Green Education Mobile Learning Assistive Booth (GEMLAB): A STEM-TVET Educators' Response to Sustainable Learning Environment Needs of Internally Displaced Persons (IDPs) and Nomadic Children in Nigeria

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Abstract

As a result of frequent insurgency activities in Nigeria, many persons are internally displaced from their homes, and many children are without access to conducive learning environments. This paper outlines some of the challenges being faced by the Internally Displaced Persons (IDPs) children and the Nomadic Herdsmen/Fishermen's children in Nigeria. As a STEM-TVET response to these challenges, the ***Greening TVET*** *group in ATBU Bauchi produced a "Green Education Mobile Learning Assistive Booth" (GEMLAB) that can help alleviate the suffering of these socially disadvantaged persons by bringing to their door steps accessible conducive learning assistive unit that is affordable and adaptable to their socio-cultural and economic predicaments. The paper also outlines some of the features, and value addition in producing this learning device (GEMLAB) as a model for solving learning problems among the socially disadvantaged groups in Nigeria, and recommends it mass production and usage among the affected groups and beyond in especially developing economies worldwide.*

Introduction

As the education industry globally continues to change with the paradigm shift from teacher centered to learner centered, a lot of new, dynamic and innovative learning strategies continue to evolve. Learning concepts such as Science, Technology, Engineering and Mathematics (STEM) or (STEAM), Maker Education Alliances (MEA), the Greening Technical Vocational Education and Training (GTVET) among others continue to emerge within the contemporary education paradigms. In Africa, although some of these concepts are not entirely new, but understanding their interconnectedness and applications in practice in the TVET classrooms for solving local, national or regional problems appear to be low. The need to explore the interplay between these emerging concepts and practices for possible transformation of TVET exists.

Contemporary Changes in Education

The rapid technological changes and increased complexity of today's world presents new challenges that put new demands on the education system globally. Generally there has been a growing awareness of the necessity to change and improve the preparation of students for productive functioning in the continually changing and highly demanding environment (Hampson, Patton and Shanks 2016). In confronting these challenges, TVET as a branch of education concertedly needs to put into consideration, the complexity of the education system as a whole, the kind of changes and challenges the system is being confronted with, which must be addressed. After reviewing a lot of documents, Yalams (2016), posited that, some of the changes noticed in the education industry in the last decade are considered as structural changes bordering majorly on the content, delivery methodology, assessment processes, learning approaches, the environment, and learning climates. These changes became more rapid and sophisticated in the digital/information era, the 21st Century. Thus, attention has now shifted from 'teacher-centered' to the 'learner-centered'. In formulating lesson objectives, the language has also changed from 'content specific' to 'performance or outcome-based'. The lesson delivery approaches and learning environments have diversified and modernized. With the advent of online/virtual learning platforms, teaching & learning no longer has to take place within the "four corners of a brick and mortar classroom" but does happen effectively outside as well. E-learning has revolutionized education and pulled down many barriers to learning such as geographical locations, class size, race or ethnic nationality, gender differences to learning etc. Vast array of learning devices now abound, ranging from the traditional Black Board to White Board and now to SMART Board, or even No Board (Digital Screens of mobile devices like computers, laptops, iPods, iPads, tablets, Smart Phones, Digital watches & clocks etc.). The assessment and evaluation approaches in education have also changed from knowledge or content-based assessments to authentic or performance-based assessments, and also from paper-and-pencil to Computer-Based Assessments. Product assessment mainly is fast giving way to both Process and Product (Competency-Based Assessment). In especially TVET, the delivery is fast changing from "Time-based Education and Training (TBET) to Competency-Based Education and Training (CBET), the awards for achievement are also changing to Local, National or Regional Vocational Qualifications. The era of long lectures, copying from textbook or teachers' old notes is also fast giving way to several other electronic or digital transfer methods. The traditional lecture or 'chalk and talk' methodologies are fast fading into contemporary Constructivist, interactive, PBL and other active learning approaches. Social media is now one of the platforms for learning than many physical classrooms. Virtual laboratories are almost taking the place of physical laboratories or workshops in some academic disciplines. Various forms of learning styles have emerged including Collaborative learning, Critical Thinking-based Learning, Problem-based Learning, Disciplinary/Interdisciplinary Learning, Discovery Learning, Systems Thinking-based Learning, and Multi-stakeholder Social Learning among others (UNESCO, 2014).

For one to be able to teach effectively using some of these learning approaches, he/she needs to acquire additional skills and competencies. Palmer (2015) has enumerated 15 different characteristics which every average 21st Century TVET teacher or Maker

Educator should possess, which include: Becoming a learner-centered teacher/maker educator, a lifelong learner, a brand new learner for the new technologies, a global-based thinking teacher, possessing the ability to use Smart Digital devices, and the ability to collaborate effectively with others, becoming a user of Social Media for educational purposes, a well networked member of digital learning communities, an innovator and a PBL compliant maker educator. Additionally, according to Hampson, Patton and Shanks (2016) all teachers in this category should have the ability to think outside the classroom box, get personal, tap into students' digital expertise, get involved and be real with projects, expect to give and get help from students to become good teachers/maker educators. They should also be good at measuring or assessing only what matters most; work with parents as well as their wards, and be sources of empowerment to the students among and not their sources of poverty and sorrows. Now it's very hard for all of us here to say with confidence that, we have met all these requirements? If so, then our jobs and the subject we teach (TVET) may be in dilemma, and under serious threats with changing demands of work place skills and competencies. This therefore, justifies the urgent call for transforming TVET system in Africa and indeed other countries of the world.

TVET in the Global Lenses (A Snap Short)

Globally, TVET appeared to have lost is glory in the past, but we are glad to note that, in recent past, a lot of things are fast changing, and these loses being regained through deliberate and vigorous transformative ideas and concerted efforts by many countries of the world. Some of the transformative toolkits being used include deliberate infusion and application of the 21st century teaching and learning approaches, such as the infusion of the concept of "Greening (GTVET)" as an aspect of education for sustainable development (ESD), the iSTEM, the Constructivists, the concept of Maker Spaces and maker education, the Engineering Design Processes, Scientific Enquiry methods, the PBL methodologies etc. in delivering content to the learners with the aim of addressing local, national and international problems. TVET as we all know, is concerned with the acquisition of knowledge and manipulative or employability skills for the world of work. Different countries name and practice it differently. In the U.S. for instance, TVET is known as Career and Technical Education (CTE), which is meant to prepare youths & adults for a wide range of high-wage, high-skill, and high demanding careers. In Germany and Australia, it is commonly called Vocational Education (VE), whereas in the UK it is referred to as Employability or Workplace Skills. In Nigeria, and indeed many African countries, TVET has many names and acronyms, ranging from Technology/Technical and Vocational Education (TVE), Industrial Technical Education (ITE), as well as Technical and Vocational Education and Training (TVET). Irrespective of all these, the major career clusters and trade areas in form of academic offerings in TVET include among others: Agricultural Education, Automobile Technology Education, Building Technology Education, Business Education, Electrical and Electronics Technology Education, Metal Work Technology Education, Woodwork Technology Education, Food and Home Economics Education. Often these technical areas are delivered as individual entities (silos) to learners, and not in an integrated form. Besides, the traditional way of learning TVET in contemporary Africa is predominantly teacher-

centered, often confined in a classroom or workshop/laboratory setting. Traditionally, the teaching and learning in such settings are often characterized with the "chalk and talk", 'lecture methods', and very often little 'practical exercises'. The assessment often time is 'paper and pencil' kind with heavy emphasis on the theoretical content, as against the practical or learner's competence. Most often projects assigned to students are teacher-designed or teacher-influenced. Related subjects such as Science, Technology, Engineering and Mathematics disciplines are implied or appended into the Technical contents and merely taught as discrete disciplines or separate standalone silos, not integrated and infused with the TVET contents. This approach has been widely criticized as not helping learners enough to develop problem-solving skills using the integrated knowledge gained, as it is the case in real world situations.

TVET and the Making of STEM/Maker Educators

In order for any country to develop, be responsive to its problems and needs, it must have a transformed, robust and sustainable TVET system as its major priorities (Reeves, 2014). In every part of the world today, TVET, Maker Educators and STEM professionals are needed to solve many of the world's problems, be they in any of the socio-economic areas as outlined in the UN's sustainable development goals (SDGs). For one reason, Maker/STEM education promotes hands-on problem solving and 21st century skills; it also promotes thinking about how the disciplines are interconnected, and how this connection impacts and shapes our lives. The integration of STEM education into TVET helps build students' interest and deepens their understanding of STEM career pathways by making mathematics and science more relevant in what they are doing in TVET. The integration also helps students grow the TVET-STEM workforce pipeline as it encourages and promotes invention and innovation through using the 21st Century learning skills inclusive of the 4Cs (i.e. Communication, Collaboration, Critical and Creative Thinking). The right and best way for transforming TVET system in Africa is therefore, to embrace, infuse and integrate TVET with STEM or maker education principles.

Some Challenges in Making the Maker Educators

Some of the challenges faced in preparing maker educators from TVET in Nigeria and indeed, many countries in Africa in the past has been the disconnection and the much crave for identity among the policy makers and stakeholders of these independent disciplines. In the past, each discipline prides on self, and strives to feature as the most prominent, most relevant or most accepted career, thus none of them was interested in identifying or compromising its fame with the other. Each strand of both the TVET and STEM disciplines were typically taught in Silos. Then, if one hears of terms like 'critical, creative and innovative thinking, or 'problem solving' etc. what flashes the mind first is certain disciplines such as the core Mathematics and the Sciences or Science Education. Seldom does it refer to Technology and Engineering Education disciplines. But the good news is that, these misconceptions have begun to change for the better in Africa. Integrated TVET- STEM/Maker (iTVET-STEMAKER) education is a more desired marriage of convenience for sustainable and entrepreneurial development of every

country that needs to move forward. The Project-Based Learning approach which aims at developing real-life learning experiences that enable students to explore real-world problems and challenges must be embraced and sustained in the teaching and learning with the 'iTVET-STEMAKER' integration for rapid development of Africa and indeed the world.

Greening TVET as a Maker Education Toolkit

Greening Technical Vocational Education and Training (GTVET) is an emerging concept emanating from UNESCO-UNEVOC as part of fulfillment of UN's decade for ESD. Majumdar (2010) describes it as "A way of thinking in a sustainable manner as it relates to acquiring, consuming and disposing of utilities, proactive actions aimed at improving human well-being and social equity while significantly reducing environmental risks and ecological scarcities."

The GTVET initiative focuses on transforming schools and campuses, changing societal attitudes, land spaces, people's culture and lifestyles towards becoming more environmentally friendly. Yalams (2016) expressed that, in the area of TVET, STEM and Maker Education, Greening Concept focuses on positively changing the direction and emphasis of TVET for the better. With GTVET, the emphasis is on waste management; renewable energy; environmental protection; community service programmes among others. According to Majumdar, (2010) Greening TVET has been introduced to play an important role in the transition to green growth and green societies; and to create a sustainable future. A green economy therefore, requires a workforce with the appropriate skills and training, but at present, skills development is lagging behind the needs of the labour market especially for the emerging sectors as renewable energy, energy efficiency, waste management etc. GTVET therefore contributes in closing these skills gap with respect to decent work and social welfare, thus it is termed as a 'toolkit' for producing sustainable educators, makers, STEM professionals and all that would help salvage the observed problems not just in Africa but all over the world.

As part of the global transformation of TVET, the UNESCO-UNEVOC has outlined a five-level framework for greening TVET as follows:

1. Greening the TVET Campuses: This is concerned with managing of the campus resources, technology deployment, environmental monitoring and others, to reduce the carbon footprint of such an institution.

2. Greening the TVET Curriculum: This refers to promoting sustainable development via the use of cleaner technology, defining green learning outcomes, integrating ESD across the curriculum, teacher professional development among others.

3. Greening the TVET Communities: Simply refers to adapting the wider communities for capacity-building, renewable technology adoption, resource support, unique practices and other means. In this case, the institution has a role to interface with the communities to interchange greening measures.

4. Green the TVET Research: This concerns fostering research activities for instance on renewable energy, water treatment, waste recycling, green construction, transportation, agriculture, health & medical areas, ICT, manufacturing and green innovations.

5. Greening the Culture: Refers to promoting the people's culture via inculcating green values, green attitudes, green ethics, green practices etc. into the communities. In whatever they do, let greening/sustainability issues become part of the system.

By doing so we will be able to build a robust green Africa, and green our world, which will be sustainable and environmentally friendly. This campaign has gone very far in developed countries like Germany, US, Australia etc. Some developing nations too are picking up, whereas, many including my country, Nigeria is just beginning to understand and implement. In Nigeria, for instance, a number of activities have recently evolved in many of our campuses in especially the areas of TVET research. It may interest you to note that, after the formal inauguration of the World Maker Education Alliance (WMEA) in Beijing, China in 2015, the Maker Education Alliance Nigeria (MEAN) was formally inaugurated in October 2017. Before then, in ATBU Bauchi, Nigeria, our own University, the Greening TVET and STEM/Maker education outreach had since been introduced to students in some of the faculties. As such, at the appropriate time, owing to the persistent insurgencies in especially the North Eastern part of Nigeria, (being the epic-centre of Boko Haram), and the recent Farmers/Fulani herdsmen clashes in some parts of the country, where many lives and property have been destroyed, and school children left without parents and proper schooling, it became necessary therefore, for public and world attention to be drawn to that direction. The TVET students in my class therefore, having been introduced to STEM, GTVET, PBL and constructivists approaches to learning, were challenged and provoked into designing a solution to the problems being encountered by children of the internally displaced persons and Nomadic Fulani children's lack of conducive environment for learning, as they migrate from one place to the other looking for greener pasture for their animals. The outcome of series of brain storming of the students gave birth to the idea called "GEMLAB."

What and Why GEMLAB?

GEMLAB is an acronym for "Green Education Mobile Learning Assistive Booth." The entire unit is powered by a renewable and sustainable energy source, (solar panel) and not fossil fuel such as a generator, electricity from the national grid or burning of wood that can pollute and degrade the environment and add to climate change and global warming. The unit is aimed at bringing education and learning to the doorsteps of socially disadvantaged persons in our communities (IDPs and the Nomadic Children) who ordinarily would not get this privilege under their current socio-economic and cultural predicaments to effectively learn, either during the day time, at night or both.

Why 'Mobile' in the Learning Unit?

As an assistive learning device, GEMLAB is easily collapsible, moveable, portable, mobile and transferable. It can be easily packed in a carrying container and be mounted on a motorbike, an ox-driven cart, a bull or a donkey, and be moved from one learning

location to the other as desired. It is an assistive learning booth because, the entire learning unit is housed in a booth or canopy designed with provisions for good ventilation, adequate lighting, spacious room, quipped with **Green Learning Box (GLB),** that powers laptops, a multimedia projector, a fan and other related computer peripherals such as for a printer, USB charging ports, among many others digital devices.

Objectives of the GEMLAB

The GEMLAB was built among other objectives to:

1. Bring education and learning to the doorsteps of the disadvantaged persons such as the IDPs and Nomadic children.

2. Bridge the generational learning gap created by insurgencies, thereby ensuring that "no child is left behind" educationally irrespective of their socio-cultural and economic predicaments.

3. Help reduce illiteracy and alleviate children's learning difficulties as they seek for safety or greener pastures moving from one location to the other without schooling.

4. Reduce barriers to learning, and ensure social inclusiveness and equality in the provision of learning environments for all.

5. Help enhance the understanding of the concepts of GTVET, waste management and STEM/Maker education practices in solving problems.

Main Features of GEMLAB

1. The illuminated display board and desk permit for teaching and learning both in the day and at night without seeking for additional light.

2. The unit is sheltered by an all-weather resilient structured canopy, designed with adequate lighting, and provisions for cross-ventilation and anti-distraction during lessons.

3. It is mounted with surveillance devices that can monitor/detect suspected intruders remotely monitored from a distance.

4. The project is fabricated using substantially waste/recycled materials, thereby converting waste to wealth and protecting the environment from pollution.

5. It has an in-built or pre-installed "Green Learning Box" (GLB) for powering a laptop, multimedia projector, a fan, and other computer related peripherals.

6. It has provision for hanging/holding a flipchart for display during lesson.

7. The display board can be used as a white board as well as a projector screen.

8. All the component parts are very easy to dismantle and be re-assembled without any specialized tool or much stress.

9. Because of its portability, the entire unit could easily be dismantled, packaged and be mounted on any means of carrying load to be moved from one learning location to the other.

Lessons Learnt

As a learning device the following lessons could be derived from this project:

1. The idea of using solar energy, other than other forms of energy that could be detrimental to our environment and health, to power the unit makes it green, renewable and sustainable.

2. The technological skills and competence involved in the selection and use of mechanical tools, machines and equipment to build a project that can solve authentic national problems as found in this project is laudable in TVET.

3. The engineering design processes applied in designing and fabricating of the various components of the unit is yet another landmark achievement of the project.

4. Getting the symmetry, balance, and the precision involved in fabricating the units, was made possible through the application of the mathematical knowledge and abilities of the team, without which there could have been a lot of technical errors.

5. The acquisition of problem-solving techniques, skills and abilities learnt and applied by the students in identifying and understanding first, the actual problem and how best it could be tackled, is an achievement worth noting.

6. Critical thinking abilities, as part of the 21st century skills, employed by the learners in dealing with project of this nature is commendable, as the learners needed to do a lot of brainstorming to conceptualize an idea of this nature.

7. The spirit of teamwork and group dynamics stood out very clearly, as the students were always engaged and played various significant roles.

8. The understanding and application of the PBL approach, the knowledge of STEM/Maker education concepts and Greening TVET helped learners in proffering solution to a real life in this project.

9. The understanding of the concept, and implications of environmental sustainability, GTVET, waste management becomes clearer to learners when, and if, taken through a project like the GEMLAB in the school. This approach achieved that.

Prospects of the GEMLAB Model

1. The use of the GEMLAB is not limited to typical school settings or learning centers only. Complete units could be purchased by government and used in all the IDP centers, Nomadic schools, or grazing reserves in all countries that are interested.

2. Complete units of this project could be purchased by families and used in homes for individualized instructions or 'extra-lessons/coaching of their wards.

3. With further research and modifications, GEMLAB could be transformed into a Hi-breed SMART/Interactive Board for use in rural schools/localities where lack of electricity and learning support devices are so much a problem.

4. The unit has high potential for advancing education, thus, could be mass-produced for use not only in Nigeria, but worldwide, wherever socially disadvantaged persons such as Refugees, IDPs, and Nomadic Children are found, and in need of these learning assistive device.

5. The military and paramilitary formations, private organizations, faith-based organizations, NGOs etc. will find this project relevant and unique for their mobile training needs, as they move or camp from one location to the other.

Some Challenges Faced

Some of the challenges encountered in fabricating this model include:

1. Lack of suitable materials such as aluminum tubing of varying sections required, that would have been used to reduce the overall weight of the unit.

2. The initial problem of ideation by the students, this being their first approach to this kind of problem-based learning, was initially a problem. However, this was overcome through practice, confidence building and facilitation by the project coordinator.

Conclusion

A lot of changes have taken place and they continue to do so in the education industry with serious implications to the viability and survival of TVET system in Africa. As 21st century TVET practitioners, if we must continue to be relevant, we have to properly understand some of these changes and build resilience to challenges inherent. TVET as the master key to sustainable development, must therefore strive to produce more makers and STEM/STEAM educators who will be problem-solving, that would transform the culture, the mind-set and disposition of our societies, our institutions and communities for our common good. The current approaches to delivering TVET system in most countries in Africa have been criticized for being deficient in preparing learners for problem-solving and sustainable development. Therefore, training our young ones in this generation with olden tools and archived methodologies will not give us the desired results. No problems will be solved by the products of our education if problem solving skills and techniques are not enshrined in our curriculum and delivered to the learners at all levels of education in Africa. Let me therefore, humbly call upon all TVET stakeholders here seated to put our hands on deck and ensure that meaningful and sustainable development of our countries, and our continent Africa is achieved. The **P**eople, the **E**conomy and the **E**nvironment are all very essential; as such must **ALL** be protected in the process of education. As we conference, let us remember the theme again '**Promoting, Designing and Making in STEM Field and Vocational Education and Training to Produce 'Makers' for Sustainable Skills Development.'** May we all see the need to, and try to transform TVET and Technology Education into a more sustainable one in Africa. This we could possibly start by changing the way TVET is practiced, its objectives, structure, delivery approach, assessment techniques, and above all our perceptions, culture, personal attitudes and practices towards it. If TVET does not address sustainability issues, the world will be in trouble. The more unsustainable our educational systems are, the more problems we are bound to face. The need therefore, for us to emphasis on **GREENING TVET** for sustainability and development of our environments become more eminent now than ever. If we think education is "expensive", or "TVET is very costly," We in this regard will not advice us to **"try ignorance".** Because doing so will suggest opting for more **youths unemployment, increased social vices, gross illiteracy, skills mismatch etc. in Africa**. But all that is needed is to transform TVET though injecting, infusing or integrating contemporary learning approaches and methodologies into the current practices, and to support it financially, thereby making it more problem solving and sustainable. At this juncture, we therefore, wish to call on all of us here, **TO GO GREEN AND GO THE GEMLAB WAY,** we will rejoice we did.

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