
Unizik Journal of Educational Laws and Leadership Studies (**UNILAWS)**
VOL.1 (1), January-April, 2025; **https://unilaws.org/unilaws**

EFFECTIVE INTEGRATION OF STEM EDUCATION IN THE MANAGEMENT OF SECONDARY SCHOOLS FOR SUSTAINABLE DEVELOPMENT IN ANAMBRA STATE

Manafa Ifeyinwa F. (Ph. D)
ifeyinwamanafa@gmail.com
Faculty Of Education
Department Of Education Foundations
Chukwuemeka Odumegwu Ojukwu University, Igbariam**.**

ABSTRACT

The study was carried out to investigate effective integration of STEM education in the management of secondary schools for sustainable development in Anambra state. Three research questions guided the study. Descriptive survey design was adopted. The population consist of all the 263 principals and 2054 science teachers in public secondary schools in Anambra state. Simple random sampling technique was used to select 80 principals and 240 science teachers, totaling 320 respondents from four education zones. A self-structured instrument titled ''Integration of STEM Education in School Management Questionnaire'' (ISTEMESMQ) was used for data collection. Reliability of the instrument was conducted to check the internal consistency using Cronbach alpha and yielded an index of 0.85. 281 copies of questionnaire were returned, being 87% return rate. Data collected were analyzed using mean and standard deviation to answer the research questions, while the hypothesis was tested using z-test statistics at 0.05 level of significance. A mean of 2.50 and above was accepted while any mean less than 2.50 was rejected. The result of the findings revealed that STEM education is not effectively integrated in secondary school management for sustainable development. It also revealed that inadequate provision of ICT, funding and poor motivation of STEM teachers are some challenges that hinder effective integration of STEM education in schools. It was recommended that provision of adequate fund and effective digitalization of schools among others are necessary to accomplish effective integration of STEM education in schools.

Keywords: Effective, Integration, STEM, Education, Sustainable Development, Management**.**

Introduction

Education as the transmission of what in worthwhile from the teacher or the person that knows it to the learner has been in existence in Nigeria from the time of our fore-fathers Before the whites in Nigeria, northern part of Nigeria was practicing Islamic education while the southern part of Nigeria was practicing traditional education. Traditional education is the type of education where parents and adult in the community were the teachers while their children were the students. Children were trained and brought up along the line of the family profession or occupation. Those children that were good at skilled work will go for apprenticeship. This type of education was very effective then, as those children were skilled and well trained in their profession and that made

them self-sustainable. This was noted by Mkpa (2012) when he stated that this type of education was revealed to be comprehensive and helped in developing social, physical, cultural, and intellectual abilities in children. This was the beginning of STEM education in Nigeria, it was later refined and reshaped when the whites came into Nigeria and introduced formal education with education ordinances to formalize the education. There were about four education ordinances and other education commissions that were later developed into National Policy on Education.

Federal Republic of Nigeria (2013) stated that there are different levels of education in Nigeria, which are primary, secondary, and tertiary education. STEM education which stands for Science, Technology, Engineering and Mathematics education cuts across all these levels. Tsupros (2009) sees STEM education as an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering and mathematics in context that make connections between school, community, work and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy. Brown, Brown, Reardon and Merrill (2011) defined STEM education as a standard-based, meta-discipline residing at the school level where all teachers, especially science, technology, engineering and mathematics (STEM) teachers, teach an integrated approach to teaching and learning, where discipline-specific content is not divided, but addressed and treated as one study. From the above definitions, STEM education is the study of Science, Technology, Engineering and Mathematics in a rigorous way with both digital and physical practical lessons that are carried out mainly in laboratory to enable the students face both technological changes and 21st century challenges.

STEM education aims at effective teaching of STEM subjects in all the levels of education as it is seen as the pathway for our children to succeed in the new Information based and technology-driven global society. In primary education, the curriculum contains the introductory part of basic sciences which gives the students basic literacy of science and prepares them for the higher aspect of science in secondary school. Secondary education has junior and senior secondary, in junior secondary, students do higher aspect of science education which is compulsory and it leads them to natural sciences in senior secondary education, this is where they choose subjects and those that are into science subjects (STEM education) are exposed to rigorous practical classes in laboratories where problems are explored and solutions preferred. This was emphasized by Okeke and Chinwe (2006) when they noted that all learning in STEM education must start and end in laboratory as many practical activities that will help students handle issues are involved. Apart from practical classes, STEM education as an integration of many disciplines with their differences and similarities needs good approach to teaching and learning that should be done through collaboration of the teachers concerned.

Research collaboration increases connectivity and communication among teachers. Hence, there should be encouragement of research collaboration activities among teachers. This helps in tackling the problems in STEM education as it calls for professionals coming together to either

discuss on progressive issues on STEM or solve any envisaged problem. Also, the introduction of Information and Communication Technology (ICT)) in schools makes students practice technology effectively in other to make their prowess pronounced and help them with relevant skills, like, critical thinking. It will also make students to have their mind-set on growth and inquisitiveness which improves their innovation practices and prepares them for the challenges of the 21st century. Oni (2012) agreed on this when he emphasized that in this technology driven age, everyone requires ICT competence to succeed.

Digitalization of Nigeria education is very important as it is a big factor that will make STEM education effective. Voogt and Robin (2012) recognized this when they stated that there is need for STEM education in the 21stcentury because the job market requires a new set of skills and there is need for intensification of effort on technological skills. This makes STEM education vital for improved economic development. It proved the emphasis of (African American Institute 2015) when they stated that STEM education is vital for improved economic development manifested in international competitiveness and job creation. This indicates that effective integration of STEM education in management of schools motivates and encourages STEM education teachers, gives students a lot of job opportunities outside the school and promotes sustainable development.

Sustainable development in education is an approach to education that aims to re-orient the learning experience and the capabilities people develop, so that they can act in support of more sustainable ways of life (Ebosie and Amuta 2018). For the purpose of this study, sustainable development in education is the use of established pedagogical approaches such as learning to re-define and re-direct individuals to enable them meet with the global innovation and improve their quality of life. This is exactly what STEM education does in the lives of students. It makes students to provide solutions to local and global problems, be globally competitive, creating opportunities for them and makes the nation technologically relevant. This was noted by Kehdinga (2019) when he stated that STEM education is a necessity for growth and development in any country as well as her educational system because the future of the country lies in the knowledge of STEM. This is so because STEM education students when effectively taught can easily fix themselves technologically or scientifically in the society without waiting to be employed.

STEM education is supposed to be very effective in secondary education in Nigeria as secondary education is the bedrock of education and the education children receive after primary education and before tertiary education, Federal Republic of Nigeria (2013). This is the stage where students' talents are sharpened and prepared to face the 21st century challenges. With STEM education effectively integrated in the management of secondary schools, students that are science inclined will be drilled in STEM subjects which will see them aiming higher to become high profile technologists, doctors, engineers and scientist that define the country's economy and compete with their counterparts globally.

For effective integration of STEM education in the management of secondary schools, principals and the concerned teachers who are the major implementers of education policies must be well-trained to enhance technological education. This is because the success of integrating STEM education in secondary schools lies with the school principals and the concerned teachers. As education management is the act of planning, coordinating, controlling, organizing and evaluating both human and material resources for the achievement of school goals, principals as the school managers carryout these functions for the effective integration of STEM education in schools. They should work with the STEM teachers, motivate them and always organize periodic training and seminars for them for deep content knowledge and mastery of STEM pedagogy. This was emphasized by Kehdinga (2019) when he noted that professional development workshops and seminars should be organized for STEM teachers to keep them abreast with change in education sector. Principals should also supervise and monitor STEM education activities both classroom and practical activities in their schools in other to get feedback from the subject teachers and students. Principals in a bid to manage STEM education effectively should again engage the services of trained educators that will help teachers in the technological and computing aspect of STEM education. Principals should also write to the ministry of education for more qualified teachers in STEM education as quality and adequate teachers are needed for its effective integration.

In schools, any education policy that is not backed up with quality and adequate teachers is destined to fail as no nation can rise without good caliber of teachers. Despite these efforts by the school managers, effective integration of STEM education in secondary schools seems not to be achieved. Ejiwale (2013) stated that there is loss of interest in STEM discipline by students who would have become future scientists, engineers and technologies. This could be as a result of the extent STEM education is effectively integrated in the management of secondary schools for sustainable development. This is the crux of this study.

Statement of problem

STEM education as an education that equips students with skills to solve tough problems, gather and evaluate evidence. It is needed highly in Anambra state secondary schools for the students to be reflective, independent, responsible learners and self-sustainable considering the challenges of 21st century. Reports have shown that some STEM education students do not performance well in external examinations like: West African Examination Council (WAEC), National Examination Council (NECO), National Business and Technical Examination Board (NABTEB) and Joint Admission and Matriculation Board (JAMB). This could be as a result of ineffective integration of STEM education in secondary schools. This may equally affect the realization of STEM education goal which is to provide students with the best-rounded education in order to prepare them for the challenges of the 21st century. The problem of this study put in question form therefore is: To what extent is STEM education effectively integrated in management of secondary schools in Anambra state?

Purpose of the study

The main purpose of the study is to investigate on the effective integration of STEM education in the management of secondary schools for sustainable development in Anambra state. Specially, the study sought to:

(1) Assess the extent STEM education is effectively integrated in the management of secondary schools for sustainable development in Anambra State.
(2) Identify the challenges that hinder the effective integration of STEM education in the management of secondary school for sustainable development in Anambra state.
(3) Suggest measures for effective integration of STEM education in the management of secondary schools for sustainable development in Anambra state.

Research questions

The following research questions guided the study.

(1) To what extent is STEM education effectively integrated in the management of secondary schools for sustainable development in Anambra State?
(2) What are the challenges that hinder the effective integration of STEM education in management of secondary schools for sustainable development in Anambra state?
(3) What are measures for effective integration of STEM education in the management of secondary schools for sustainable development in Anambra state?

Methodology

Descriptive survey design was adopted for the study. Descriptive survey design according to Nworgu (2015) is a study which aims at collecting data on, describing and assessing in a systematic manner the characteristics, features or facts about a given population. The study was carried out in secondary schools in Anambra State. There are six education zones in Anambra State, which are: Aguata, Awka, Nnewi, Ogidi, Onitsha and Otuocha. The population of this study comprised 263 principals and 2,054 science teachers in 263 secondary schools in Anambra state. Multistage sampling technique was used to select 320 respondents for the study. Simple random sampling technique was used to select four education zones which are – Onitsha, Nnewi, Aguata and Ogidi. Again, simple random sampling technique was used to select 20 secondary schools from each education zone which is 80 principals while simple random sampling technique (balloting) was used to select 3 science teachers from each of the 80 secondary schools, making it 240 science teachers. The instrument for data collection was a self-structured questionnaire titled "Integration of STEM Education in School Management Questionnaire" (ISTEMESMQ). The questionnaire has 2 sections, section A and B. Section A solicited information on the personal data of the respondents while section B elicited information on the 3 research questions. Each item of the questionnaire has a four-point rating scale thus: Very High Extent (VHE)/Strongly Agree (SD) = 4point, High Extent (HE)/Agree (A) = 3 points, Low Extent (LE)/Disagree (D) = 2 points and Very Low Extent (VLE)/Strongly Disagree (SD) = 1 point. The instrument was validated by three experts, two from Educational Management unit and one from Measurement and Evaluation unit, all from Faculty of Education in Chukwuemeka Odumegwu Ojukwu

University, Igbariam. Their recommendations were used for the final correction of the instrument. The reliability of the instrument was carried out using 5 principals and 15 teachers in Enugu state which is outside the area of the study. Cronbach alpha method was used in establishing the internal consistency of the instrument, which yielded an index of 0.80 and was considered high enough to justify the use of the instrument for data collection. The researcher administered the instrument with the help of four research assistants who were instructed on how to administer and retrieve the instrument. The return rate percentage of the instrument was 87% which was 281 copies.

Research questions were answered using mean and standard deviation. In order to interpret the result of the research question, a mean value of 2.50 was calculated as a limiting value. Therefore, any mean value of 2.50 and above was regarded as high extent or accepted while a mean of less than 2.50 was regarded as low extent or rejected.

Result

Table 1: Mean scores and standard deviation of principals and teachers on the extent of effective integration of STEM education in the management of secondary schools for sustainable development in Anambra State.

No = 281 (Principals – 80; Teachers – 201)

S/N	Extent of effective integration of STEM Education in secondary schools in Anambra State	Principals		Teachers		Decision
		X	SD	X	SD	
1	There is provision of digital laboratories for practical lessons	2.23	0.97	2.16	0.99	LE
2	Adequate provision and maintenance of ICT facilities.	2.17	0. 81	1.75	0.95	LE
3	There are adequate qualified STEM teachers in schools	2.04	0.88	2.39	0.87	LE
4	Online resources are provided for STEM teachers in a computer room	1.65	0.79	1.98	0.99	LE
5	Provision of internet connectivity for STEM teachers are adequate	1.70	0.82	2.17	0.13	LE
6	Organizing periodic training for STEM teachers on the teaching methods of STEM education	2.45	1.06	2.23	1.02	LE
7	Providing adequate physical laboratories for STEM subjects	2.41	0.76	2.45	0.88	LE
8	STEM club is encouraged in secondary schools	2.01	0.91	1.95	0.75	LE
9	Principals are exposed to adequate knowledge of STEM education	2.08	0.98	2.41	0.76	LE
10	There is encouragement of collaboration of STEM teachers.	1.88	0.85	2.33	0.91	LE
11	Memorization of factional knowledge in STEM class is encouraged in secondary schools	2.34	0.89	2.16	0.84	LE
	Cluster mean	2.08	0.89	2.16	0.84	LE

Analysis of the result in table 1 showed that all the items are rated below the acceptable mean score of 2.50 indicating low extent to all the items. From this analysis, the cluster mean of principals and teachers are 2.08 and 2.16 respectively showing that the respondents are of the opinion that effective integration of STEM education in management of secondary schools is to a low extent.

Table 2: Mean scores and standard deviation of principals and teachers on the challenges that hinder the effective integration of STEM education in the management of secondary schools for sustainable development in Anambra state.

N = 281 (Principals – 80; Teachers -201)

S/N	Challenges that hinder effective integration of STEM education.	Principals		Teachers		Decision
		X	SD	X	SD	
12	Inadequate provision of fund.	3.18	0.73	3.27	1.01	A
13	Inadequate teaching equipment.	3.58	0.59	3.42	0.50	A
14	Poor digitalization of Anambra secondary school.	3.50	0.60	3.33	0.85	A
15	Inadequate number of trained and qualified teachers.	3.20	1.01	3.18	1.07	A
16	Inadequate professional training and seminars for STEM teachers.	3.28	0.85	3.37	0.74	A
17	Poor motivation and rewarding of STEM education teachers.	3.59	0.67	3.33	0.78	A
18	No STEM innovation network in schools and creation of STEM awareness by school management.	2.86	1.08	3.48	0.51	A
19	Inadequate infrastructure for teaching STEM education.	3.04	1.12	3.62	0.70	A
20	Poor electricity supply.	3.07	1.03	3.11	0.80	A
21	Over population of students in schools.	3.32	0.78	2.70	0.99	A
22	Poor conditions of secondary school laboratories and libraries.	3.26	1.01	3.26	0.66	A
	Cluster Mean	**3.26**	**0.86**	**3.28**	**0.78**	**A**

Table 2 above shows the results presentation of the challenges that hinder the effective integration of STEM education in management of secondary schools for sustainable development in Anambra state. The principals and teachers have grand mean of 3.26 and 3.28 respectively and average standard deviation of 0.86 and 0.78 respectively. Thus, the respondents were of the opinion that the above items are challenges that hinder effective integration of STEM education in secondary school management for sustainable development in Anambra State.

Table 3: Mean ratings and standard deviation of principals and teachers on the measures for effective integration of STEM education in the management of secondary schools for sustainable development.

No = 281 (Principals - 80; Teachers – 201)

S/N	What are the measures for effective integration of STEM education	Principals		Teachers		Decision
		X	SD	X	SD	
23	Adequate provision of fund.	2.91	0.81	2.88	0.90	A
24	Provision of adequate and working ICT facilities for effective digitalization of Anambra secondary schools	3.03	0.88	2.97	0.87	A
25	Motivation and rewarding of STEM teachers	3.33	0.75	3.50	0.50	A
26	Organizing periodic professional training, seminars and workshops for STEM education teachers	2.83	0.97	3.33	0.76	A
27	Employment of adequate and skilled STEM education teachers.	3.00	0.92	3.32	0.66	A
28	Admission of adequate number of students to avoid over population	2.74	0.86	2.79	0.98	A
29	Adequate provision and maintenance of infrastructure in schools.	3.51	0.50	2.97	0.92	A
30	Provision of STEM innovation network in schools and creation of STEM awareness by school authorities	3.34	0.67	2.97	0.92	A
	Cluster Mean	**3.09**	**0.80**	**3.07**	**0.81**	**A**

Table 3 above shows the results presentation of the measures for effective integration of STEM education in the management of secondary schools for sustainable development in Anambra state. The principals and teachers agreed on the items on table 3. The principals and teachers have grand mean of 3.09 and 3.07 respectively and average standard deviation of 0.80 and 0.81 respectively. Thus, the respondents' opinions were similar.

Discussion of Findings

The major findings of this study revealed that STEM education is not effectively integrated in the management of secondary schools in Anambra state, this from the study is as a result of some challenges which if well tacked will yield a positive result and improves students' involvement in STEM education, improves students' innovation practices and prepares them for the challenges of the 21st century. STEM education not being effectively integrated in the management of secondary schools was discovered in table 1 where principals and teachers had cluster mean of 2.08 and 2.16 respectively.

Table 1 revealed that there is poor provision of digital laboratories for practical lessons, inadequate provision and maintenance of ICT facilities, inadequate qualified STEM teachers, and inadequate provision of internet connectivity for STEM teachers. The study also discovered that training for STEM teachers on the teaching methods was to a low extent, STEM club is not functional in some secondary schools, and some principals are not exposed to adequate

knowledge of STEM education. It further revealed that most STEM teachers are not encouraged to practice research collaboration activities and no adequate physical laboratories. This finding collaborates with the view of Ajewale (1997) who emphasized that memorization of factual knowledge with the teacher as an informer and controller of the learning process is one of the major factors opposing effective science teaching and learning in Nigeria. The finding also agrees with Umoh who opined that teachers must be ready to create or provide situations where students can learn effectively and by themselves. In a situation where the STEM education is not effectively integrated as seen in table 1, it indicates that students cannot perform well in these STEM subjects in external examinations which might affect their future ways of handling innovations especially in this 21st century. This shows that it will be difficult to achieve the aims and objectives of STEM education in relation to sustainable development.

Evidence from the analysis in table 2 on the challenges that hinder effective integration of STEM education in the management of secondary schools for sustainable development reveal the challenges as: inadequate provision of fund, inadequate teaching equipment's, poor digitalization of secondary schools, inadequate number of qualified teachers, inadequate professional training and seminars for STEM teachers, poor motivation and rewarding of STEM teachers. Inadequate provision of fund poses a very big challenge to effective integration of STEM education; this is because no project or program can be carried out effectively without adequate funding. The finding of inadequate fund agrees with the submission of Ejiwale (2013) who noted that the present economic situation that has necessitated cutting funds needed to support educational activities makes it very easy for the school system to truncate the need for STEM program. This finding is also in line with the opinion of Kehdinga (2019) who emphasized that STEM education requires much financial input and situation where the finances have been mismanaged as a result of selfish interest of people, STEM education is affected.

The study further revealed inadequate qualified teachers as one of the challenges that hinder effective integration of STEM education in secondary schools. The finding also agrees with Umoh (2016) who observed that dearth of teachers makes a single teacher handle virtually all the students for that particular subject in the school and this makes teachers worked up each day and cannot be effective. This problem of inadequate qualified teachers makes them to resort to normal classroom teaching instead of using rigorous practical lesson, demonstration and excursion for effective teaching of STEM education. The challenges also include no STEM innovation network in schools, inadequate infrastructure for teaching STEM education, poor electricity supply, over population of students in schools and poor conditions of secondary school laboratories and libraries. This agrees with the finding of Mgbono (2013) who stated that there is inadequate teaching equipment that will facilitate effective STEM teaching and learning. Umoh (2016) further stated that due to overcrowded condition of the classes coupled with the absence of laboratory support staff, teachers in majority of cases carry out practical classes only two or three weeks to external examinations. It is therefore, obvious that STEM education has a lot challenges that affects its effective integration in the management of secondary schools for sustainable

development. This invariably impedes the attainment of sustainable development in secondary schools.

Finally, the findings of research question three under table 3 revealed the measures for effective integration of STEM education in the management of secondary schools as: adequate provision of fund, provision of adequate and working ICT facilities, motivation and rewarding of STEM teachers, organizing periodic professional training, seminars and workshops for STEM teachers, employment of adequate and skilled STEM education teachers, admission of adequate number of students to avoid over population, adequate provision and maintenance of school infrastructure and provision of STEM innovation network in schools. This finding is in agreement with Kehdinga (2019) who stated that professional development workshops and seminars should be organized for STEM teachers to keep them abreast with change in education sector. Ejiwale (2013), corroborated that there is need for in-service and outreach courses to help the efficiency and the performance of both in-service and veteran teachers in the classrooms. He also noted that professional development should be encouraged and continue to train teachers in effective classroom management so as to update their knowledge in the modern trend of teaching STEM education and to apply all they have learnt for effective teaching of students. The finding of adequate funding agrees with the view of Umoh (2016) who maintained that government should increase the level of funding of these schools so that more innovations in STEM education may be enhanced. The finding also concurs with the opinion of Umoh who noted that there should be greater and enhanced incentive by way of science or hazard allowances for all STEM teachers. Christine et-al (2015) also agreed that school authorities should build career awareness from primary school awards by exposing children to role models like professionals, scientists, engineers and technologists. This shows that government and school authority should organize periodic career day on STEM education indicating its benefits early enough so as to motivate student's interest to study STEM education.

Conclusion

STEM education is education that will help our students develop critical thinking, creative skill, analytical skills and cue into the world of technological advancement. This makes STEM education important in other to attain sustainable development. However, the study revealed that STEM education is not effectively integrated in the management of secondary schools for sustainable development which is because of some challenges that hinder it. When the measures noted in this study are applied, it will go a long way in improving effective integration of STEM education in secondary schools. With this, sustainable development will be achieved.

Recommendations

Consequent upon the findings of this study, it is recommended as follows:

1. Principal should be organizing periodic seminar and conference for teachers on STEM program so as to foster good STEM learning experiences and expertise in their schools.
2. Adequate fund should be provided in secondary schools by the government for the procurement and maintenance of facilities and equipment. It will also help in facilitating professional development and trainings of concerned teachers.
3. School principals should make adequate provision of electricity in their schools to avoid any impediment on the usage of ICT facilities and digitalized laboratory.

REFERENCES

African American institute (2015).State of education in Africa Report 2015.*www.aaionline.org(wp-content/uploads/2015/09/AASOE-report-2015-final.pdf.*

Ajewale J. A. (1997). Innovation in Biology; Adopting innovations strategies for improving the teaching/learning of Biology. *4th Anniversary of Science Teachers Association of Nigeria.* Proceedings of A. J. JUMOGOBIA STAN conference Pp 135-136.

Brown R., Brown J, Reardon K & Merrill C (2011). Understanding STEM current perception. *Technology and Engineering Teacher. 70 (6) 5-9.*

Christine, A et al (2015). The Nigeria child, science and technology education; current challenges and possible solution. *International journal of education learning and development (4C.),68-76.*

Ebosie F. N & Amuta O .F. (2018). Education for the attainment of sustainable development goals: focus on university education. *Nigeria journal of educational leadership and management. Vol 2 (1) . pp 206-212*

Ejiwale J. A. (2013). Barriers to successful implementation of STEM education. *Journal of Education and learning. Vol 7 (2) pp 63-74.*

Federal Republic of Nigeria (2013). National policy on Education. 6th edition. Lagos: NERDC Press.

Kehdinga G. F. (2019). Teaching STEM education in Nigeria: Challenges and recommendations. *International journal of mechanical Engineering and Technology. Vol 10 (12) pp85-93*

Mgbono T. (2013). Empowerment of science, technology and Mathematics (STM) trs : A strategy for the realization of the Millennium Development Goals, *proceedings of the 54th Annual conference of STAN pp 69-73.*

Nworgu B.G. (2015). *Educational Research. Basic Issues and Methodology*. Owerri: Wisdom Publishers.

Okeke, U.A & Chinwe E. N. (2006), Analysis of Human Resource for STM instruction in Awka education zone, Anambra state. *Proceedings of the 47th Annual conference of STAN, PP58-61*

Oni S. (2012). *Revitalizing Nigerian Education in digital age*. London: Trafford Publishing.

Tsupros, N. Kohler, R & Hallinen J. (2009). *STEM education: A project to identify the missing components.* Intermediate unit 1 and Carnegie Mellon, Pennsylvania.

Umoh S. W. (2016). Problems and prospects of effective Science, Technology, Engineering and Mathematics (STEM) education delivery in Nigeria. *Knowledge Review Vol. 35 No 1. Pp 1-5.*

Voogt J & Robin, N. P, (2012). A comparative analysis of international frameworks for 21st century competences: implications for national curriculum policies. *Journal of curriculum studies, 44 (33), 299-321.*