



# ASSOCIATION OF SCIENCE EDUCATORS ANAMBRA (ASEA)

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INNOVATIONS, DIGITAL TRANSFORMATION AND  
SUSTAINABLE SCIENCE EDUCATION IN THE 21ST CENTURY



# 2<sup>nd</sup> Annual CONFERENCE PROCEEDINGS 2026

Editor in Chief  
Prof. Josephine N. Okoli

**ASSOCIATION OF SCIENCE EDUCATORS  
ANAMBRA (ASEA)**

**THEME:  
INNOVATIONS, DIGITAL TRANSFORMATION AND  
SUSTAINABLE SCIENCE EDUCATION IN THE 21<sup>ST</sup>  
CENTURY.**

**2<sup>ND</sup> ANNUAL CONFERENCE PROCEEDINGS HELD ON  
9<sup>TH</sup> APRIL, 2026 AT ARCHBISHOP ALEXANDER  
IBEZIM COLLEGE OF EDUCATION NIBO-NISE,  
ANAMBRA STATE, NIGERIA.**

*Editor*

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## TABLE OF CONTENT

Table of Content .....	iii
Members Of Conference Planning Committee .....	v
Chairman’s Address Venerable Nnamdi B. Emendu (Phd) Presented During the Second Conference of the Association of Science Educators, Anambra (Asea) Held at Archbishop Alexander Chibuzo Ibezim College of Education, Nibo-Nise, Anambra State on 9th April 2026 .....	vi
A Welcome Address Presented to the Association of Science Educators Anambra State at Its Second Conference on the Theme: Innovations, Digital Transformation And Sustainable Science Education In The 21 <sup>st</sup> Century. Revd Canon Dr H. O. N. Bosah .....	ix
Meritorious Award .....	x
Foreword .....	xi
Preface .....	xii
Address of the Acting President of Association of Science Educators Anambra (ASEA), Dr. Johnbosco Onyekachukwu Okekeokosisi; At the Opening Ceremony of the 2 <sup>nd</sup> Annual Conference Held At Archbishop Alexander Ibezim College of Education Nibo-Nise, Anambra State, Nigeria on 9 <sup>th</sup> April, 2026. ....	xiii
A Key Note Address Presented At 2 <sup>nd</sup> Conference of the Association Of Science Educators Anambra on April 09, 2026 .....	xv
Lead Paper Presentation of the Conference Theme: Innovation, Digital Transformation and Sustainable Science Education In The 21 <sup>st</sup> Century. Okonta, Okechukwu Emmanuel (PhD, FNCS, MCPN, MIAENG) .....	xx
<b>PAPER 1</b> <b>Innovation, Digital Transformation and Sustainable Mathematics Education in the 21st Century</b> Ogoke, Chinemeze James, <sup>2</sup> Otumegwu Tina Uchenna, <sup>3</sup> Ike, Iheanacho Chukwudi, <sup>4</sup> Anthony Anyanwu, <sup>5</sup> Alfred Okolie, <sup>6</sup> Achugamonu, Pius, C .....	1
<b>PAPER 2</b> <b>Leveraging Multimedia Resouces in the Teaching And Learning of The Biology in Public Secondary Schools in Orumba South Local Government Area of Anambra State</b> <sup>1</sup> Dr. Eze Irene.F, <sup>2</sup> Engr. Mokwe Celine N, <sup>3</sup> Umeadi Somtochukwu F .....	8
<b>PAPER 3</b> <b>Effect of The Eduphys Ai Tutor on the Learning Achievement of Undergraduate Physics Students At Federal University Dustinma, Katsina State, Nigeria</b> <sup>1</sup> Ahmed Salihu, <sup>2</sup> Nura Muhammad, <sup>3</sup> Lukman Samaila .....	16
<b>PAPER 4</b> <b>Enhancing Tertiary Students’ Mindset Towards Learning Approach</b> <sup>1</sup> JohnBosco O.C. Okekeokosisi, <sup>2</sup> Ebere J. Okekeokosisi, <sup>3</sup> Samuel Alfayo Boh .....	24

**PAPER 5**

**Effects of Concept Mapping Strategy on Students' Achievement in Chemistry in Senior Secondary Schools in Yenagoa Metropolis, Bayelsa State.**

Dr. Moses, John Billy ..... 29

**PAPER 6**

**Intrinsic Motivation as A Predictor of Senior Secondary Students' Academic Achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria**

<sup>1</sup>Ibok, Ekpenyong Effiong (Ph.D), <sup>2</sup>Osung, John Ekpo, <sup>3</sup>Bassey, Hope Joseph, <sup>4</sup>Ukabi, Efaemiode Bassey ..... 36

**PAPER 7**

**Innovation, Digital Transformation and Sustainable Mathematics Education in The 21<sup>st</sup> Century**

<sup>1</sup>Dr. Emmanuel C. Nwigboji, <sup>2</sup>Dr. Caroline I. Okorie, <sup>3</sup>Emenike Ethel Chika 47

**PAPER 8**

**Extent of Use of Artificial Intelligence (AI) Tools in The Learning of Mathematics in Secondary Schools in Onitsha Education Zone, Anambra State**

<sup>1</sup>Okoli Nneka Chigozie, <sup>2</sup>Oraneto Modesta Chioma, <sup>3</sup>Okoli Jacinta Chiamaka 61

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- Ahueansebhor Emmanuel** Human kinetics and Sports Science Department  
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- Ogbonna Marachi Samuel (Sec.)** Physical and Health Education Department  
Federal College of Education (Tech) Umuze,  
Anambra State, Nigeria
- Usan Peter** Chemistry Department  
Federal Technical College, Awka,  
Anambra State, Nigeria

## **PROGRAMME OF EVENTS**

- Opening Praying
- Chairman's Opening Remark
- Breaking of Kola nut
- Welcome Address by the Provost of the College
- Welcome Address by the acting President of the Association
- Keynote Presentation by Dr. Peter I.I. Ikokwu
- Lead Paper Presentation by Dr. Emmanuel O. Okonta
- About the Electronic Book / Unveiling of Book Chapter – E-Book launch
- Item 7
- Meritorious Award
- Paper Presentations

**CHAIRMAN’S ADDRESS VENERABLE NNAMDI B. EMENDU PhD. PRESENTED  
DURING THE SECOND CONFERENCE OF THE ASSOCIATION OF SCIENCE  
EDUCATORS, ANAMBRA (ASEA) HELD AT ARCHBISHOP ALEXANDER CHIBUZO  
IBEZIM COLLEGE OF EDUCATION, NIBO-NISE, ANAMBRA STATE ON 9TH  
APRIL 2026**

**THEME: Innovation, Digital Transformation, and Sustainable Science Education in the  
21st Century**

Distinguished Professors, Esteemed Researchers, Academic Leaders, Policy Partners, Ladies and Gentlemen,

**Introduction**

It is my distinct honour and privilege to welcome you to the Second Conference of the Association of Science Educators. I extend warm greetings to our keynote speakers, paper presenters, research scholars, institutional representatives, and valued partners whose presence underscores the importance of this gathering.

Our theme — “Innovation, Digital Transformation, and Sustainable Science Education in the 21st Century” — speaks directly to the evolving mandate of higher education institutions and research communities in shaping scientific literacy, discovery, and societal progress.

**The Imperative for Academic Innovation**

Higher institutions have historically been the custodians of knowledge creation and dissemination. However, in the contemporary era marked by rapid technological advancement and global interconnectivity, the academy must transcend traditional pedagogical models. Innovation in schools is essential because it prepares students for the future, enhances learning experience, encourages creativity and curiosity, improve teaching methods, promoting problem solving skills, increases students engagement, supports inclusive education and keeps education relevant.

Innovation in science education within academia must be:

1. **Research-driven** – informed by evidence-based pedagogical studies and discipline-based education research.
2. **Interdisciplinary** – integrating science with technology, engineering, social sciences, and humanities to address complex global challenges.
3. **Problem-oriented** – focusing on real-world applications, design thinking, and translational research.

Generally, our curricula must reflect not only foundational theories but also emerging scientific frontiers. We must continuously revise course content to incorporate developments in data science, artificial intelligence, climate science, biotechnology, and other rapidly evolving fields. Furthermore, innovation in academia demands that we reconsider assessment models. Are our evaluation frameworks measuring deep conceptual understanding, research competence, and critical thinking — or merely factual recall? The 21st century requires scholars who can analyze, synthesize, and innovate.

**Digital Transformation in Higher Education**

Digital transformation is important for schools because it improves how students learn, and how institutions operate. According to Hurb (2020), digital tools improve schools efficacy and enable better decision making through data. It enhances teaching and learning. Study by QECD (2019). shows that technology supports better learning outcome when combined with effective teaching practice. Likewise digital transformation helps to expand access to education. The world bank

(2020). highlight that digital learning helps researcher understands population and ensures during.

### **Sustainable Science Education: Institutional Responsibility**

Sustainability within science education must be understood in both environmental and systemic terms. As academic institutions, we bear responsibility for cultivating graduates who are equipped to confront global challenges such as climate change, biodiversity loss, food security, renewable energy transitions, and public health crises. Science education must therefore embed sustainability principles across curricula rather than isolating them within specialized courses.

Moreover, sustainable science education requires:

1. Strengthened research infrastructure.
2. Long-term funding commitments for scientific inquiry.
3. Mentorship pipelines for early-career researchers.
4. Gender and diversity inclusion in STEM disciplines.
5. Institutional policies that promote environmentally responsible campus practices.

Sustainability also means ensuring that our educational systems remain adaptable, resilient, and responsive to societal needs. Higher institutions must remain spaces where rigorous inquiry, ethical reflection, and innovation coexist harmoniously.

### **The Role of Academic Leadership in Innovation, Digital Transformation, and Sustainable Science Education**

As researchers, and academic leaders, our influence extends beyond lecture halls and laboratories. We must Champion inquiry-based learning and undergraduate research opportunities. We need to foster industry-academia partnerships to enhance experiential learning. We need to advocate for policy reforms that strengthen STEM education nationally and globally. Also, we need to mentor the next generation of scientists with integrity and intellectual humility. Our scholarly work must bridge theory and practice. Publications, policy briefs, and community outreach must reflect the societal relevance of our research endeavors.

Academic leadership must also prioritize education development programs that enable educators to integrate digital tools, innovative pedagogies, and sustainability frameworks effectively.

### **Conference Expectations and Scholarly Engagement**

This conference provides a vital platform for intellectual exchange. Over the coming sessions, we will engage with research findings, pedagogical innovations, technological applications, and policy perspectives that shape the future of science education.

I encourage participants to:

Share empirical evidence and best practices.

Engage in constructive critique and interdisciplinary dialogue.

Form collaborative research networks that extend beyond this conference.

Let this gathering generate not only discussions, but actionable frameworks and research agendas that inform institutional strategies.

### **Conclusion**

In closing, innovation, digital transformation, and sustainability are not isolated ambitions. They are interconnected imperatives that define the mission of modern academia.

If we are to remain relevant as institutions of higher learning, we must embrace transformation while preserving the core values of scholarship: rigor, integrity, curiosity, and service to humanity. Let us commit to advancing science education that is intellectually robust, technologically empowered, and socially responsible.

I thank you all for your dedication to this cause and wish us a conference marked by insightful deliberations, meaningful collaborations, and lasting impact.

Thank you.

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**A WELCOME ADDRESS PRESENTED TO THE ASSOCIATION OF SCIENCE EDUCATORS ANAMBRA STATE AT ITS SECOND CONFERENCE ON THE THEME: INNOVATIONS, DIGITAL TRANSFORMATION AND SUSTAINABLE SCIENCE EDUCATION IN THE 21<sup>ST</sup> CENTURY.**

**REVD CANON DR H. O. N. BOSAH**

**AG. PROVOST, ARCHBISHOP ALEXANDER IBEZIM COLLEGE OF EDUCATION NIBO-NISE**

On behalf of the Proprietor of this citadel of learning, His Grace, The Most Revd Alexander Chibuzo Ibezim, Archbishop Ecclesiastical Province of the Niger and Bishop, Diocese of Awka, the College Governing Council, College Management and the entire College Community, I cordially welcome the Association of Science Educators, Anambra State and its cream of attracted conferees to Archbishop Alexander Ibezim College of Education, Nibo-Nise: A Centre Par Excellence in Teacher Education.

Conscious of the fact that that we are here for an intentional academic conference - a gathering where scholars and experts have deliberately gathered to foster meaningful discussions, collaborations, and knowledge sharing around a specified theme, quite different from mere traditional conference; engagement, interaction, and outcomes are set to be prioritized over mere presentation of papers. We are therefore here for a curated dialogue, rather than mere series of lecture presentations.

Lead discussions on innovations, digital transformation and sustainable science education in the 21<sup>st</sup> century shall consequently be interrogated as a theme, across academic seniority levels, diverse experiences, and intellectual interests among the conferees. Focus on how learning, networking, exploring and how digital transformation will impact research areas will be anticipated. Sharing experiences, application discussions, inter disciplinary interactions and collaborative explorations will not be left out .

Research papers will therefore be anticipated from diverse areas of interests, such as data-driven research; digital tools & methods with modeling, computational techniques; collaboration & data sharing enhanced through digital platforms; open science initiatives and impacts on disciplines, simulation and predictive modeling.

Finally, sharing insights, and shaping future development directions would apparently constitute a path finder to the Conference colluding remarks. Panel discussants will constitute the much needed brainstorming in this conference.

We earnestly pray that the conference turns out a huge success, with a scholarly proceeding and publication that will positively project the association in the community of sound academics. This second conference shall not be the last but an improvement on previous ones with sustainable qualitative development in the future.

Revd Canon Dr H. O. N. Bosah

Ag. Provost, Archbishop Alexander Ibezim College of Education Nibo-Nise.

**MERITORIOUS AWARD  
CITATION OF DR. SULEIMAN DAMBAI MOHAMMED**



Dr. Suleiman Dambai Muhammed was born to the family of Mallam Mohammed Ozaki Toto in Toto Local Government Area of Nasarawa State on 2nd June 1961. He attended Government Teachers' College Wukari from 1975-1980. He proceeded to the prestigious Ahmadu Bello University Zaria, first to Institute of Education from 1985-1989 and then Faculty of Education from 1990-1995 where he obtained his NCE and B.Sc Ed. (integrated Science)

After his First Degree, Dr. Suleiman proceeded to University of Jos Plateau State, where he obtained M.Sc (Ed) Biology in 2003. He later enrolled and obtained his Ph.D in Science Education in University of Abuja (Nigeria) in 2016.

Dr. Suleiman started his work Career as a Lecturer III in Nasarawa State College of Education Akwanga from 1998-2002. He later transferred his services to FCT College of Education, Zuba-Abuja as Lecturer II in 2002 and rose through the ranks to the Chief Lecturer in 2017. In 2020 he transferred his services to Federal University of Lafia Nasarawa State as Senior Lecturer. In 2023; he was promoted to the rank of Associate Professor by the University.

During his career, he had served as Head of Department, Member Junior Staff, Appointment Promotion and Disciplinary Committee, Etc in both Colleges (College of Education Akwanga and Zuba).

In recognition of his astute leadership qualities and administrative acumen, he was appointed as Acting Head of Department, Science Education in 2022 by the Vice Chancellor, Professor Shehu AbdulRahman, The position he is still holding till date. He is a Member of the Senate of the University of Lafia.

Dr. Suleiman has some honors and distinctions to his name. Some of them are; The Best Lecturer, the Best Teaching Practice Coordinator and the Best Head of Department of FCT College of Education Zuba 2007, 2009 and 2012 respectively.

Dr. Suleiman has over forty (40) publications in reputable Journals both nationally and internationally, numerous papers presented at National and International Conferences, contributions to chapter in Textbooks and a number of Textbooks

He is a member of the following organizations: International Research and Development Institute (Research and Development Network) from 2012 to date; Academic Staff Union of Universities (ASUU); Teachers' Registration Council of Nigeria (TRCN) etc.

Amongst countries he has visited are Singapore, Saudi Arabia, and Dubai. He is married with Children.

He is now an Associate Professor with the Federal University of Lafia, Nasarawa State.

## FOREWORD

It is with great pleasure that I present this conference proceedings, which brings together a rich collection of scholarly works centred on digital literacy and its transformative role in contemporary education. The articles featured in this volume, collectively reflect the growing recognition that digital competence is no longer optional but essential for effective teaching, learning, and sustainable development in the 21st century.

A dominant theme across the contributions is the critical role of digital literacy in enhancing students' academic achievement, particularly in core subject areas such as Mathematics, Chemistry, Biology, and Basic Science. Several studies in this volume establish digital literacy competence as a strong predictor of learners' performance, while also demonstrating how innovative instructional strategies such as science video instruction and virtual learning environments can significantly improve learning outcomes.

The proceedings also highlight the importance of equipping educators with the necessary digital skills. Papers examining teachers' digital competence, awareness, and utilization of educational technologies reveal both progress and gaps, underscoring the urgent need for continuous professional development. Contributions focusing on tools such as Google Classroom and Google Scholar further illustrate how accessible technologies can enrich teaching practices and expand learning opportunities when effectively deployed.

Another notable strand of research in this collection explores personalized and technology-driven learning approaches. Studies on online platforms, personalized learning environments, and digital assessment practices demonstrate how technology can support learner-centred education and foster improved engagement and achievement. These insights are particularly relevant in advancing flexible and inclusive education systems.

Beyond classroom practice, the proceedings also address broader systemic and societal dimensions. Papers examining the sustainability of academic programmes within current economic realities, as well as the role of digital education in promoting national development, provide valuable perspectives for policymakers and educational leaders. Additionally, interdisciplinary contributions such as those linking digital literacy with physical and health education and environmental monitoring systems underscore the expanding scope of digital competence across diverse fields.

Collectively, the papers in this volume make a significant contribution to knowledge by providing empirical evidence, practical insights, and innovative approaches to integrating digital literacy into education. They not only deepen our understanding of current challenges but also offer actionable pathways for improving teaching and learning in Nigeria and beyond.

It is my hope that this compilation will serve as a valuable resource for researchers, educators, policymakers, and all stakeholders committed to advancing education through technology. May it inspire further inquiry, collaboration, and innovation in the pursuit of quality and sustainable education.

**Telima Adolphus, FHEA.**  
**Professor of Science Education,**  
**Rivers State University.**

## PREFACE

This years' conference on innovations, digital transformation and sustainable science education in the 21<sup>st</sup> century is meant to educate and re-educate science educators effectively. It exposed educators towards evolving scientific and technological world. Science educators must embrace digital tools and resources to enhance their teaching methods, re-structure learners' mindset, foster students' scientific literacy, critical thinking and problem-solving skills. This includes leveraging online platforms, using educational technologies and digital content to create engaging and meaningful learning experiences.

In this conference proceedings efforts has been made towards promoting the use of digital tools in science education.

**Prof. Josephine N. Okoli**

Science Education Department

Nnamdi Azikiwe University, Awka,

Anambra State, Nigeria.

**ADDRESS OF THE ACTING PRESIDENT OF ASSOCIATION OF SCIENCE  
EDUCATORS ANAMBRA (ASEA), DR. JOHNBOSCO ONYEKACHUKWU  
OKEKEOKOSISI; AT THE OPENING CEREMONY OF THE 2<sup>ND</sup> ANNUAL  
CONFERENCE HELD AT ARCHBISHOP ALEXANDER IBEZIM COLLEGE OF  
EDUCATION NIBO-NISE, ANAMBRA STATE, NIGERIA ON 9<sup>TH</sup> APRIL, 2026.**

The chairman of the occasion, Dr. Ven. Nnamdi Emendu,  
Mother of the Day, Dean School of Science Education, Federal College of Education  
(Technical) Umunze, Dr. Stella O. Okoli.  
Special Guest of Honor, Deputy Mayor Anambra East, Hon. Lady Dr. Martina Nwawube  
The Executive Provost of ArchBishop Alexander Ibezim College of Education, Nibo- Nise,  
Revd. Canon Dr. H.O.N. Bosah  
Our Esteemed Keynote and lead Paper Presenters, Drs: Peter I.I. Ikokwu, Emmanuel O. Okonta  
Meritorious Awardee: Suleiman Dambai Mohammed  
The Local Organizing Committee (LOC)  
My Fellow Science Educators,  
Distinguished Guests,  
Ladies and Gentlemen

I am highly delighted to extend a warm royal welcome to you all at the opening ceremony of the 2<sup>nd</sup> Annual Conference of Science Educators Anambra (ASEA) on the **Theme: Innovations, Digital Transformation and Sustainable Science Education in the 21<sup>st</sup> Century.**

I welcome most heartily the Executive Provost of ArchBishop Alexander Ibezim College of Education, Nibo- Nise, Revd. Canon Dr. H.O.N. Bosah, the chairman of the occasion Dr. Ven. Nnamdi Emendu, Special Guest of Honour, Deputy Mayor Anambra East, Hon. Lady Dr. Martina Nwawube, our erudite mother of the day Dr. Stella O. Okoli, Dean School of Science Education, Federal College of Education (Technical) Umunze for honoring our invitation. Your presence is a great source of inspiration and we are grateful for your unwavering support towards science education in the state.

**To our Host**, Board of Directors Prof. Josephine N. Okoli, Prof. Isaac N. Nwankwo and Prof. M.C. Anaekwe, Local Organizing Committee (LOC), I say thank you for you have worked round the clock towards the success of this year's conference.

**Special thanks** also go to our Meritorious Awardee, Dr. Suleiman Dambai Mohammed whose contributions to teaching and learning in tertiary institutions lead to the foundation of our members.

We have gathered not just to deliberate on academic issues but to collectively reflect and shape our minds on possible ways to educate learners and re-educate ourselves on **“innovations, digital transformation and sustainable science education in the 21<sup>st</sup> century”**. The stated conference theme is very apt considering the fact that we are in the digital age and are advocating for possible ways to educate learners for fast, easy understanding and recall.

**Participants** will be taken through hands-on and minds-on activities in various sessions and they will find the conference package very rewarding. I invite you to pay attention during keynote address to be presented by Dr. Peter I.I. Ikokwu, Nwafor Orizu College of Education, Nsugbe, Anambra State, Nigeria. Your continuous attention is also needed during the lead paper presentation of Dr. Emmanuel O. Okonta, Dean Students Affairs, Federal College of Education (Technical) Asaba Delta State, Nigeria.

**To all participants** – educators, researchers, students, policy makers – thank you for making out time to be here. Your presence signifies hope for the future of science education. I urge you to make the most of this gathering by networking, exchanging ideas and exploring new strategies to embed innovative and digital practices in science classroom and curricula.

**As we officially** declare this conference open, let us do so with a shared sense of purpose and vision. Let us reflect, discuss intelligently and leave this gathering better equipped. May our deliberations be fruitful and beneficial to all .

Thank you and God bless you all.

**Dr. JohnBosco O.C. Okekeokosisi**

**Ag. President ASEA**

**9<sup>th</sup> April, 2026**

**A KEY NOTE ADDRESS PRESENTED AT 2<sup>ND</sup> CONFERENCE OF THE  
ASSOCIATION OF SCIENCE EDUCATORS ANAMBRA ON APRIL 09, 2026**

**THEME: INNOVATION, DIGITAL TRANSFORMATION AND SUSTAINABLE  
SCIENCE EDUCATION IN THE 21<sup>ST</sup> CENTURY.**

**Harnessing Innovation and Digital Transformation for Sustainable Science Education in the 21<sup>st</sup> century**

I am honored and indeed humbled to speak at this esteemed conference of the Association of Science Educators Anambra . As we gather here today, we recognize the pivotal role science education plays in shaping the future of our nation. The theme of this conference, "Innovation, Digital Transformation and Sustainable Science Education in the 21<sup>st</sup> century" is particularly apt, as it highlights the need for a paradigm shift in our approach to science education. I also see it as a veritable follow up on the theme of our maiden conference, "Science Education and Digital Literacy in the 21<sup>st</sup> Century", which provided the tools for the implementation of the obvious demands of this conference. I commend the organizers proper articulation

**The Challenge Before Us**

Nigeria's science education sector faces numerous challenges, including inadequate infrastructure, outdated curricula, and a shortage of skilled teachers. These challenges hinder our ability to produce globally competitive scientists and innovators. According to UNESCO(2022), Nigeria has one of the lowest science literacy rates in the world, with only 22% of students achieving a minimum level of proficiency in science. This is unacceptable, given the critical role science plays in driving economic growth and development. To give a broader look at the theme, the key factors in the were briefly discussed.

**Innovation in Science Education**

Innovation is key to driving sustainable science education. We must:

1. ***Foster inquiry-based learning:*** Encourage curiosity, creativity, and problem-solving skills. This involves shifting from a teacher-centered to a student-centered approach, where students are encouraged to explore, investigate, and discover concepts on their own.
2. ***Industry-academia collaboration:*** Foster partnerships to develop relevant curricula and provide real-world experiences. This includes collaborations with industries to provide internships, mentorship, and research opportunities for students.
3. ***STEM education:*** Emphasize science, technology, engineering, and mathematics to equip students with skills for the future. This includes promoting interdisciplinary approaches to learning, where students work on real-world problems that require integration of multiple subjects.

**Digital transformation**

Digital transformation is the strategic integration of digital technologies into all areas of an organization to improve operations, enhance customer experience, and sustain competitive advantage.

**Definition and Purpose**

Digital transformation involves **rewiring an organization** to continuously deploy technology at scale, enabling improved efficiency, innovation, and value creation. It is not a onetime project but an ongoing journey that reshapes how businesses operate, interact with customers, and

deliver products or services. The ultimate goal is to **meet evolving customer expectations** edge in a rapidly changing digital landscape.

### Key Components

1. **Strategy and Roadmap:** A clear digital transformation strategy focuses on specific domains such as customer journeys, processes, or functions that generate significant business value. A detailed roadmap guides the implementation of solutions and allocation of resources.
2. **Technology Integration:** Organizations adopt technologies like **cloud computing, big data analytics, AI, mobile applications, and social media platforms** to modernize operations and create new revenue streams.
3. **Talent and Culture:** Successful transformation requires a strong inhouse digital talent pool, agile HR processes, and a culture that encourages innovation and collaboration.
4. **Operating Model:** Scalable operating models, such as digital factories, product and platform models, or enterprisewide agility frameworks, support cross-functional teams and largescale digital initiatives.
5. **Change Management:** Digital transformation is as much about **organizational change** as technology adoption. Leadership alignment, employee engagement, and continuous monitoring of key performance indicators (KPIs) are essential.

### Benefits

- **Enhanced Customer Experience:** Personalized, seamless interactions across channels.
- **Operational Efficiency:** Streamlined processes and reduced costs.
- **Innovation and Growth:** Ability to create new products, services, and business models.
- **Resilience and Agility:** Faster adaptation to market changes and emerging technologies.

### Sustainable Science Education

Sustainable science education is a critical component of the 2030 Agenda for Sustainable Development, aiming to equip learners with the knowledge, values and skills necessary to address complex environmental and social challenges. Taylor in Emendu(2018) presented sustainable development as development that continues to meet today's needs in ways that will not jeopardize future generations. UNESCO(2023) observed that sustainable science education requires a multifaceted approach:

1. Curriculum reform: Develop curricula that address local challenges and global trends. This includes incorporating emerging fields like artificial intelligence, biotechnology, and renewable energy into the curriculum.
2. Teacher training: Provide continuous professional development for educators. This includes training on digital literacy, pedagogical integrates learning, skills, and knowledge to achieve global goals and promote sustainable development.
3. Development: Invest in modern laboratories and equipment. This includes leveraging public-private partnerships to upgrade infrastructure and provide access to cutting-edge technology. The 2030 agenda integrates learning, skills, and knowledge to achieve global goals and promote sustainable development

**UNESCO's ESD for 2030:** This program produces and shares knowledge, offers policy guidance, and implements projects on the ground to strengthen countries' capacity to provide quality climate change education and 'green' every aspect of learning.

- **Science Education in Nigeria:** Functional science education is urgently required to promote scientific knowledge for sustainable development, with a focus on practical skills for individual and national development.
- **Science on Stage Germany:** This project offers STEM teachers wide range of hands-on teaching materials to develop 21<sup>st</sup> century skills and promote skills and knowledge in the classroom.

These initiatives reflect a global commitment to integrating sustainability into science education, ensuring that students are equipped to make informed decisions that benefit both the environment and society.

### **Innovation, Digital Transformation and Sustainable Science Education in the 21st Century**

The 21st century is characterized by rapid technological advancements and evolving societal needs, prompting a significant transformation in education systems globally. This includes the integration of technology, the development of essential 21<sup>st</sup> century skills, and the prioritization of student centered learning. These shifts enhance student engagement and performance while contributing to more inclusive and equitable learning environments. Innovative practices and adaptive strategies are essential for addressing these challenges. They promote creativity, critical thinking, collaboration, and resilience, which are vital for preparing learners to navigate the complexities of a rapidly changing world.

The integration of digital technologies in education is a powerful tool for advancing Sustainable Development Goals (SDGs) and fostering behavioral shifts toward sustainability. Digital education offers opportunities to integrate SDGs across all levels and forms of education, responding to evolving needs and challenges. UNESCO supports the use of digital innovation to expand access to educational opportunities, advance inclusion, and enhance the relevance and quality of learning. It promotes digital inclusion and guides international efforts to accelerate progress toward education goals.

By embracing these changes, education systems can better equip students for success in a complex, interconnected global landscape. Recent innovations in science education are transforming teaching and learning through technology integration, personalized learning, and immersive experiences.

### **Key Innovations in Science**

**Technology Integration:** The use of **virtual reality (VR)** and **augmented reality (AR)** is becoming increasingly prevalent in science classrooms. These technologies allow students to engage in immersive learning experiences, such as exploring the human body or conducting virtual experiments, which enhance understanding of complex scientific concepts.

**Artificial Intelligence (AI):** AI driven personalized learning systems are being implemented to tailor educational experiences to individual student needs. These systems can adapt the difficulty of materials based on performance, provide real time feedback, and automate grading, making learning more efficient and effective.

**Interactive Simulations:** Interactive simulations are being used to create engaging learning environments where students can experiment and visualize scientific phenomena. This hands-on approach helps students grasp difficult concepts and fosters critical thinking skills.

**Interdisciplinary Approaches:** There is a growing recognition of the importance of integrating science education with other disciplines, such as technology, engineering, and mathematics (STEM). This interdisciplinary approach prepares students for real world challenges and promotes a more holistic understanding of scientific principles.

**Focus on Equity and Inclusion:** Innovations in science education are also addressing issues of equity and inclusion. Programs are being developed to recruit and retain diverse educators and to create inclusive learning environments that support all students, particularly those from underrepresented backgrounds.

### **Science Education Innovations - Full Analysis (Updated 2024)**

- 1. Babbel - Innovative Language Learning for Science Education**
- 2. PIMSLEUR - Innovative Language Learning for Science Education**
- 3. MONDLY - Revolutionizing Science Education Globally**
- 4. Rosetta Stone - Master Language Learning with Ease**
- 5. LingQ - Innovative Language Learning Platform**
- 6. Memrise - Innovative Language Learning Platform**
- 7. Busuu - Language Learning Made Simple and Effective**
- 8. ITALKI - Personalized Language Learning Platform**
- 9. Skillshare - Empowering Creative Learning Worldwide**
- 10. VARSITY TUTORS - Personalized Learning Solutions**

### **Conclusion**

The landscape of science education is rapidly evolving, driven by technological advancements and a commitment to improving learning outcomes. By embracing these innovations, educators can create more engaging, effective, and inclusive science learning experiences that prepare students for the challenges of the future. As these trends continue to develop, they will play a crucial role in shaping the future of science education.

### **The Digital Imperative**

The digital revolution has transformed every aspect of our lives, including education. To remain relevant, science education must leverage digital tools and technologies. They include:

- 1. E-learning platforms:** Online resources and virtual labs can enhance learning outcomes and increase access to quality education. For instance, platforms like Coursera and edX have democratized access to global knowledge, allowing students to access top-class courses from anywhere in the world.
- 2. Digital literacy:** Educators must develop skills to effectively integrate technology into their teaching practices. This includes using tools like simulations, animations, and games to make learning more engaging and interactive.
- 3. Data-driven instruction:** Leveraging data analytics to inform teaching and learning. By analyzing student performance data, educators can identify areas of strength and weakness, tailor instruction to meet individual needs, and improve learning outcomes.

### **Case Studies: Success Stories in Nigeria**

There are several success stories in Nigeria that demonstrate the impact of innovation and digital transformation in science education. For instance:

1. The African Leadership in Science Program (ALSP) has trained over 1,000 science teachers in Nigeria, improving science education in over 500 schools.
2. The Nigeria Science Foundation has invested over ₦1 billion in science education projects, including the development of science clubs and competitions.

As educators, we have a critical role in shaping Anambra and indeed Nigeria's future. By harnessing innovation and digital transformation, we can create a sustainable science education system that produces globally competitive scientists and innovators.

**Let us work together to:**

3. Develop a digitally enabled science education system
4. Foster a culture of innovation and inquiry
5. Build partnerships for sustainable science education

Together, we can create a brighter future for Nigeria through science education.

**Recommendations**

The national education sector should:

1. Establish a national policy on science education that prioritizes innovation and digital transformation.
2. Invest in digital infrastructure and teacher training programs.
3. Foster partnerships with industries and international organizations to support science.

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## LEAD PAPER PRESENTATION OF THE CONFERENCE

### THEME: INNOVATION, DIGITAL TRANSFORMATION AND SUSTAINABLE SCIENCE EDUCATION IN THE 21<sup>ST</sup> CENTURY.

Okonta, Okechukwu Emmanuel (PhD, FNCS, MCPN, MIAENG)

#### **The Symbiotic Triangle: Weaving Innovation, Digital Transformation, and Sustainability into 21st Century Science Education**

##### **Introduction**

The 21st century is defined by its dual, often contradictory, nature. It is an era of breathtaking innovation and Digital Transformation, where artificial intelligence can diagnose diseases and virtual reality can transport a student to the surface of Mars. And it is also an era of profound, interconnected crises—climate change, biodiversity loss, and persistent social inequality—that collectively threaten the sustainable future of our planet. At the crossroads of this paradox lies education, specifically Science Education. The central challenge for educators and policymakers is no longer simply about equipping students with scientific facts, but about fostering the complex competencies needed to navigate an uncertain future.

In this context, science education cannot remain static. It must evolve to prepare learners not just to consume knowledge, but to innovate solutions, leverage digital tools responsibly, and act sustainably at all times. Therefore, there must be a pedagogical shift towards sustainability competencies and a deep, structural integration of digital technology.

However, as evidence from international bodies and cutting-edge research makes clear, *technology alone is not a panacea*. True transformation occurs not when digital tools are used as a substitute for traditional methods, but when they are deliberately deployed to enable inquiry-based, collaborative, and real-world learning that prepares students to become active agents of a more sustainable world.

Furthermore, we can assert that the future of effective science education lies at the intersection of three powerful forces: *Innovation, Digital Transformation, and Sustainability*. These are not isolated trends but rather the vertices of a symbiotic triangle. Innovation provides the pedagogical drive to rethink how we teach; digital transformation offers the tools and infrastructure to scale and deepen this new pedagogy; and sustainability provides the critical purpose and context—the "why"—those grounds learning is the most pressing challenges of our time. This lead paper will explore each vertex and demonstrate how their convergence creates a robust framework for preparing a generation of uncompromising scientists, digital citizens, and undeterred innovators capable of thriving in and healing the world.

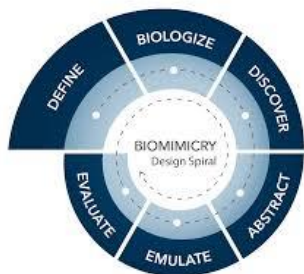
##### **Innovation as the Catalyst for Modern Science Education**

For decades science education was often a didactic transfer of facts, formulas, and established theories. In today's world, this is no longer sufficient. The 21st century, demands a different approach. Innovation in pedagogy means shifting the focus from learning about science to doing science.

##### **Redefining the "Scientific Method" for the 21st Century**

The traditional, linear scientific method is being augmented by more iterative, collaborative, and interdisciplinary approaches. Projects across Europe exemplify this shift. The **InNature** project,

for instance, introduces biomimicry as a core pedagogical framework. Instead of simply reading about natural phenomena, students are challenged to "understand, learn from and copy the strategies used by living things, with the intention of creating sustainable, innovative designs and technologies". This is innovation in action—teaching students to view nature not just as a subject to be studied, but as a database of proven solutions to be emulated.



**Diagram 1: Biomimicry Design Spiral**  
**From Rote Learning to Inquiry-Based Exploration**

## Biomimicry

Biomimicry is the innovation method of studying nature's models, systems, and processes to solve complex human problems sustainably. By emulating natural forms (design), processes (chemistry), and ecosystems, it aims to create more efficient and regenerative technologies. Common synonyms include bio-inspired design, biomimetics, and nature-based innovation

## **LESTO (Learn and Experience Science Together Online) - Education**

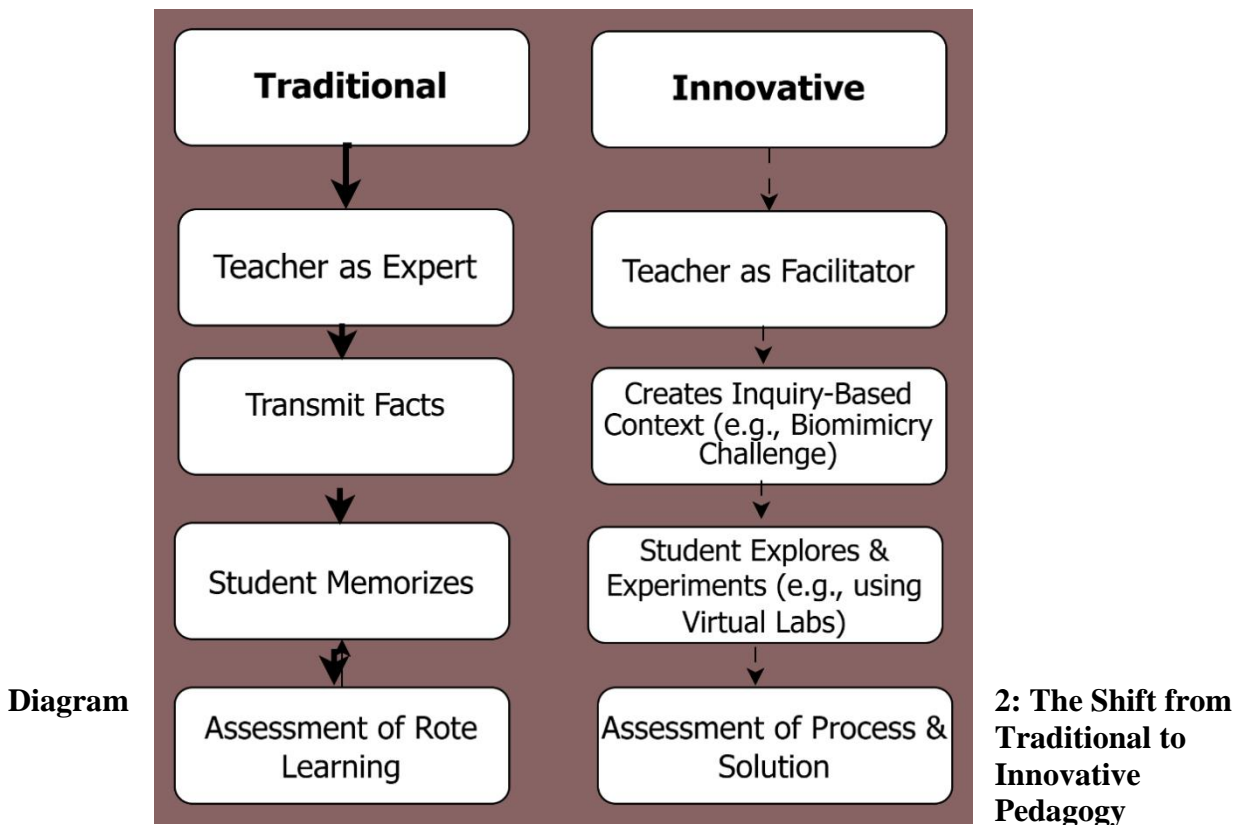
- **Context:** This project was developed as a direct response to the COVID-19 pandemic, which forced school closures and interrupted practical science teaching.
- **Focus:** It aimed to create a "Hands-on Science Education Platform" to combine practical, physical science kits with digital tools, aimed at students aged 10–14.
- **Post-COVID Impact:** Even beyond the immediate pandemic, the project addresses ongoing needs for digital tools, improved student engagement, and increased equity in education for disadvantaged students and girls.

Innovation also means breaking down the classroom walls. The TASTE project uses planetariums as immersive learning environments, allowing students to "move closer" to distant objects, feel the enormity of space or speed up time". This experiential framework moves learning from abstract reception to tangible, emotional experience, dramatically increasing motivation.

Similarly, the LESTO project, born out of the necessity of the COVID-19 pandemic, developed an online platform for hands-on science experiments. This ensures that even in remote settings, or for students from disadvantaged backgrounds, science learning remains an active, inquiry-based process. These examples demonstrate that pedagogical innovation is about creating active, engaging, and context-rich experiences that foster genuine curiosity and deeper cognitive

TASTE Project (Erasmus+): *The Teaching ASTronomy at educational level (TASTE) project is a European initiative involving planetariums and science centres that uses digital dome technology to teach topics like seasons and space sciences to students.*

processing.



### Digital Transformation—The Scaffolding for Deeper Learning

If innovation is the catalyst, digital transformation provides the essential scaffolding. It is the ecosystem of tools, platforms, and data that makes new forms of learning possible, accessible, and scalable. This goes far beyond simply replacing chalkboards with interactive whiteboards; it is a fundamental shift in the infrastructure of learning.

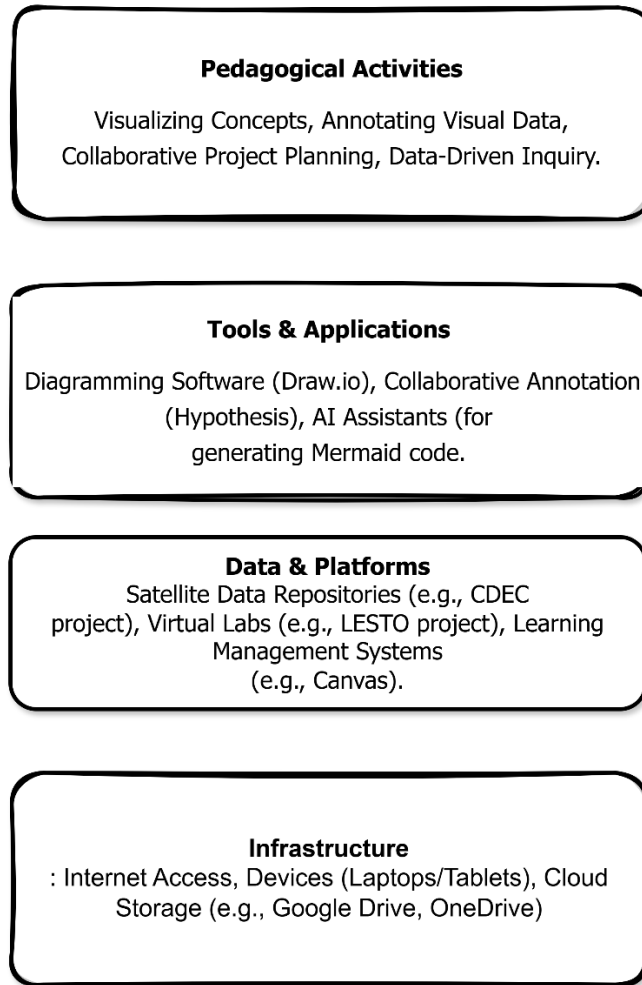
### The Digital Toolkit: From Virtual Labs to Satellite Data

The modern science classroom is no longer confined to a single room. It extends into virtual spaces and draws upon professional-grade data. The LESTO project's online portal for science experiments allows students to safely "carry out science experiments online and receive feedback from teachers and peers". Even more powerful is the use of authentic scientific data. The CDEC (Climate Data Entrepreneurial Club) project at the University of Paderborn brings "freely available European geo and earth observation data" directly into the hands of students. Learners in grades 10-13 use actual satellite data to develop their own sustainability projects, acquiring expertise in computer science and data analysis in the process. This is digital transformation at its most potent—democratizing access to the same tools that professional climate scientists use.

### **Fostering Collaboration and Visual Literacy**

Digital tools also revolutionize how students interact with information and each other. The ability to create, manipulate, and annotate visual representations is a key 21st-century skill. Tools like Draw.io enable students to build "concept maps," "scientific illustrations," and "process flows," which are high-impact instructional strategies with significant effect sizes on learning. Concept mapping, for example, helps students move towards the "Relational" and "Extended Abstract" levels of understanding by visually linking ideas.

Furthermore, collaborative annotation tools like Hypothesis now allow for "image annotations," enabling students and teachers to place pins and comments directly on "charts, graphs, and other visuals in online PDFs". This "brings the full page into the conversation," allowing for rich, collaborative deconstruction of complex scientific diagrams and data visualizations. The Victorian government's educational strategy even formalizes this as "joint construction of visual representations," where students collaboratively annotate maps and diagrams to design solutions for local environmental problems.



**Diagram 3: The Layers of Digital Transformation in Education**

## Sustainable Science Education—The Guiding Light

Innovation and digital tools, while powerful, remain directionless without a guiding purpose. In the 21st century, that purpose must be sustainability. A Nature Collection on "Education in the Anthropocene" argues that education is the key to "producing sustainability-oriented technologies, and their integration with everyday societal needs". It posits that a misalignment between technological innovation and societal understanding risks creating a world with advanced green technologies that populations cannot afford, integrate, or accept.

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***Education in the Anthropocene focuses on fostering ecological literacy, systemic thinking, and agency to prepare learners for a rapidly changing planet where human activity shapes Earth's systems. It moves beyond traditional curricula to emphasize interconnectedness, sustainability, and action-oriented approaches that foster resilience, ethics, and "planetary health" in response to environmental crises.***

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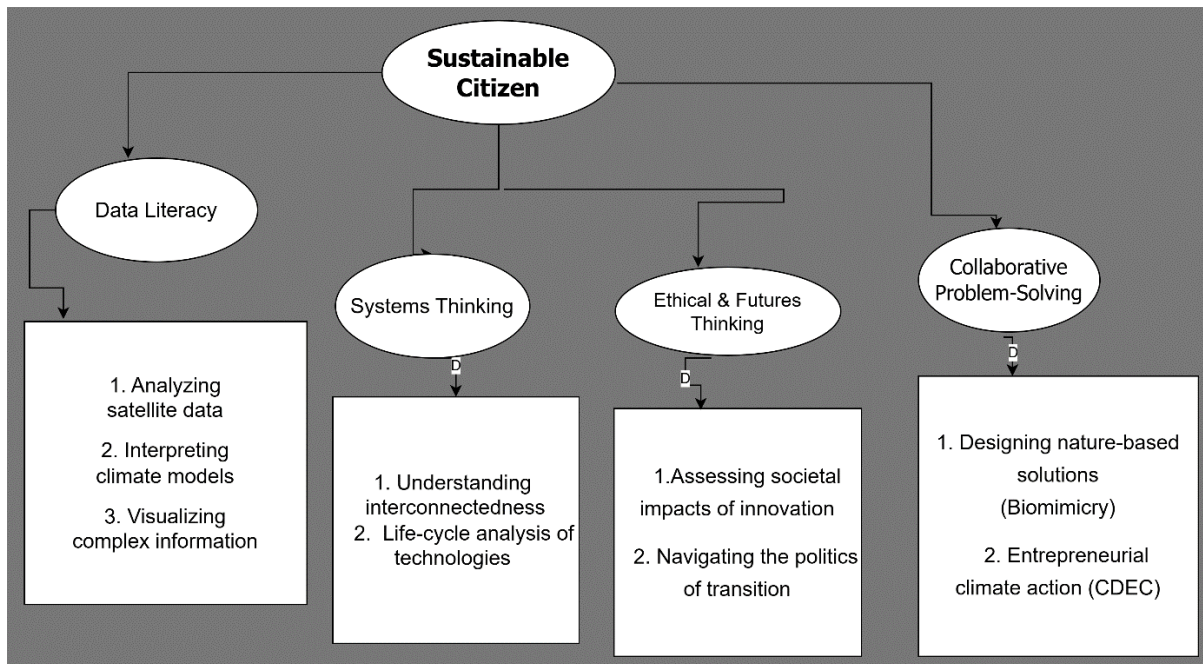
## Education for the Anthropocene: A New Foundational Ethos

Sustainable science education, therefore, is not just an add-on topic about recycling or climate change. It is a foundational principle that frames all scientific inquiry. It asks students to consider the socio-economic realities, ethical implications, and long-term impacts of scientific and technological solutions. The **SHORE** project embodies this by aiming to "increase scientific literacy about European seas and rivers" and directly supports the EU Mission to "Restore our Oceans and Waters". Students are not just learning marine biology; they are engaging in "blue curricula" to actively safeguard biodiversity.

## Developing Competencies for a Green and Digital Transition

***The Shore Project (Shore - School Outreach for Ocean Restoration) Is A Horizon Europe-Funded Initiative Empowering Schools to Promote Blue Sustainability in Five Key European Regions: Baltic, Black, Mediterranean, Danube, And Rhine. It Provides Up To €10,000 In Grants Per School Project to Foster Ocean Literacy, Empowering Youth to Become Agents of Change in Water Protection.***

This new focus demands a new set of competencies. Students must learn to navigate the "interconnected matrix (human-economic-societal)" that determines whether a sustainability-oriented technology succeeds. This involves critical thinking about "values embedded in the transition economy" and understanding the "societal barriers" to change. The interdisciplinary approach of the CDEC IT/ Technology Services, which brings together geography, computer science, and entrepreneurial education, is a direct response to this need, training teachers to help students become "data literate" and apply that literacy to climate action. The goal is to create citizens who can not only understand a graph of rising CO<sub>2</sub> levels but can also use data to advocate for and implement local solutions.

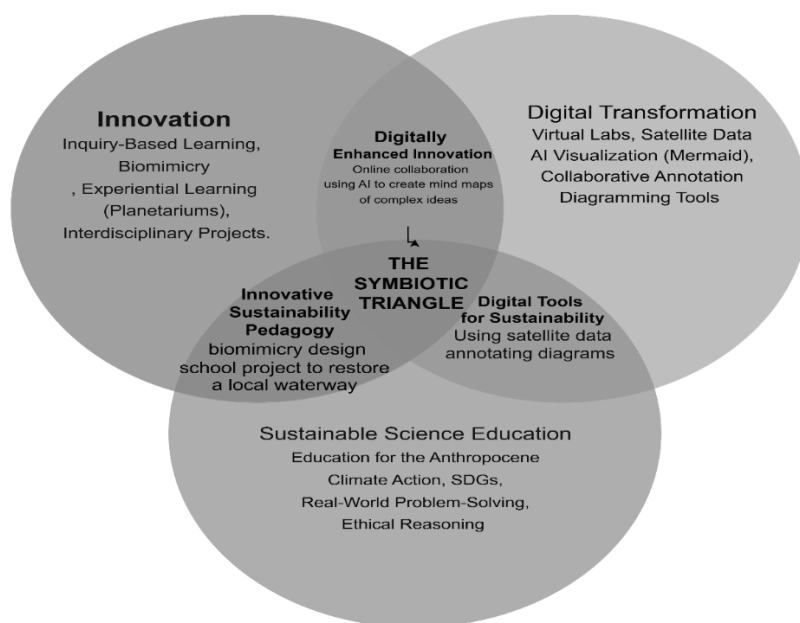


**Diagram 4: Competencies for the Green-Digital Transition**

### Synthesis: The Symbiotic Triangle in Action

The true power of this framework is revealed when all three vertices—Innovation, Digital Transformation, and Sustainability—converge. They do not operate in silos but in a state of dynamic synergy.

- Digital tools enable innovative pedagogies for sustainability. The CDEC project is a perfect illustration. It uses digital transformation (satellite data, AI tools) to fuel pedagogical innovation (project-based, entrepreneurial learning) with the explicit goal of sustainability (climate action projects). The digital data is the raw material, the innovative project format is the process, and climate protection is the purpose.
- Innovation redefines how we use digital tools. The move towards "joint construction" and "image annotation" represents a pedagogical innovation in how we use technology. It shifts students from passive consumers of digital diagrams to active, collaborative constructors of visual knowledge, a skill essential for tackling complex environmental problems.
- Sustainability provides the context for innovation. The challenge of "restoring our oceans" or designing a biomimetic solution provides a rich, meaningful, and urgent context that drives student engagement and justifies the use of sophisticated digital tools. It answers the student's question: "Why are we learning this?"



**Diagram 5: The Symbiotic Triangle (Venn Diagram)**

**Description:** A three-circle Venn diagram, each circle representing one core concept.

**Circle A: Innovation.** Keywords: *Inquiry-Based Learning, Biomimicry, Experiential Learning (Planetariums), Interdisciplinary Projects.*

**Circle B: Digital Transformation.** Keywords: *Virtual Labs, Satellite Data, AI Visualization (Mermaid), Collaborative Annotation (Hypothesis), Diagramming Tools (Draw.io).*

**Circle C: Sustainable Science Education.** Keywords: *Education for the Anthropocene, Climate Action, SDGs, Real-World Problem-Solving, Ethical Reasoning.*

**Overlap A+B (Digitally Enhanced Innovation):** *Online collaboration spaces for project design, using AI to create mind maps of complex ideas.*

**Overlap B+C (Digital Tools for Sustainability):** *Using satellite data to monitor local deforestation, annotating diagrams of carbon capture technologies.*

**Overlap A+C (Innovative Sustainability Pedagogy):** *A biomimicry design challenge, a school project to restore a local waterway.*

**Centre (A+B+C - THE SYMBIOTIC TRIANGLE):** *The CDEC project—students using digital satellite data (B) in an innovative, project-based format (A) to develop entrepreneurial solutions for climate sustainability (C).*

**Conclusion:** Educating Symbiotic Thinkers for an Interconnected WorldThe challenges of the 21st century are too complex to be addressed by single-discipline, rote-learned knowledge. They demand a new kind of thinker—one who is as comfortable with a satellite data stream as they are with the principles of biomimicry, and who approaches every technological problem with an ethical and sustainable mindset.

The symbiotic triangle of Innovation, Digital Transformation, and Sustainable Science Education provides a roadmap for cultivating this new generation. *Innovation* sparks the curiosity and drive to explore; *digital transformation* provides the powerful, real-world tools for that exploration; and *sustainability* anchors the entire endeavour in the urgent task of building a better, more equitable, and more resilient society. By consciously weaving these three threads together, educators can transform science education from a compulsory subject into a vital, empowering, and hopeful discipline—one that equips learners not just to understand the world, but to innovate within it and sustain it for the future.

Thank you for your patience in listening.

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## PAPER 6

### INTRINSIC MOTIVATION AS A PREDICTOR OF SENIOR SECONDARY STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN ORON LOCAL GOVERNMENT AREA OF AKWA IBOM STATE, NIGERIA

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#### Abstract

This study adopted predictive research design to examine intrinsic motivation as a predictor of students' academic achievement in Mathematics in the Oron Local Government Area of Akwa Ibom State, Nigeria. Two research questions were posed, and two hypotheses were formulated to guide the study. A proportionate sampling technique was used to select a sample of 240 SS2 students for the research. Two instruments, titled "Intrinsic Motivation (IM)" and "Students Mathematics scores from their classroom teachers (SMSCT)," The intrinsic motivation questionnaire was developed by the researcher, validated by experts, and utilized for data collection. The average reliability of the instruments was determined using the Cronbach Alpha method which yielding coefficients of 0.87. The hypotheses were tested using Simple Linear Regression Analysis for both hypotheses, with all tests conducted at a 0.05 level of significance. Findings indicated that both Interest-Based Motivation and Mastery Motivation were significant predictors of students' academic achievement in Mathematics. It was concluded that students' achievement in Mathematics depends on their intrinsic motivation, specifically in terms of Interest-Based Motivation and Mastery Motivation. It is recommended, among other strategies, that educators implement methods to spark interest and make learning more engaging, allowing students to explore mathematical concepts that align with their personal interests and goals.

**Keywords:** Intrinsic motivation, Interest based motivation, Senior secondary students' achievement, Mastery motivation

#### Introduction

Mathematics is a foundational subject that plays a critical role in students' academic success and future career opportunities. It is a gateway subject for many fields, including science, technology, engineering, and mathematics (STEM). However, many students struggle with mathematical concepts, leading to low academic achievement, negative self-image and decreased motivation, creating a cycle of underachievement (Ibok, Unoh, & Asuquo, 2024). The consequences of low academic achievement in mathematics extend beyond immediate academic performance which also limit students' options for advanced studies and their careers options (Wang et al., 2019). According to Duncan and Murnane, (2016), the low achievement in mathematics can have lasting effects on students' educational trajectories, including higher dropout rates and lower school enrollment. Previous studies may not have focused specifically on the Oron Local Government Area or similar regions in Akwa Ibom State, limiting the

generalizability of findings. This study aims to fill this gap by providing insights specific to this locality. Many studies may focus on primary or tertiary education, leaving a gap regarding secondary school students, particularly those in SS2 (Senior Secondary 2). Existing research may have primarily examined extrinsic factors (e.g., rewards, parental support) influencing academic achievement, with less emphasis on intrinsic motivation. Understanding the role of intrinsic motivation can inform teaching strategies that foster students' internal drive to learn, leading to improved academic outcomes in mathematics. This study aims to address significant gaps in the understanding of intrinsic motivation as a predictor of academic achievement in mathematics among SS2 students in Oron Local Government Area. By exploring this relationship, the study seeks to contribute valuable insights that can enhance educational practices and outcomes in the region (Ibok, *et al* , 2025).

Intrinsic motivation is a vital determinant of students' academic achievement in mathematics. It not only enhances engagement and persistence but also fosters the development of critical thinking and problem-solving skills. Intrinsic motivation is characterized by a genuine interest in the subject matter and a desire to master skills and concepts. Ibok , Thomas, and Nyong,(2019) defined intrinsic motivation as the internal drive that compels individuals to engage in activities for their own sake, driven by personal interest, enjoyment, or the desire to master a skill. Intrinsic motivation is crucial for students' academic success, particularly in subjects like mathematics, which often present challenges that can discourage learners. The foundation of intrinsic motivation is rooted in Self-Determination Theory (SDT), developed by Deci and Ryan (2000). This theory posits that intrinsic motivation flourishes when three basic psychological needs are met: autonomy, competence, and relatedness. Autonomy refers to the desire to have control over one's actions, competence involves feeling effective in one's activities, and relatedness encompasses the need to connect with others. When these needs are satisfied, individuals are more likely to engage in activities with intrinsic motivation, leading to enhanced performance and well-being. According to Schunk, Pintrich, and Meece, (2014), students who are intrinsically motivated are more likely to engage deeply with mathematical concepts, persist through difficulties, and achieve higher academic outcomes. Intrinsic motivation is associated with a deeper engagement in learning activities, which is essential for mastering complex subjects like mathematics (Ibok, Thomas, & Nyong,(2019). However, many students who report lack of intrinsic motivation can lead to decreased academic performance and lower overall achievement in mathematics. A study conducted by Sierens et al. (2017) found that students who exhibited higher levels of intrinsic motivation performed better in mathematics assessments compared to their peers with lower motivation levels.

Also a research study conducted by Delen et al. (2020) revealed that students who are intrinsically motivated are more likely to engage in higher-order thinking and apply mathematical concepts in real-world situations, leading to enhanced academic performance. Research by Wang et al. (2019) emphasized the importance of a supportive classroom environment that encourages exploration and fosters a sense of belonging. Additionally, teaching strategies that promote autonomy, such as providing choices in learning activities, have been shown to enhance intrinsic motivation (Patall, Cooper, & Robinson, 2018). For this study to have direction, two Intrinsic motivation were considered which include Interest-Based Motivation and mastery motivation.

Interest-Based Motivation is the type of motivation that arises when individuals engage in activities that they find inherently enjoyable or interesting. Students may pursue mathematics problems out of curiosity or a desire to explore mathematical concepts further(Ibok, Ogar, Akpa, Olofu, Obeten, Ewa, Obeten, Unamba, Edeh, Patrick, Bessong, Bessong, Obi, Omini & Anam, 2025). Interest-based motivation is crucial in educational settings, as it often leads to deeper engagement and sustained learning particularly in subjects like mathematics. This type of

motivation is characterized by the inherent enjoyment and curiosity that students experience when engaging with mathematical concepts. Numerous studies have explored the relationship between interest-based motivation and academic performance, highlighting its significance in educational settings (Ryan & Deci, 2017). Liu et al. (2020) conducted a meta-analysis examining the relationship between students' interest in mathematics and their academic performance. The findings indicated that higher levels of interest were significantly associated with improved mathematics achievement across various educational contexts. The authors emphasized that fostering interest in mathematics can lead to better engagement and persistence in learning. Baker et al. (2019) explored the impact of interest on students' engagement and performance in mathematics. Their study revealed that students who reported higher levels of interest in mathematics not only performed better on assessments but also exhibited greater persistence in problem-solving tasks. The researchers concluded that interest serves as a motivational driver that enhances students' academic success. Keller and Bless (2017) investigated the role of interest in mathematics learning among middle school students. Their results showed that students with strong interest in mathematics were more likely to engage in self-regulated learning strategies, which in turn positively impacted their academic achievement. The study highlighted the importance of cultivating interest to promote effective learning strategies. Hidi and Renninger (2017) provided a comprehensive review of the literature on interest and academic achievement, concluding that interest-based motivation significantly influences students' learning outcomes. They noted that interest not only enhances engagement but also facilitates deeper cognitive processing of mathematical concepts, leading to improved performance. Zhang et al. (2021) examined the relationship between interest-based motivation and academic achievement in a sample of high school students. Their findings indicated that students who were intrinsically motivated by their interest in mathematics achieved higher scores on standardized tests. The study suggested that educators should implement strategies to enhance students' interest in mathematics to improve academic outcomes.

Another intrinsic motivation examined in this study is Mastery motivation. Mastery motivation refers to the intrinsic drive to improve one's skills and competencies through effort and persistence in challenging tasks. This type of motivation is particularly relevant in mathematics education, where students often face complex problems that require sustained effort and a willingness to learn from mistakes (Ibok, Ogar., Olofu, Anam., Bessong, Oduk, Bessong, Amos, Ewa, Obeten, Patrick, Masor., Owan, , Akpan , Ani., Afiene, Olenye, & Igba, 2025). Mastery motivation is grounded in the concept of self-regulated learning, which emphasizes the importance of goal setting, self-efficacy, and persistence in achieving academic success (Zimmerman, 2018). When students are motivated by a desire to master mathematical concepts, they are more likely to engage in effective learning strategies that enhance their performance. Recent empirical studies have highlighted the significant role of mastery motivation in influencing students' academic achievement in mathematics. *Schunk and Zimmerman (2017)* conducted a comprehensive review of research on self-regulated learning and its impact on academic achievement. They found that students with high mastery motivation were more likely to set challenging goals, utilize effective learning strategies, and ultimately achieve higher academic performance in mathematics. *Perry et al. (2018)* explored the role of mastery motivation in a sample of high school students. Their study found that students who focused on mastering mathematical skills rather than merely performing well on tests experienced greater academic success. The authors emphasized that mastery-oriented students tended to adopt adaptive learning strategies, leading to improved performance. *Rauf et al. (2021)* investigated the impact of mastery motivation on academic achievement in mathematics among primary school students. Their results indicated that mastery motivation significantly predicted students' performance in mathematics, suggesting that fostering a mastery-oriented mindset can enhance academic outcomes. *Vallerand et al. (2019)* explored the relationship between mastery

motivation and academic achievement in a longitudinal study involving high school students. The researchers found that students who maintained a focus on mastery over time showed consistent improvements in their mathematics performance, highlighting the long-term benefits of mastery motivation.

### **Statement of the problem**

Intrinsic motivation is increasingly recognized as a critical factor influencing students' academic achievement, particularly in subjects like mathematics. This internal drive to learn and succeed—characterized by a genuine interest in the subject matter—has significant implications for how students engage with mathematical concepts and their overall performance. Despite its importance, many students exhibit low levels of intrinsic motivation in mathematics, leading to disengagement, poor performance, and negative attitudes toward the subject. A considerable percentage of students in Oron Local Government Area of Akwa Ibom, Nigeria are not proficient in mathematics, they are not committed neither motivated or encouraged. This has resulted to students showing negative attitude, low self concept, loss of interest and lack of attention in class during Mathematics instructions which lead to students' persistence poor academic performance in Mathematics for both internal and external examination.. It is against these notable and identified problems that the research intended to examine intrinsic motivation as a predictor of students' academic achievement in mathematics in Oron Local Government, Akwa Ibom State, Nigeria.

### **Purpose of the Study**

Specifically, the study sought to examine;

1. The predictive value of interest-Based Motivation on students' academic achievement in Mathematics
2. the predictive value of mastery Motivation on students' academic achievement in Mathematics

### **Research Questions**

The following research questions were posed;

1. What is the predictive value of interest-based motivation on students achievement in mathematics?
2. What is the predictive value of mastery motivation on students achievement in mathematics?

### **Hypotheses**

The following null hypotheses were formulated to guide the study.

1. Interest-Based Motivation does not significantly predicts students' academic achievement in Mathematics
2. Mastery motivation does not significantly predicts students' academic achievement in Mathematics

### **Methodology**

The study was conducted in the Oron Local Government Area of Akwa Ibom State, Nigeria, using predictive research design. This design was chosen because the variables of the study had already occurred, and the researcher had no direct control over them. Instead, the study aimed to establish the relationship between intrinsic motivation (specifically Interest-Based Motivation and Mastery Motivation) and students' academic achievement in Mathematics. This is done by identify how variations in intrinsic motivation predict changes in academic outcomes.

The population for the study consisted of 879 SS2 students (478 females and 401 males) from four approved public secondary schools in the Oron Local Government Area. A proportionate sampling technique was employed to ensure that all schools and students from the four secondary schools had an equal chance of being selected. This technique ensured that 27.3% of the total student population from each school was included in the study.

To select the schools, the researcher utilized all four schools in the study area. The sampling method involved a hat-and-draw technique, where "Yes" and "No" were written on pieces of paper, folded, mixed, and placed in a basket. Each student was then asked to draw a paper without replacement. Those who drew papers marked "Yes" were included in the study. A sample of 240 SS2 students (131 females and 109 males) was selected, representing 28.4% of the entire SS2 student population in the area.

Data collection instruments included a self-developed questionnaire titled “Intrinsic Motivation and Students Mathematics scores from their classroom teachers (SMSCT).” The questionnaire comprised 12 items, with 6 items measuring each sub-level of Interest-Based Motivation and Mastery Motivation. Responses were based on a four-point scale: strongly agree, agree, disagree, and strongly disagree.

Both instruments underwent face validation by two experts in Measurement and Evaluation and two Mathematics Educators from the University of Calabar. Corrections suggested by the experts were implemented, and the instruments were deemed valid. The average reliability of the questionnaire, assessed using the Cronbach Alpha method, was 0.87. Since both reliability indices exceeded 0.50, they were considered sufficiently high for the study.

Data collected were analyzed using the Statistical Package for Social Sciences (SPSS). The research questions was answer using *Mean, Beta (B) and Adjusted R<sup>2</sup>* while hypotheses were tested using Simple Linear Regression for two hypotheses, with all tests conducted at a 0.05 level of significance.

**Results**

**Research Question 1:** What is the predictive value of interest-based motivation on students achievement in mathematics?

**Table 1:** *Mean, Beta (B) and Adjusted R<sup>2</sup> on the extent to which Interest-Based Motivation predicts students’ academic achievement in Mathematics*

Variables	No of item	Mean	SD	B	R <sup>2</sup>	Adjusted R <sup>2</sup>
Interest-Based Motivation	6	17.000	1.73567	.965	.931	.930
Mathematics achievement	50	36.5000	4.79714			

The results in Table 1 show an adjusted R<sup>2</sup> of 0.931 indicates that, 93.1% variation in achievement attributed to Interest-Based Motivation.. Furthermore, the Beta value of 0.965, which measures the effect size or strength of the relationship between the variables, reveals that Interest-Based Motivation contributes 96.5% to the effect, predicting students’ academic achievement in Mathematics in Oron Local Government, Akwa Ibom State, Nigeria.

**Research Question 2:** To what extent does mastery motivation predicts students’ academic achievement in Mathematics?

**Table 2: Mean, Beta (B) and Adjusted R<sup>2</sup> on the extent to which Mastery motivation predicts students' academic achievement in Mathematics**

Variables	No of item	Mean	SD	B	R <sup>2</sup>	Adjusted R <sup>2</sup>
Mastery motivation	6	18.500	1.89693	.929	.863	.862
Mathematics achievement	50	36.5000	4.79714			

The results in Table 2 show an adjusted R<sup>2</sup> of 0.862 indicates 86.2% variation in achievement attributed to mastery motivation.. Furthermore, the Beta value of 0.929, which measures the effect size or strength of the relationship between the variables, reveals that mastery Motivation contributes 92.9% to the effect, predicting students' academic achievement in Mathematics in Oron Local Government, Akwa Ibom State, Nigeria.

**H0<sub>1</sub>:** Interest-Based Motivation does not significantly predicts students' academic achievement in Mathematics.

**Table 3: Simple Regression Analysis of Interest-Based Motivation as predictors of students' academic achievement in Mathematics.**

Variables	Mean	Standard deviation				
Interest-Based Motivation	17.000	1.73567				
Mathematics achievement	36.5000	4.79714				
Model	R	R. square	Adjusted R. Square	Std error of the estimate		
1	.965 <sup>a</sup>	.931	.930	1.26358		
Model	Sum of square	Df	Mean square	F-value	p-value	
Regression	5120.000	1	5120.000	3206.737	.000 <sup>b</sup>	
Residual	380.000	238	1.597			
Total	5500.000	239				
Variables	Unstandardized regression weight B	Standardized regression weight	Beta weight	t-value	p-value	
(Constant)	78.833	.805		97.967	.000	
Interest Based motivation	2.667	.047	.965	56.628	.000	

\* Significant at p<.05

The results in Table 3 shows that the R-value of .965 was obtained which shows a positive high relationship between Interest-Based Motivation and students' academic achievement in Mathematics. The r value produced an R-squared value and adjusted R-square of 0.921 and

0.930 respectively. This indicated that Interest-Based Motivation accounted for 93.0% which is high determinant of students' academic achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria. The positive value of unstandardized regression weight indicates that as the independent variable increases(interest-based motivation), the dependent variable also increases(Mathematics achievement). The p-value (.000) associated with the computed F-value (3206.737) was less than .05. As a result, the null hypothesis was rejected. This means that Interest-Based Motivation significantly influence students' academic achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria with both the regression constant (78.833) and coefficient (2.667) contributing significantly in the prediction model (t= 97.967 & 56.628 respectively, p=.000 & .000 < .05). Conclusively, Interest-Based Motivation significantly predicts students' academic achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria.

**H<sub>02</sub> :** Mastery Motivation does not significantly predicts students' academic achievement in Mathematics.

**Table 4: Simple Regression Analysis of mastery Motivation as predictors of students' academic achievement in Mathematics.**

Variables	Mean	Standard deviation			
Mastery Motivation	18.500	1.89693			
Mathematics achievement	36.5000	4.79714			
Model	R	R. square	Adjusted R. Square	Std error of the estimate	
1	.929 <sup>a</sup>	.863	.862	1.78150	
Model	Sum of square	Df	Mean square	F-value	p-value
Regression	4744.651	1	4744.651	1494.974	.000 <sup>b</sup>
Residual	755.349	238	3.174		
Total	5500.000	239			
Variables	Unstandardized regression weight B	Standardized regression weight	Beta weight	t-value	p-value
(Constant)	69.907	.949		73.695	.000
Mastery motivation	2.349	.061	.929	-38.665	.000

\* Significant at p<.05

The results in Table 4 shows that the R-value of .929 was obtained which shows a positive high relationship between mastery Motivation and students' academic achievement in Mathematics. The r value produced an R-squared value and adjusted R-square of 0.863 and 0.862 respectively. This indicated that mastery Motivation accounted for 86.2% which is high determinant of students' academic achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria. The positive value of unstandardized regression weight indicates that as the independent variable increases(mastery motivation), the dependent variable also increases(Mathematics achievement). The p-value (.000) associated with the computed F-value

(1494.974) was less than .05. As a result, the null hypothesis was rejected. This means that mastery Motivation significantly influence students' academic achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria with both the regression constant (69.907) and coefficient (2.349) contributing significantly in the prediction model ( $t=73.695$  &  $38.665$  respectively,  $p=.000$  &  $.000 < .05$ ). Conclusively, Interest-Based Motivation significantly predicts students' academic achievement in Mathematics in Oron Local Government Area of Akwa Ibom State, Nigeria.

## **Discussion**

The results of research question one show a high variance in the predictive value of students' academic achievement in mathematics attributed to interest-based motivation. Students with a genuine interest in mathematics are more likely to engage deeply with the subject, leading to better understanding and retention of mathematical concepts. Interest-based motivation often leads to higher levels of engagement in classroom activities, such as discussions, group work, and hands-on learning experiences, which can positively impact academic performance. The results of the first hypothesis revealed that interest-based motivation significantly predicts students' academic achievement in Mathematics. This is because interest-based motivation is a significant determinant of students' academic success in mathematics. The empirical evidence highlights the positive correlation between students' interest in mathematics and their performance, emphasizing the need for educators to foster this type of motivation. By implementing strategies that enhance interest, educators can improve students' engagement and academic success in mathematics. These findings align with Liu et al. (2020), who found that higher levels of interest were significantly associated with improved mathematics achievement across various educational contexts. Additionally, the findings are consistent with Keller and Bless (2017), who investigated the role of interest in mathematics learning among middle school students and found that students with a strong interest in mathematics were more likely to engage in self-regulated learning strategies, positively impacting their academic achievement. The findings also align with Hidi and Renninger (2017), who found that interest-based motivation significantly influences students' learning outcomes. Similarly, Zhang et al. (2021) examined the relationship between interest-based motivation and academic achievement in a sample of high school students, finding that students who were intrinsically motivated by their interest in mathematics achieved higher scores on standardized tests. In conclusion, the academic achievement of students in Mathematics depends on their interest-based motivation in learning mathematical concepts.

The results of research question two show a high variance in the predictive value of students' academic achievement in mathematics attributed to mastery motivation. Students motivated by mastery are often more resilient when encountering difficulties in mathematics. They view challenges as opportunities to learn rather than obstacles, which can lead to improved achievement. Mastery motivation encourages students to put in the necessary effort and practice to improve their skills, which directly contributes to their academic success in mathematics. The results of the second hypothesis revealed that mastery motivation significantly predicts students' academic achievement in Mathematics. This is because mastery motivation plays a vital role in determining students' academic success in mathematics. The empirical evidence underscores the importance of fostering mastery-oriented mindsets to enhance engagement and performance. By implementing strategies that promote mastery motivation, educators can significantly improve students' success in mathematics. This finding is in line with Schunk and Zimmerman (2017), who conducted a comprehensive review of research on self-regulated learning and its impact on academic achievement. They found that students with high mastery motivation were more likely to set challenging goals, utilize effective learning strategies, and ultimately achieve higher

academic performance in mathematics. The findings are also consistent with Perry et al. (2018), who found that students who focused on mastering mathematical skills rather than merely performing well on tests experienced greater academic success. Similarly, Rauf et al. (2021) investigated the impact of mastery motivation on academic achievement in mathematics among primary school students and found that mastery motivation significantly predicted students' performance in mathematics. In agreement with this finding, Vallerand et al. (2019) found that students who maintained a focus on mastery over time showed consistent improvements in their mathematics performance, highlighting the long-term benefits of mastery motivation. In conclusion, the academic achievement of students in Mathematics depends on their mastery motivation in learning mathematical concepts.

### **Conclusion**

The findings of the study revealed that interest-based motivation and mastery motivation are significant predictors of students' academic achievement in Mathematics. Intrinsic motivation plays a vital role in students' academic success in mathematics. It encompasses the internal drives that encourage students to engage with mathematical concepts for the sake of learning and personal satisfaction rather than external rewards. Intrinsic motivation—such as interest and mastery—collectively contributes to a deeper engagement with the subject matter, fostering persistence, resilience, and a positive attitude towards learning. In conclusion, when students are intrinsically motivated, they are more likely to perform better academically, develop a growth mindset, and cultivate a lifelong appreciation for mathematics.

### **Recommendations**

Based on the findings of the study, the following recommendations were made;

1. Educators should implement strategies that encourage the creation of a relevant curriculum that incorporates real-world applications and examples resonating with students' lives and interests. This relevance can spark interest, make learning more engaging, and allow students to explore mathematical concepts that align with their personal interests and goals.
2. Teachers should be encouraged to offer feedback that emphasizes improvement and mastery rather than just grades, helping students understand their progress and areas for growth.
3. School administrators should be encouraged to build students' confidence in their mathematical abilities, which should include fostering intrinsic motivation by setting achievable goals and celebrating small successes.
4. The government, in partnership with the Ministry of Education, should implement programs focused on intrinsic motivation among students. These programs can include activities that promote students' interest, mastery, and positive coping strategies in the face of mathematical challenges.

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