is typically referred to as social norms and taboos. These norms and taboos influence the way the people behave, dress, eat, drive, and their sex life. Generally, taboos are acts of prohibition of actions based on the belief that such behaviour is either too sacred and consecrated or too dangerous and accursed for ordinary individuals to undertake (Fershtman, *et al.*, 2018). In Ghana, taboos are very common restricting individuals in specific communities from undertaking specific actions at particular times of the day, week, month or the year. In other cases individuals are completely prohibited from undertaking certain actions. For, example, in some communities it is a taboo to enter into certain reserved areas, or not allowed to work in the farm on certain days or not allowed to eat fish from certain rivers or not to eat certain animals. These, taboos go a long way to conserve certain rare species in the environment and thereby contributing to biodiversity conservation. Therefore, such practices should not be considered as primitive and obsolete but should be modernized and used in teaching biological concepts.

No doubt, all the respondents (100% and a mean score of 4.99) unanimously endorsed the existence of this practice in the Sissala East Municipality. They indicated that totems are to be protected from all forms of harm. Anyone caught causing harm to, or killing a totem is either fined or made to perform funeral and burial rites respectively. This idea of protecting wild animals could be brought to the fore as a way of managing wildlife.

**Table 4. Totems and taboos in the area that can be used in teaching Biology**

Clan	Item	Reason
Gilinga-viaraa	Crow	Saved their warrior ancestors from his enemy
Nyibi-viaraa	Crocodile	Each member of the clan has a crocodile soul. Once a crocodile dies, a clan member dies
Gelibagilaa (Sang-viaraa)	Porcupine	Saved their ancestor with its powerful spines.
Kpe-viaraa	Leopard; Monkey	Leopard saved their ancestor Monkeys are their souls
Heing-viaraa	Red earthenware bowls	Reverence to 'mother earth'
Bondialla	Crocodile	It represents their soul.

Source: Field data, 2023

Actually, the use of these totems and taboos in teaching biological concepts can help in the better illustrations in ecology, biodiversity, evolution, ethics, natural selection and species diversity and conservation. Reniko et al. (2018) suggested that totems and taboos are a form of indigenous cosmological knowledge that can foster students' respect and dialogue with other ways of knowing. They provide examples of how totems and taboos can be used to teach the interconnectedness and interdependence of all living and non-living beings, the sacredness and responsibility of life, and the challenges and opportunities of intercultural education.

**Research question 3. How can the challenges be overcome for an effective integration of local technological knowledge in the teaching and learning of Biology at the SHS in Sissala East Municipality?**

Strategies stated by the teachers for the integration of LTK into the teaching and learning of Biology have been presented in Table 5.

**Table 5: Strategies stated by the teachers for the integration of LTK into the teaching and learning of Biology**

Item	Percentage response					Mean	Decision
	SD	D	U	A	SA		
Having field trips to local/indigenous industries	0.0	0.0	0.0	16.7	83.3	4.2	Agree
Inviting local craftsmen to schools during Biology lessons to assist teachers	0.0	16.7	0.0	66.7	16.7	3.8	Agree
Incorporating indigenous technologies into national curriculum	0.0	0.0	0.0	83.3	16.7	4.2	Agree
Attaching children /students to local craft men as apprentices	0.0	16.7	16.7	50.0	16.7	3.8	Agree

**Decision points:** Strongly disagree (SD) = 1.0 – 1.4; Disagree (D) = 1.5 - 2.4; Undecided (U) = 2.5 – 3.4; Agree (A) = 3.5 – 4.4; strongly agree (SA) = 4.5 – 5.0.

Source: Field data, 2023

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It can be seen from Table 5 that majority of respondents agreed that undertaking field trips to local/indigenous industries (mean of 4.2); invitation of local craftsmen to schools during Biology lessons to assist teachers (mean of 3.8); incorporating indigenous technologies into national curriculum (mean of 4.2); and attaching children /students to local craftsmen as apprentices (mean of 3.8) will help in better teaching and learning of Biology. In any case, traditional ecological knowledge is the advanced knowledge systems highly specific to local environments and ecosystems (Mueller & Tippins, 2010). Despite the fact that traditional resource management methods are considered to have negative effects on natural resource conservation, research findings point to the fact that they are useful ways of managing resources (Agatha, 2016). Therefore, modern science and technology could explore the use of traditional wisdom and knowledge of the environment for explaining specific issues. By so doing they can complement modern technology and science because they are based on parallel and similar modes of thinking (van Binsbergen, 2009). For that to be effectively done, such knowledge should be incorporated into the biology curriculum and the experts should be involved as stated by the teachers from Sissala East Municipality.

In a study to assess the historical perspective of traditional wisdom in land use and resource management among the Lugbara of Uganda, Agatha (2016) discovered that traditional wisdom and mechanisms were applied in land use and resource management as a means to maintain social and environmental order. Such traditional wisdom and laws were used to regulate the use of socioeconomic resources such as labour, land, water, grazing, and hunting grounds for societal harmony. Agatha (2016) further observed that societal rules and norms guided individual, family, and clan behaviour and attitude, strengthening the social bond and the sense of social responsibility in the use of environmental resources. Such wisdom enhanced the conservation of natural valuable forest trees for their medicinal, timber, food, and ritual value. As a result destruction of shea trees was not allowed because they are useful source of fruit and seed from which shea butter was processed for consumption, ritual, and body oil. Therefore, the findings of the current study are making that clarion call to educational managers in Ghana to consider fully integrating and institutionalizing the use of local technological knowledge in the Biology curriculum for teaching and learning purpose. If that is done, it will help to indigenize the curriculum so that graduates produced can effectively use the knowledge gained in solving local problems.

#### 4. CONCLUSIONS

It is evident from the study that various forms of LTK are prevalent in the community, such as food processing, agriculture, traditional healthcare, and totem practices as well as rich cultural heritage that can be used to enhance teaching and learning of Biology. However, challenges abound, including lack of teacher expertise, insufficient literature, unsupportive government policies, and inadequate resources, which hinder the effective incorporation of LTK into the curriculum. Despite these challenges, practical strategies for overcoming these obstacles, exist. These include field trips, curriculum integration, inviting local practitioners to schools to assist teachers, student attachment programs, and teacher capacity building. These strategies, aligned with the goal of empowering students with a comprehensive understanding of both conventional science and traditional wisdom, offer a pathway towards meaningful integration of LTK into Biology education. The study thus underscores the importance of recognizing and leveraging indigenous knowledge to enrich teaching and learning of Biology and ultimately contributing to a more holistic and culturally relevant educational experience for students in the Sissala East Municipality and beyond. The implication of the findings of this study is that for Biology teachers to effectively integrate local technological knowledge into teaching and learning, they need to acquaint themselves with the existing LTK and devise strategies of incorporating them into the teaching and learning process.

#### 5. RECOMMENDATIONS

It is hereby recommended that educational authorities in the Municipality should put in programmes to enhance teachers' knowledge and understanding of LTK that could be used to teach Biology. Such programmes should involve incorporating LTK components into teacher training programs and providing regular professional development sessions focusing on LTK integration strategies. Schools should actively engage with local communities and traditional practitioners to facilitate the incorporation of LTK into biology education. This could involve inviting local craftsmen/women and traditional healers to share their knowledge with students, organizing field trips to indigenous technological industries, and fostering partnerships between schools and community organizations. Authorities should ensure that adequate resources are allocated to support the integration of LTK into Biology education. This includes

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funding for the development of teaching materials and resources, as well as investments in infrastructure to facilitate field trips and other experiential learning opportunities. Stakeholders, including educators, policymakers, and community leaders, should advocate for supportive government policies that promote the inclusion of LTK in the curriculum. This may involve lobbying for policy changes at the local, regional, and national levels to create an enabling environment for LTK integration in education.

**Recommendation for further research**

It is hereby recommended that this study be replicated in other parts of Ghana in order to become more conversant with the situation of integrating LTK into teaching and learning of Biology and the way forward.

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