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Evaluating STEM Education in Nigeria: Secondary School Teachers' Perspectives from Imo State on Preparing Students for the Digital Era

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Abstract**-***This descriptive survey research investigates the perception of male and female secondary school teachers in Owerri Municipal, Imo State, Nigeria, regarding the effectiveness of the Nigerian curriculum in delivering quality STEM education and their preparedness to integrate technology into their teaching. The study populationconsistedof all310 seniorsecondary schoolteachers(78 males and 132females)inOwerri Municipal Council.Thestudyemployedthreeresearchquestionsandutilizeda15-itemquestionnairetitledTeachers' PerceptiontowardstheEffectivenessofSTEMEducationintheNigerianCurriculum"(TPESENC)fordata collection. The instrument's reliability was determined using Cronbach's Alpha, yielding a coefficient of 0.83. The findings revealed concerns among teachers regarding the curriculum's adequacy in covering essential STEM concepts, its relevance to students' needs, and the effectiveness of assessment methods. While teachers reported adequateaccesstotechnologicalresourcesandadministrativesupport,theyindicate alackofsufficient laboratory equipment. Encouragingly, teachers expressed confidence in their ability to integrate technology into theirteachingandbelievedinitspotentialtoenhancestudentengagementandlearningoutcomes.Basedonthese findings, the study recommends a comprehensive review and revision of the Nigerian STEMcurriculum to ensure alignment with 21st-century skills and the specific needsof Imo State students.*

Keywords::*DigitalAge,SecondarySchoolTeachers,Perception,Effectiveness,STEMEducation,NigerianCurriculum*

Introduction

Thereisnodenyingthesignificance ofSTEM educationinthedigitalage.STEMeducationisa significantpartofpreparingstudentsfor21st-century jobs which include mostly technology-oriented occupationswithinscience,technology,engineering, andmath's(Kozma,2020).Itiscrucial thatina digital age,educationemphasizesscienceeducationto acquirethenecessaryskillsandcompetenciesneeded foranevermorecomplexworldbeing shapedby technology(Harris*etal.,*2009).STEM education, whichencompassesscience,technology,engineering, andmathematics,hasbecomeacrucial aspectof moderneducation.Inthedigitalage,STEMeducation hastakencenterstage,asitisessentialforpreparing studentsforthedemandsofthe21stcentury(Kozma, 2020).Therapidadvancementoftechnologyhas createdaneedforindividualswhocanthinkcritically, solvecomplexproblems,andadapttonewsituations (Harris*etal.,*2009).STEMeducationisvitalinthe digitalagebecauseitenablesstudents todevelop skillsthatareessentialforsuccessinanincreasingly complexandtechnology-drivenworld(Mishra& Koehler,2020).ByintegratingSTEM subjectsinto the curriculum,studentscandevelopproblem-solving skills,criticalthinking,and creativity,whichare essentialforaddressingreal-worldproblemsand creatinginnovativesolutions (Koehler&Mishra, 2020).STEMeducationplaysavitalroleindeveloping 21st-centuryskills,whichareessentialforsuccessin themodernworkplace. STEMeducationhelps studentsdevelopcriticalthinkingandproblem-solving skills,whichareessentialforaddressingcomplex problemsandcreatinginnovatvesolutions(Harris*et al.,*2009).STEMeducation fosterscreativityand innovation,asstudentsare encouragedtothink outsidetheboxanddevelopnovelsolutionstoreal-worldproblems(Mishra& Koehler,2020).STEM education emphasizes the importance of communication and collaboration, as students work togethertodevelopsolutionstocomplexproblems (Koehler&Mishra,2020).STEMeducationhelps studentsdevelopdigitalliteracy,whichisessentialfor

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navigating the digital landscape and leveraging technology to improve learning outcomes (Kozma, 2020).STEMeducationpreparesstudentstoadaptto newsituationsandtechnologies,whichisessentialfor success in an increasingly complex and rapidly changing world (Harris *et al.,* 2009). One of the main reasons for adapting is that it makes students learn problem-solving,criticalthinking,andcreativitywhich are very necessary to solve day-to-day life problems (Mishra& Koehler, 2020). Further, STEM education also promotes the importance of digital literacy in a modernagewheremanyoftheyounggenerationwill work and learn effectively through technology (Koehler& Mishra, 2020). Additionally, STEM education is vital for the eventual employment of students. As advances in technology are made, the need for those with STEM skills is increasing and countries where they invest more time in the education of high-quality physical sciences will most likely see economic growth as well (Kozma, 2020**).** Through training in the STEM area, students will be abletodeliversolutionstospecificcomplexproblems stemming from environmental issues and benefit themselves as well as future generations (UNESCO, 2015). Little wonder why the Nigerian curriculum education is in constant flux to align itself with the dynamism of STEM education. The Nigerian secondary school curriculum has undergone significant reforms in recent years, with a growing emphasis on STEM education. The Nigerian government has recognized the importance of STEM education in preparing students for the challenges of the 21st century and driving economic growth and development (Federal Ministry of Education, 2023).The current Nigerian school curriculum, as outlined in the National Policy on Education (2023), places a strong emphasis on STEM education, particularly at the secondary school level. The policy document highlights the importance of STEM education in developing critical thinking, problem-solving, and analytical skills, as well as promoting innovationandentrepreneurship(FederalMinistryof Education,2023).Intermsof curriculum content,the Nigerian secondary school curriculum includes a rangeofSTEM-relatedsubjects,suchasmathematics, physics, chemistry, biology, and computer science. These subjects are compulsory for students in junior secondary school (grades 7-9), and optional in senior secondary school (grades 10-12) (West African Examinations Council, 2020). Furthermore, the Nigerian government has introduced several initiatives aimed at promoting STEM education and improving student outcomes. For example, the FederalMinistryofEducationhas launched programs such as the National Science and Technology Education Programmed, which provides training and resources for teachers, as well as the Science, Technology, Engineering, and Mathematics (STEM) Education Initiative, which aims to promote STEM education in schools (Federal Ministry of Education, 2023).Research has shown that the Nigerian curriculum's emphasis on STEM education has led to improvedstudentoutcomesinthesesubjects.Astudy by Okebukola (2023) found that Nigerian students who received instruction in STEM-related subjects showed significant gains in their understanding of scientific concepts and their ability to apply mathematical principles to real-world problems. However, despite these efforts, challenges remain. Many schools in Nigeria lack the resources and infrastructure needed to effectively teach STEM subjects, including qualified teachers, laboratories, and technology (Adeyinka& Ogundare, 2022& National Science Foundation. (2023). additionally, there is a significant gender gap in STEM education, with girls and women underrepresented in these fields (Okebukola, 2023). The Nigerian government hasconsistentlyfailedtoallocatesufficientfundingto the education sector, leading to a lack of resources, infrastructure,andfacilities(Adeyemi,2023).Thishas resulted in overcrowded classrooms, outdated textbooks, and inadequate teacher training. Nigeria has a shortage of qualified teachers, particularly in rural areas. Many teachers lack the necessary training, skills, and experience to effectively teach students (Ololube, 2023). This has led to a decline in the quality of education and student performance. ManyschoolsinNigerialackbasicinfrastructuresuch as classrooms, libraries, and laboratories. This has createdanunfavorablelearningenvironment,making itdifficultforstudentstolearneffectively(Okebukola, 2023). Corruption is a major challenge facing the Nigerian education system. Embezzlement of funds, bribery, and nepotism are common practices that have undermined the integrity of the system (Transparency International, 2019). Insecurity is a majorchallengefacingtheNigerianeducationsystem, particularlyintheNorth-Eastregion.TheBokoHaram insurgency has led to the destruction of schools, the abduction of students, and the killing of teachers, making it difficult for students to access education (UNICEF, 2020).The Nigerian curriculum has been criticized for being outdated and irrelevant to the needs of the 21st century. The curriculum does not emphasize critical thinking, problem-solving, and entrepreneurship skills, which are essential for the modern economy (Adeyinka, 2023). Nigeria has a significantproblemofaccessandequityineducation.

Many students, particularly from disadvantaged backgrounds,lackaccesstoqualityeducation,leading toawideninggap ineducationaloutcomes(UNESCO, 2019). The concept of Technological Pedagogical Content Knowledge (TPACK) is a framework that highlights the interplay between technology, pedagogy, and content knowledge in teaching and learning (Mishra & Koehler, 2020). This framework is particularly relevant in the context of STEM education, where teachers need to integrate technology, pedagogy, and content knowledge to create effective learning experiences for students. The TPACK framework consists of three main components.TechnologicalKnowledge(TK),refersto the teacher's knowledge of technology and its applications in teaching and learning. Pedagogical Knowledge (PK) is the teacher's knowledge of teaching and learning strategies, including classroom management and assessment techniques. Content Knowledge (CK),refers tothe teacher'sknowledgeof the subject matter being taught, including the curriculum and standards. The TPACK framework suggests that effective teaching involves the integration of these three components, resulting in a deeper understanding of how to use technology to support student learning (Koehler& Mishra, 2020& Eze.,& Okoli, 2022). The TPACK framework can provideinsightsintothechallengesandopportunities faced by teachers in integrating technology, pedagogy,andcontentknowledgetocreateeffective learning experiences for students. For instance, the TPACK framework can help to identify the gaps in teachers' knowledge and skills in integrating technology,pedagogy,andcontentknowledge,which can inform professional development programs to support teachers in improving their practice. Studies have highlighted the importance of STEM education in promoting economic growth and development in Nigeria (Adeyinka,& Ogundare, 2022). However, the current state of STEM education in Nigeria is faced with challenges such as inadequate infrastructure, lack of qualified teachers, and outdated curriculum (Okebukola, 2023).Research has also shown that teacher perception and attitude towards STEM education play a crucial role in its effectiveness (Adeyinka,& Ogundare, 2022& National Science Foundation. (2023). Teachers' perceptions of the effectiveness of STEM education can influence their teaching practices and student outcomes. Research has shown that effective technology integration requires a deep understanding of the interplay between technology, pedagogy, and content knowledge (Mishra& Koehler, 2006& Eze.,& Okoli, 2022).TheTPACKframeworkprovidesausefullens for understanding this interplay, highlighting the importance of teachers' knowledge and skills in technology, pedagogy, and content (Koehler& Mishra, 2005).However, there is a gap in the literature in terms of understanding how STEM educationisperceivedbyImoStatesecondaryschool teachers in Nigeria. Specifically, there is a need for research on the effectiveness of STEM education in the Nigerian curriculum, and how technology can be integrated effectively to prepare students for the digital age.

ResearchQuestions

1. What is the perception of male and female secondary school teachers in Owerri Municipal of Imo State secondary school regarding the effectiveness of the Nigerian curriculum in delivering quality STEM education?
2. Howdomaleandfemalesecondaryschoolteachers in Owerri Municipal of Imo State secondary school perceive the availability and adequacy of resources (e.g., technology, infrastructure, and training) for effective STEM education implementation in their schools?
3. To what extent do male and female secondary school teachers in Owerri Municipal of Imo State secondary school teachers feel confident and prepared to integrate technology effectively into their STEM teaching practices to prepare students for the digital age?

Methodology

The study used a descriptive survey research design to gather information from senior secondary school teachersinallelevenpublicseniorsecondaryschools in Owerri Municipal Council of Imo State. The Population of the study consisted of all 310 Senior Secondary School teachers (78 males and 132 females)inOwerrimunicipalCouncilofImostate.The whole population was used because of its small size. An instrument for data collection was a teachers' perceptionquestionnaireitled"Teachers'Perception towards the Effectiveness of STEM Education in the Nigerian Curriculum"(TPESENC). A 15-item questionnaire was designed by researchers and validated by three experts in Science education, teachereducation,andeducationalpsychology.Their inputswereaffectedinthefinaldraft.Theinstrument hasparts1,2,3,and4.Partonesoughtdemographic information of respondents, part two sought information to determine perceptions of male and female secondary school teachers regarding the effectiveness of the Nigerian curriculum in delivering quality STEM education, and part three sought information to determine how male and female secondary school teachers perceive the availability andadequacyofresources(e.g.,technology,

infrastructure, training) for effective STEM education implementationin theirschools and part four sought information to determine how confident and preparedmaleandfemalesecondaryschoolteachers aretointegratetechnologyeffectivelyintotheirSTEM teaching practices. The items had four response categories ofStrongly Agree (SA);Agree(A); Disagree (D) and Strongly Disagree (SD) scoring 4, 3, 2, and 1 respectively Respondents were made to tick the option that best described their opinion. The reliabilityindexwastestedusingsubjectsoutside the study population. A reliability coefficient of 0.83 was realized when data generated were subjected to Cronbach Alpha. The researchers used two research assistantsintheadministrationandcollectionofdata from the subjects. This yielded a 100% return. The data collected were analyzed using mean and standard deviation in answering the research questions. Any Item with a mean less than 2.50 was rejected while within and above 2.50 was accepted. The hypothesis was analyzed using a t-test statistical tool tested at a 0.05 level of significance.

Presentationofresult

Table:1:PerceptionofmaleandfemalesecondaryschoolteachersinOwerriMunicipalregardingthe effectivenessoftheNigeriancurriculumindeliveringqualitySTEMeducation

S/N	ITEMSTATEMENT	Male			Female		
		$\bar{x}$	SD	REM	$\bar{x}$	SD	REM
1	TheNigeriancurriculumadequatelycoversthe essential concepts andskills needed for quality STEM education	2.34	0.31	Reject	2.43	0.72	Reject
2	TheSTEMcurriculumeffectivelyprepares students for higher education in STEM fields.	3.12	0.49	Accept	3.05	0.75	Accept
3	Thecurriculum'sapproachtoSTEMeducationis engaging and relevant to the needs of students in Imo State.	2.42	0.58	Reject	2.349	0.59	Reject
4	TheassessmentmethodsusedintheSTEM curriculumaccuratelymeasurestudentlearning andprogress	2.21	0.37	Reject	2.23	0.69	Reject
5	Thecurriculumprovidessufficientopportunities forstudentstoapplytheirSTEMknowledgeand skillsinpracticalways	3.67	0.71	Accept	3.65	0.78	Accept
	AverageMean	**2.75**	**0.40**		**2.82**	**0.51**	

Table 1 shows that , Items 1, 3, and 4 were rejected by both male and female teachers, indicating that they do not perceivetheNigeriancurriculumaseffectivelycoveringessentialSTEMconceptsandskills,engagingandrelevantto student's needs, or accurately measuring student learning and progress

Table: 2:Perception ofmale and female secondaryschool teachers in Owerri Municipal on the availability and adequacy of resources for effectiveSTEMeducation implementation intheir schools

S/N	ITEMSTATEMENT	Male			Female		
		□	SD	REM	□	SD	REM
6.	My school has adequate technological resources (e.g., computers, software, internetaccess)foreffectiveSTEMteaching	2.51	0.51	Accept	2.50	0.52	Accept
7.	Ihaveaccesstosufficientandwell-maintained laboratory equipment and materials for practical STEM learning experiences	2.30	0.49	Reject	2.33	0.40	Reject
8.	Ihavereceivedadequateprofessional developmentopportunitiestoenhancemy skillsinteachingSTEMsubjects effectively.	3.06	0.61	Accept	3.10	0.59	Accept
9.	Theschooladministrationprovides sufficientsupportandresourcesfor implementingSTEMeducationeffectively	3.25	0.56	Accept	3.27	0.51	Accept
10.	Textbooksandlearningmaterialsprovided areup-to-dateandalignedwiththecurrent STEMcurriculum.	3.31	0.61	Accept	3.22	0.60	Accept
Averagemean		**2.87**	**0.45**		**2.88**	**0.42**	

Table 2 shows that, Item 7 (Laboratory Equipment):The rejection of this item by both genders suggests a lack of access to sufficient and well-maintained lab equipment. This lack of practical learning opportunities can hinder students' ability to develop essential scientific inquiry and problem-solving skills.

Table: 3: Perception responses of male and female secondary school teachers in Owerri Municipal on their confidenceandpreparednesstointegratetechnologyeffectivelyintoSTEMteachingpracticestopreparestudents for the digital age

S/N	ITEMSTATEMENT	Male			Female		
			SD	REM	□	SD	REM
11.	Ifeelconfidentinmyabilityto integrate technology effectively into my STEM teaching.	3.57	0.78	Accept	3.58	0.77	Accept
12.	Iamcomfortableusingavariety of digitaltoolsandresourcestoenhance STEM learning.	3.41	0.60	Accept	3.43	0.61	Accept
13.	Ibelievethattechnologyintegration cansignificantlyimprovestudent engagementandlearningoutcomesin STEM subjects	3.56	0.64	Accept	3.58	0.64	Accept
14.	Ihavereceivedadequatetrainingand support to effectively integrate technologyintomySTEMteaching practices	3.35	0.68	Accept	3.57	0.69	Accept
15.	Ifeelpreparedtoadaptmyteaching strategiestoincorporateemerging technologies in the field of STEM education.	3.38	0.69	Accept	3.39	0.68	Accept
Averagemean		**3.48**	**0.41**		**3.51**	**0.45**	

Table3showsthatbothmaleandfemaleteachers feel confident in their ability to integrate technology effectively into their STEM teaching, are comfortable using digital tools and resources, believe technology integration can improve student engagement and learning outcomes, and feel prepared to adapt their teaching strategies to incorporate emerging technologies.

Discussion

This study investigated the perceptions of male and femalesecondaryschoolteachersinOwerri Municipal, Imo State, regarding the effectiveness of STEM education in the Nigerian curriculum. Thefindings reveal a complex picture with bothencouraging and concerning aspects. The results presented in Table 1 highlight concerns regarding the perceived effectiveness of the Nigerian curriculum in delivering quality STEM education. Both male and female teachers expressed reservations about the curriculum'sabilitytoadequatelycoveressential STEMconceptsandskills(Item1),aligningwith Adeyinka, & Ogundare, (2022), assertion that the Nigerian curriculum is outdated and needs revision to meet 21st-century demands. This suggests a potential gap between the curriculum's content and the skills required for students to thrive in a technology-driven world. Furthermore, the low scores on Item 3 indicate that teachers find the curriculum's approach to STEM potentially lacking engagement and relevance to the specific needs of Imo State students. This finding emphasizes the importance of contextualizing the curriculum, as advocated by Okebukola (2023), to ensure that learning materials resonate with students' livedexperiencesandinspireapassionforSTEM fields. The dissatisfaction with assessment methods (Item 4) further underscores the need for a more comprehensive approach to STEM education. Relying solely on traditional assessment methods might not accuratelycapturestudents'understandingof complex STEM concepts and their ability to apply knowledge in real-world scenarios. Exploringalternative, authentic assessment strategies, as suggested by Harris, Mishra, & Koehler (2009), could provide a more accurate reflection of student learning and progress. Table 2 presents a mixed bag regarding the availability and adequacy of resources for effective STEM education implementation. While teachers reported adequate access to technological resources (Item6) and administrative support (Item 9),the lack of sufficient and well-maintained laboratory equipment (Item7)raisesconcerns.Thisfindingaligns withOkebukola's(2023)observationthatinadequate infrastructure poses a significant challenge to STEM educationinNigeria.Withoutaccesstoproper laboratory facilities, students are deprived of opportunities for hands-on learning and experimentation, hindering their ability to develop essential scientific inquiry and problem-solving skills.

The results displayed in Table 3 offer an encouraging perspective on teachers' preparedness to integrate technology into their STEM teaching practices. Both male andfemaleteachersexpressed confidence intheir ability to effectively integrate technology (Item 11), demonstrating a positive attitude towards leveraging digital tools for enhanced learning experiences. This findingalignswiththeemphasisplacedonTechnological Pedagogical Content Knowledge (TPACK)byMishra & Koehler (2006), highlighting the importance of teachers possessing the knowledge and skills to effectively integrate technology, pedagogy, and content knowledge. Moreover, the high scores on Items 12, 13, and 15 indicate that teachers are comfortable using a variety of digital tools and resources, believe in the potential of technology integration to improve student engagement and learning outcomes and feel prepared to adapt their teaching strategies to incorporate emerging technologies. These findings suggest that teachersareeagertoembracetechnologyandrecognize its transformative potential in STEM education.

However, it is crucial to acknowledge the need for continuousprofessionaldevelopmentopportunities (Item 14) to ensure that teachers stay abreast of the latest advancements in technology and pedagogical approaches.Equippingteacherswiththenecessaryskills and knowledge will empower them to create engaging andeffectivelearningexperiencesthatpreparestudents for the digital age.

Conclusion

This study reveals that while teachers in Owerri Municipalareoptimisticaboutintegratingtechnology and recognize its potential in STEM education, concerns remain regarding the curriculum's effectiveness and the availability of essential resources like laboratory equipment. Addressing these concerns is crucial to creating a conducive learningenvironmentthatfostersapassionforSTEM andequipsstudentswiththeskillsneededtothrivein the 21st century.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Ministry of Education with its relevant agencies shouldconduct a comprehensive review of the Nigerian STEM curriculum to ensure its alignment with 21st-century skills and the specific needs of Imo State students. This review should involve teachers, subject matter experts, and industry professionals to ensure the curriculum's relevance and practicality.
2. MinistryofEducationwithitsrelevantagencies

shouldintegrate local examples, case studies, and real-world problems into the STEM curriculum to enhanceitsrelevanceandengagementforstudents. This could involve partnering with local industries and organizations to provide students with authentic learning experiences.

3. Thegovernmentshouldincreasefundingtoimprove STEMinfrastructureinschools,particularlyfocusing on providing well-equipped and maintained laboratories. This investment will provide students with hands-on learning opportunities and foster a deeper understanding of scientific concepts.
4. MinistryofEducationwithitsrelevantagencies should provide ongoing professional development opportunities for teachers, focusing on enhancing their TPACK and equipping them with the skills and knowledge to effectively integrate technology into their STEM teaching practices.
5. Ministry of Education with its relevant agencies Encourage the adoption of diverse and authentic assessment methods that accurately measure students'understandingofSTEMconceptsandtheir ability to apply knowledge in real-world contexts. This could involve incorporating project-based learning, portfolio assessments, and performance-based tasks.

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