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Research Paper

A Vocabulary Graphic Organizer for Meaningful Learning of Classification Concepts in Biology

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Abstract: *The paper examines the inherent vocabularies that are associated with biology terms and concepts. These vocabularies are not only aliens to the biology students, but also make meaningful learning difficult for biology students during instructional delivery. The reason being that, these vocabularies are not in the conventional language of communication among the students. Resultantly, the usual phobia for these terms and concepts with its multiplier effects on students' inability to use the technical terms to describe some processes as well as incorrect spelling of these technical terms in biology. These problems have contributed to poor academic achievement in biology at secondary school level of education in Nigeria. In surmounting these problems, this paper proposes a vocabulary instructional strategy of vocabulary graphic organizers premised on the theories of meaningful learning by Ausubel and social constructivism by Vygotsky. Model lesson note for the vocabulary graphic organizer instructional strategy is also presented as guide for use in order to enhance meaningfulness during the teaching and learning of these biology terms and concepts at secondary level of education.*

Keywords: *vocabulary instruction, graphic organizer, wordmap, classification concepts*

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I. Introduction

Science education in Nigeria concentrates on the teaching of science concepts, method of teaching and addressing misconceptions held by learners regarding science concepts. Science education comprises three subjects at senior secondary level of Nigeria's educational system and these are biology, chemistry and physics. It is noteworthy to remark that, science education cultivates students' curiosity about the world and enquires scientific thinking. The role of science education is to teach students how to use thematic patterns of science to communicate meanings, "talking science" to solve problem in writing or speaking about issues in which science is important, Carrier (2010) remarked. The European Molecular Biology Organization (2014) had argued that, thinking the view that science education should address how we apply scientific knowledge to improve the human condition raises the question of whether science research should be entirely at the service of human needs, or whether scientist should retain the freedom to pursue knowledge for its own sake- albeit with a view to eventual application. The quest for sustainable development could only be attained with inculcation of right values of science and science education. Inculcating these right values require nonetheless students who are not only scientifically literate but could also communicate science in their everyday life through meaningful understanding of scientific concepts.

Without prejudice to the above posits, it is noteworthy to remark that Science is valued by society because the application of scientific knowledge helps to satisfy many basic human needs and improve living standards. For instance, finding a cure or vaccine for Corona virus (covid-19) and sourcing a clean form of energy through conversion of wastes to gas are just two typical examples. In supporting this, Namarata et al (2014) opined that "the process and ideas of science are of great importance to everybody in their ways". Hence, the justification of heavy investments in science world over.

Biology, as a subject, is required for everyday life on matter of personal and community health as espoused in the National Policy on Education (NEDRC, 2012). It has been defined as scientific study of life, (Silivia & Micheal, 2010); also as the scientific study of life and structure of plants and animals, (Hornby,

2010); and as the study of living organism (Bason, 2012). Biology is regarded as one of the core sciences' subjects at the senior secondary science in Nigeria educational curriculum (Gambari, Yaki & Gana, 2015; Obochi, 2021; Chinweuba, 2021). This subject, due to its importance according to a report by the West Africa Examination Council (2011) is the most enrolled by students. The modern tendency toward cross disciplinary research and the unification of scientific knowledge and investigation from different fields has resulted in significant overlap of the field of biology with other scientific disciplines, Kara, Edna and Susan (2019) remarked. Resultantly, biology as a field of study is often studied in conjunction with other sciences, engineering and even social sciences (Begley 2017), hence its pivotal and central roles in all fields of live.

Despite the importance of Biology, the Chief Examiners' Reports of WAEC, 2017 and 2018 remarked that poor spelling of technical terms; not using capital letter to start biological names; use of plural words when it is supposed to be singular for labels; starting taxonomic names with small letters; all contributed to loss of marks to answered questions in the practical session. In a more related view, candidates' weaknesses were also captured by the Chief Examiners' Reports in Biology 2 as "poor spelling of scientific names such as succulent, venation, exoskeleton, appendages, antennae, proboscis, and Arthropoda (Chief Examiners' Reports – Biology 3, 2018:284) Further to the above, and while suggesting remedies to various students' weaknesses in answering questions, the Chief Examiner's remarked among others that "candidates should learn the conventions of writing scientific or technical terms" (Chief Examiners' Reports, WAEC 2018:264). Specifically, the Chief Examiners' Reports in Biology 2 suggested among others remedies that "candidates should be taken through spelling drills with respect to technical and scientific names" (Chief Examiners' Reports – Biology 2, WAEC, 2018:275).

Neil (2016) posited that Biology is not plants and animals, it is language about plants and animals. One method to introduce key vocabulary in science is when teachers display keywords at the beginning of a lesson and encourage students write down the meaning of words, Fleek (2019). However, this method was considered inappropriate considering the amount of time and the pressure to teach content and concepts. Fleek (2019) also argued that this is not the best way to embed deep understanding of a word and help students become fluent in the language of science. It was however posited that "building a greater understanding of the structure and origin of words can support the learning of new vocabulary and aid understanding of science more generally".

Classification of living things is the second thematic topic in the West Africa Examination Council's syllabus. It should be noted that terms and concepts embedded in classification of living things go beyond their uses at this stage to extend to subsequent themes in biology from SSS1 to SSS3 and even post-secondary education. Remarkably, classification concepts in biology have coverage across almost all other concepts in biology. In this wise, if meaningfulness and relevant knowledge of biology must be acquired by students, those classification concepts in biology must be well understood to enhance their eventual transfer to subsequent and more advanced topics in biology. For example, it would be easier for a student who had meaningfully understood some words/terms/concepts such as "ecto", "dermis", "ctyo", "sessile", and "motile" during the learning of basic classification concepts to use those words/terms/concepts at more and advanced complex stages in biology.

In biology, most of the terms and concepts associated with the classification of living things are not the conventional language or better still, are not the usual lingua franca which the students are used to on daily basis. Hence, the need for biology students at this level of education to have the required sound knowledge of these vocabularies in order to enhance meaningful learning of these terms and concepts in their subsequent engagements and encounters. The classifying features as well as the naming of organisms in biology have their roots in Greek and Latin with diverse roots or origin of those words. Thus, the students are having their first encounters with such words during the classification and naming of the organisms and hence the need for the students to have basic and sound knowledge and create meaningfulness of these terms and concepts which form the vocabulary of classification in biology. In some cases, there are prefixes and suffixes which can be used to predict correctly a terminology or the meaning of a concept. For example, word like "pseudopodia" which is a feature that enable the naming of "Amoeba" because it confers on it the "shapelessness" whenever the organism glides on the substrate, is better understood in perspective of prefix "Pseudo" and suffice "podia". This implies that knowing the meaning of "pseudo" as "false" and "podia" as limbs/foots/legs will obviously enable students to make meaning of the word like "pseudo alimentary" and "tetrapoda" to mean "false alimentary and four-legged" in their subsequent encounters in biology. In a more related view, a student who had created the meaning of "logy" to be "study" while defining biology can easily create meaning for words such as "ecology", "pathology" "parasitology" in their subsequent encounter in biology.

In order to help students to decode vocabulary in science, the morphology and etymology, (Fleek, 2019) and morpheme (Anne, 2012) of the words must be understood. Morphology is the study of different parts of a word and these are prefix, root and suffix. Prefixes appears at the beginning of the words, e.g hypo- (below), hyper- (above), cyclo- (ring), poly- (many), endo- (within), exo- (outside),; roots words that have meaning standing alone. They often from the longest part of a word. Suffix appears at the end of the word and provides additional information e.g -ane (saturated hydrocarbon), -phillic (love, affection), -phobic (hats, fears), -lysis (decompose, breakdown). Science vocabulary often has Greek and Latin roots e.g chloro (green), iso

(equal), allo(other), com (together). Hence, science learning involves lots of new vocabulary words focusing on roots words, prefixes and suffixes that can help child learn science words more quickly and become a word detective, Fleek (2019).

II. Literature Review

Graphic organizers are visual and spatial displays designed to facilitate the teaching and learning of textual material through the "use of line, arrows, spatial arrangements that describe text content, structure and key conceptual relationship, Kim, Vaughn, Wanzek and Wei (2004). It was further explained that graphic organizers include sematic maps, sematic future analyses, cognitive maps, story maps, framed outlines and venn diagrams. In a similar vein, Tracey and Nicole (2008) opined that "a graphic organizer is a visual graphic display that depicts relationship between facts, terms and or idea within a learning task. In supporting the place and importance of graphic organizers, Sakatoon Public School in her annual report of 2014-2015 remarked that "most graphic organizers form a powerful picture of information and allow the mind "to see" undiscovered patterns and relationship. In a related view, vocabulary graphic organizers are visuals maps in displaying key elements of a vocabulary, such as definition, part of speech. affix, synonyms, and anonyms, Pamela, (2019) submitted.

While advocating for vocabulary instructional strategy that would better enhance understanding of biology concepts, Fullwood and Henley (2012) found out that "presenting abstract words in conjunction with an image and word used in a context sentence resulted in better transfer of students' understandings of the word on a posttest compared with when students learned the word without the image and content". Premised on the above, this paper advocates the use Word map Vocabulary Graphic Organizers for leaning of biology concepts and terms which form the vocabulary of biology

Word map according to Hediza, Gatot and Endang (2016) is graphic organizer that helps students build their vocabulary rather than just memorize words and terms which is the common place in the traditional classroom setting. Students during word map instructional strategy use the map to help them retain learning, use vocabulary in content and develop a framework on which to build new knowledge is built. Hence, the learning of classification terms and concepts which form the basics in subsequent terms and concepts in Biology could be effectively learned using word maps. In the words of Ashrat, Abbas and Kelvan (2015), it was posited that "a word map is a strategy to help learners learn new vocabulary words". Humaira and Fatimattuzahro (2014) opined that word map learning strategy is a vocabulary strategy which is especially great for abstract concept words of difficult academic terms.

Terms and concepts in classification of living things are often abstract words which students are possibly inter-phasing with for the first time, hence, the need to use a strategy that can adequately situate their abstractness into real world activities. The word mapping strategy engages students in thinking about words relationships (Graves, 2007). Gibbon (2011) posited that word mapping strategy promotes students' active explorations of words relationships, thereby leading to a deeper understanding of word meanings by developing their conceptual knowledge related to words.

According to Wardami (2017), word mapping strategy is a graphic organizer which enables students to expand definitions of words. In the view of Rikko, Ari and Ramlan (2017), word mapping itself is a visual representation of a definition which functioned to encourage the students to move from simple dictionary-like statement to more complex critical thinking definition. It was stressed further that using the word mapping strategy as a graphic organizer could help students think about terms and concepts in different ways. Going by these submissions, biology students at this formative stage could be equipped with the basic knowledge needed for higher order thinking having being exposed to the fundamentals of those terms and concepts during classification of living things using word map strategy.

In a similar vein, Humaira and Fatimattazhro (2014), described word map concept as a strategy for representing knowledge in graphs. Earlier, Ronnia (2010) had submitted that knowledge graphs are networks of concepts; networks of nodes (points/vertices) and links (arcs/edges); nodes represent concepts and links represent the relation between concepts. In inference from the above, word maps could be helpful visual organizers that would encourage vocabulary development by establishing relationships between and among terms and concepts. This is such that, terms and concepts learnt at a classification of living things stage could be carried forward to new and related concepts in student's subsequent leaning engagements. This is more so that Ashrat et al (2015) had submitted that word mapping strategy engage students in developing a definition, synonym, antonym and a picture for vocabulary. Hence, forming an association between a term or a concept with pictorial evidence as well as linking such with an associative object could be effective in ensuring effective learning of such terms and concepts in classification of living things.

It is important to remark that one of the critical components of word map instructional strategy is the "mini biology dictionary" that contains the biology definitions of those terms and concepts, as well as the root words and origin of those words. Oladosu (2020) had found out that students taught with Mobile BioApps

performed better than their counterparts in the conventional classroom. Hence, the use of mini-dictionary in the vocabulary graphic organiser instructional strategy could further enhance the meaningfulness of classification concepts in biology.

Ausubel Theory of Meaningful Learning and Vocabulary Graphic Organiser

As opposed to many other instructional theories, which are psychology-based models applied to instructional design, (Pappas, 2014), Ausubel's theory is concerned with how individuals learn large amounts of meaningful materials from verbal/textual presentations in a school setting (in contrast to theories developed in the context of laboratory experiment), Calatta (2021) opined. There are four forms of advance organizers in bringing meaningful learning as espoused by Hsue-H and Han-Chin (2014). These are advance organizers are Expository organizers, Narrative organizers, Skimming organizers and Graphic Organizers. Graphic organizers further include pictographs, descriptive or conceptual patterns and concept maps. Out of these advance organizers, Graphic Advance Organizers which were first suggested under rubric of "structured overview" by Barron (1969) are visual and verbal presentations of key vocabulary in a new learning task in relation to subsuming and/or parallel term that presumbly have previous been incorporated into the learner's cognitive structure (Estes, Mills and Barron, 1969). According to Gunstone (2016), the term "meaningful learning" became popularized in the parlance of science education through the work of the educational psychologist – David Ausubel in the 1960s to designate learning that is in total contrast to rote learning. This postulation by Ausubel in 1968 brought into fore the need for student to be an active rather than passive participant in the learning process. A clear departure from an arrangement where students solely relay on the teacher for "knowledge impartation".

Graphic Organizers were developed on the basis of Ausubel's theory of meaningful verbal and textual learning, which states that when students are introduced to material for which they have little background knowledge, their learning will be improved if they have a structured and clear method for organizing the information (Ausubel, 1963). This theory was proposed after Ansubel's work on how learners learn large amount of useful information from textual and verbal inputs. It is noteworthy to posit that Vocabulary Graphic Organizers draws heavily on the theory of learning as proposed by Ausubel (1968). Damils, Braaf and Fourie (2013) had noted that a central importance to Ausubel's theory of learning is the proposition that in the process of meaningful learning, people construct meanings for concepts and propositions based on experiences, and building up their knowledge structure. Meanwhile, in the process of traditional learning, Damils, et al (2014) remarked that student is conceived of as an empty vessel waiting to be filled with the knowledge held by the teacher or lecturer as "expert".

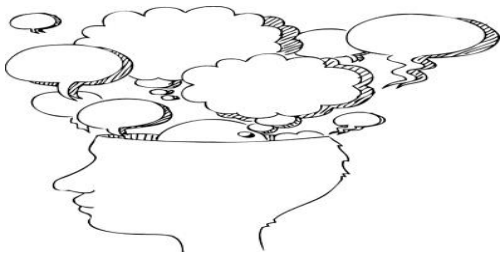


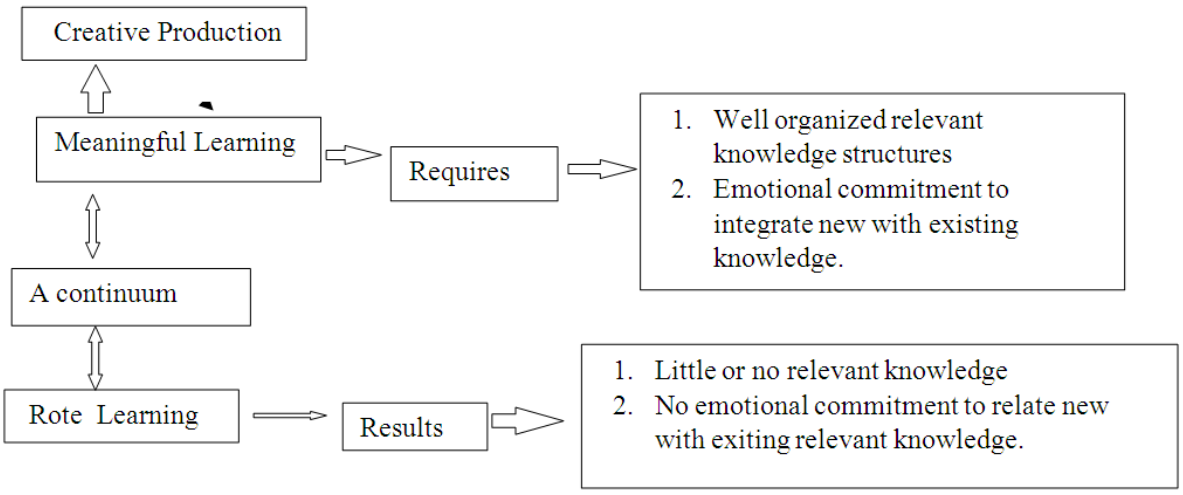
Figure 5: Head of a student and Knowledge being released to fill the empty brain

On the contrast to the traditional learning process, Ausubel (1968) had posited that learning involves changing one's current knowledge as a result of the comprehension of new knowledge. This process is called "assimilation" and there are four fundamental processes that lead to assimilation as puts by McDaniel, Elisbeth, Brenda and Michael (2005) and these are enumerated below:

i. progressive differentiation of concept and relations overtime.
ii. superordination of concepts under more general, more inclusive concepts
iii. subsumption of new concepts into existing, more general concepts and prepositions
iv. integrative reconciliation to achieve coherence and consistencies over time.

Considering the above highlights in the learning of vocabulary of science in general and those of biology in specifics, learning would be meaningful when the basics of a preposition (i.e 2 concepts) are understood and meaning of each is built into existing knowledge. The meaningfulness of each concept which makes the proposition would further enhance the incorporation into existing science vocabulary. This is such that when any whole part of the proposition is encountered at a more complex or advanced knowledge domain, a knowledge link would be established with what has been previously known about the concept and this would be carried into the new knowledge being formed.

The differences between rote learning and meaningful learning are lucidly presented in the illustrative diagram put forward by Damils, Braaf and Fourie (2013)



Damils, Braaf and Fourie (2013)

Social Constructivism Theory of Learning by Lev Vygotsky and Vocabulary Graphic Organiser

According to Davies and Smith (2017), social constructivism, is social learning theory propounded by Russian Psychologist Lev Vygotsky. The theory posited that individuals, during creation of their own knowledge, do so in an active mode (Schreiber & Valle, 2013). In other words, learners actively participated when constructing their own knowledge. It was further positioned that Vygotsky asserted that learning take place not solely within individual but in a social and cultural setting

Social interaction entails allowing students to relate and interrelate among one another and with materials being taught as well as with the school environment. On the basis of Vygotsky's theory of social interaction, students learn very well when ideas are shared among them and share their knowledge with their peers, thereby, learning from one another (Cole, John-Steineer, Scribner & Souberman, 1978; Vygotsky,1997). In other words of Ellison, Boykin, Tyler and Dellihunt (2005), it was posited that an added benefit in enhancing student's learning is that they show preference in learning through social interaction more than that of independent learning. This is because students are able to generate the idea and knowledge together in a community-like manner. In making recourse to Vygotsky on social interaction, Gunning (2000) as well as Wink and Putney (2002) corroborated the claim that students learn more when they socially interact than when they learn in an independent manner. In other words, social interaction creates a viable environment that is more conducive for students to learn together in a community-like manner.

Social constructivism is a theory of knowledge and learning which posits that all forms of knowledge are actively created by social interaction and relationships. In other words, social constructivists assert that knowledge is an outcome of collaborative construction in a social context and that learning is fostered through interactive processes of information sharing, negotiation and discussion (Richardson, 2003; Wang 2008). Word wall and Word map instructional strategies are based on social constructivism in that students form a social network of groups and generate together meaning, definition, examples with pictures of various terms and concepts which form the vocabulary of the classification of living things in biology.

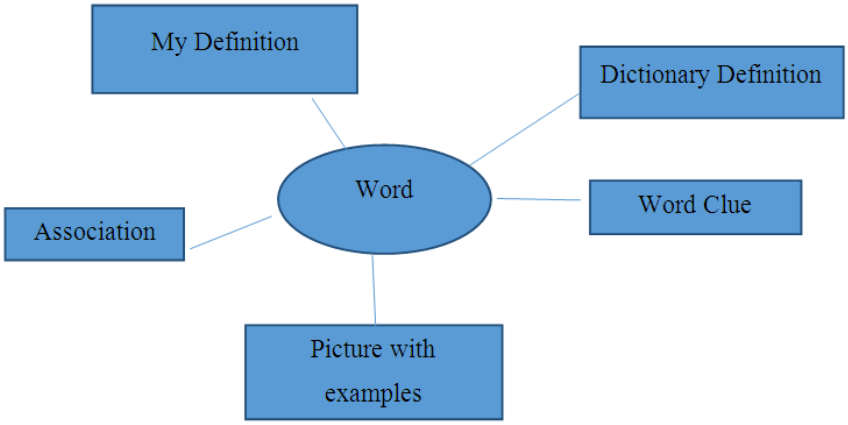
In the view of Vygotsky's (1978), "learning leads to development through the gradual internalization of intellectual process that are activated through social interaction". Vygotsky's (1978) theory views human developments as Socio-genetic process by which children gain master over cultural tools and signs in the course of interaction with their environments. Though Vygotsky (1978) stressed the individual's active role in development, the researches have shown that a child can always do more in collaboration than can do independently. Hence, this paper proposes the use of a vocabulary graphic organizer which create an interactive environment for students to generate meanings, provides association in pictures as well as examples for concepts and terms being learnt.

Teacher's Instructional Guide on Wordmap Vocabulary Graphic Organizer Strategy
A Model Lesson Note One
Main Topic : Classification of Living thing
Specific Topic: Classification and Naming
Behavioural Objectives: At the end of the lesson, the students should be able to:
i. define classification
ii. mention the correct arrangement of major groups used in classification
iii. classify some common living organism using the above classification arrangements
iv. explain binomial system of nomenclature with relevant examples
Instructional material: A printed chart showing pictures of illustration of classification system using continent (as a domain) and a person (as a specie)
Reference Material: Michael, M.C . (2015). Essentials Biology for Senior Secondary Schools. TONAD Publishers Limited. Ogun. Pgs 9-10
Entry Behaviour: The students are aware that there are different living things with different forms and types as well as the fact that they have unique features. For example, the students are aware that domestic dog is different from hen with features differentiating them from each other.
Presentation: The lesson is presented in the following steps
Step I
Teacher's activity: The teacher distributes the wordcards to be used to the students and explain its components
Student's activity: The students reproduce the template for the Wordmap on the provided wordcards showing all its components' features.
Step II:
Teacher's activity: The teacher introduces the lesson by defining classification and naming system
Students' activity: The students would engage one another in their assigned group and identify those terms and concepts that form the vocabulary of the unit taught during the teacher's introduction of the lesson. These are then written on the word cards provided for that purpose

Step III
The students then look up for the definition of the term "classification" and this is written in the box labelled "dictionary definition"
Students' activity ii:
The students are guided by the teacher at this stage to pay attention to the origin or root word of the term "classification"
Step IV
Students' activity i.:
The students brainstorm at the group level on several possible associations and write one of such suggestions in the box labelled "association"
Step V
The students are guided by the teachers to suggest picture(s) and examples that show the meaning of the term "classification". The pictures alongside with the examples would be in the box labelled "picture"
Step VI
Individual student would use their previous knowledge to guess the meaning of classification and write it in the box labelled "my definition"
Step VII
Step 8: Pairs of wordscards would be used to create vocabulary sets, one card each for classification and other vocabulary words mentioned during the unit lesson, and one card each for their corresponding definitions. Half of the class would be given vocabulary cards, and the other half, definition cards. The students would then take turns asking questions to find their vocabulary word of definition match
Summary: The teacher summarises the lesson for the students
Evaluation: The teacher asked the following questions from the students based on the earlier stated objectives:
i. What is classification?
ii. List in descending order the correct arrangement of major groups used in classification
iii. Use the above classification arrangement to classify some organisms
iii. With relevant examples, what is binomial nomenclature?

Extended Learning/ Assignment
The students are to identify other vocabulary terms and concepts during the lesson and present a complete vocabulary wordwap for each. These wordmap vocabulary graphic organizers would be kept by the students in a binder or a science portfolio

A Typical Wordmap Instructional Template



III. Conclusion and Recommendation

This paper, taking cognizance of the fact that students often interface with biology vocabularies in the their senior secondary 1 in the Nigeria Science Curriculum, advocates that the Word map vocabulary graphic organiser instructional strategy be adopted and integrated as an instructional strategy at this level of education. Thus, making biology students to be ownership of the concepts and terms which form the biology vocabularies. In specific and considering that classification concepts are found across almost all themes and topics in biology, hence, the need to enhance their meaningful understanding for advanced and subsequent encounter at higher order learning of concepts in biology. Resultantly, this would not only enable Nigeria nation parades pools of scientifically literate citizens but also those whose could contribute to solving arrays of societal cum health-related problems having meaningfully understood the terms and concepts that form the biology vocabularies. This is more so that the knowledge of biology is required to pursue life-saving careers such as medicine and nursing as well as agro-allied careers. Ahmad, Abubakar and Yau (2018) had posited that biology is a central focus in some human activities including being a solution to the problem of food scarcity, health, hygiene, family life, poverty eradication, management and conservation of natural resources, biotechnology, and by extension, sustainable of the required balance in ecosystem. Hence, meaningful understanding of the various terms and concepts that form the biology vocabularies is important so that biology students can pursue these life-saving careers and in turn enable them to contribute meaningfully to the attainment of global sustainable goals. Going forward, a model lesson note to enhance the integration of this strategy at this level of education is presented in this paper. This paper, strongly recommends a further study on the adoption and integration of wordmap vocabulary graphic organiser using the model lesson note at this level of education -senior secondary- as it has mainly been used in language at all levels of education and in basic elementary science classes with evidences of improved learning outcomes. In addition, a further study on the adoption and integration of this strategy for other concepts in biology is highly recommended.

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