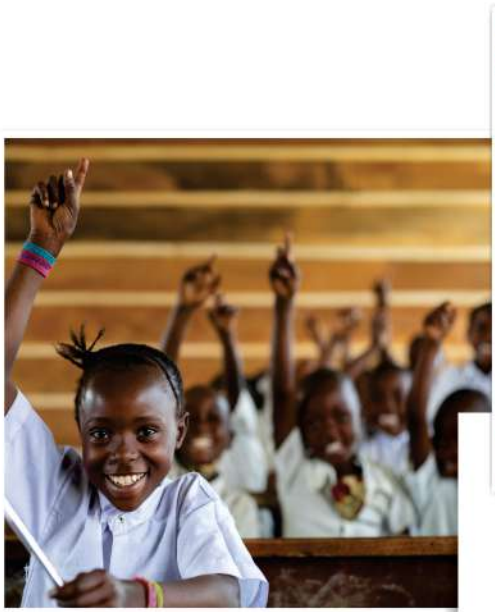
2025 Electronic Book (E-Book) of Association of Science Educators Anambra (ASEA)
http://jisepublications.org

# INNOVATIVE STRATEGIES FOR TEACHING VOCATIONAL, SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION: CLASSROOM PRACTICES



PROF. JOSEPHINE N. OKOLI

INNOVATIVE STRATEGIES FOR TEACHING VOCATIONAL, SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION: CLASSROOM PRACTICES

PROF. JOSEPHINE N. OKOLI

# INNOVATIVE STRATEGIES FOR TEACHING VOCATIONAL, SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION: CLASSROOM PRACTICES

**EDITOR**
**PROF. JOSEPHINE N. OKOLI**

# INNOVATIVE STRATEGIES FOR TEACHING VOCATIONAL, SCIENCE, TECHNOLOGY AND MATHEMATICS EDUCATION:

# CLASSROOM PRACTICES

A publication of Association of Science Educators Anambra (ASEA)

Printed in Nigeria in the year 2025 by:
**Love Isaac Consultancy Services**
No 1 Etolue Street, Ifite Awka, Anambra State, Nigeria
+234-803-549-6787, +234-803-757-7391

© Association of Science Educators Anambra (ASEA)
Anambra State, Nigeria.

**ISBN: 978-978-695-938-2**

**Copyright**

*All rights reserved. No part of this publication should be reproduced, stored in any retrieval system or transmitted in any form or by any means in whole or in part without the prior written approval of the copyright owners*

# PREFACE

The electronic book (e-book) acknowledges that traditional methods in Vocational, Science, Technology and Mathematics Education: Classroom Practices may not be sufficient to equip students with the necessary skills for a rapidly evolving technological landscape.

Therefore, it advocates for the adoption of Innovative teaching approaches that promote a more dynamic and effective learning experience.

**Prof. Josephine N. Okoli**
Faculty of Education,
Science Education Department,
Nnamdi Azikiwe University Awka, Anambra State, Nigeria.

# TABLE OF CONTENT

## FOREWORD

This book entitled "**Innovative Strategies for Teaching Vocational, Science, Technology and Mathematics Education: Classroom Practices",** is a book of readings on various innovative classroom pedagogies. It is a welcome literature for Education System and a very important resource book for teachers who are functioning in the disciplines of Vocational Education, Science, Mathematics and Technology education and training. It is a compendium of most of the **active learning strategies** aimed at producing graduates who have been prepared for adaptation to the conditions of the 21st century world of fluidity. The 21st century world accommodates soft skills which the individual can edit from time to time as the conditions of socio-cultural, economic and technological environments change constantly and uncontrollably. A century in which cross-border job openings are important means of employment, a century where attitude is more important than subject-based excellence, a century where collaboration, innovation and creativity are irreducible demands by employers of labour, a century where adaptive skills are critical for entrepreneurship, creation of jobs and wealth.

All categories of teachers at all levels of education would find this resource book interesting and professionally helpful for their teaching practice. Because conditions of the modern world are in perpetual flux, teachers have to re-skill in order to produce adaptive graduates and the era of lecture method is literally over. It is these modern innovative instructional strategies that would enable teachers to produce such graduates who would survive and then succeed in the 21st century global economy.

This book would also be very useful to researchers and innovators in the envisioned pedagogic paradigm shift of this era. I therefore, proudly recommend this book, a compendium on innovative pedagogies to all classes of teachers and researchers on pedagogies and curriculum reforms in the modern era.

**Prof. Zephrinus C. Njoku**
Faculty of Education,
Science Education Department,
University of Nigeria, Nsukka, Nigeria.

# BIODATA OF CONTRIBUTORS

**Chika M. Okonkwo** is a staff of Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, Nigeria. She obtained her M.ed in measurement and evaluation from Imo state university, Nigeria. Currently she is a PhD student in measurement and evaluation from Michael Okpara University of Agriculture Umuahia, Abia State, Nigeria. She is a researcher who have contributed in some Journals. Chika M. Okonkwo has attended conferences and workshop. She is a member of learned societies such as Teachers Registration Council of Nigeria (TRCN) and Association of behavioural Research Analysis and Psychometricians (AB-ReAP).

**Mrs Anaekwe Grace U. (MSTAN)** is a lecturer at Federal College of Education (Technical) Umunze, Anambra State. She attended Girls High School Uga (1983). She later proceeded to Federal College of Education (Technical) Umunze, Anambra State where she obtained her National Certificate in Education (NCE) in Home Economics in 1995. Mrs Anaekwe continued with her academic pursuit at Nnamdi Azikiwe University, Awka, Anambra State, where she got her Bachelor's Degree in Education (B.ed) in Adult / Health Education in 2003. At University of Nigeria Nsukka, she bagged her Masters in Education (M.ed) in Public Health in 2017. She had attended many conferences with paper presentations. She belongs to many professional bodies including Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN). Mrs Anaekwe Grace is married and the marriage is blessed with many children.

**Obiefuna, Grace Chigozie** is a Biochemistry graduate. She holds a Post Graduate Diploma in Education with Master's degree in Biochemistry and a lecturer at Federal College of Education (Technical) Umunze, Anambra State. She is a successful academician with an ample wealth of knowledge and skills in teacher training techniques, writing and explaining innovative ideas on education related issues in order to motivate others. Grace has written and published many Journal articles in education and health niches. She finds it fulfilling attending conferences, seminars, and workshop; so as to become more relevant in her field of study and career. She is a member of professional bodies such as Science Teachers Association of Nigeria (STAN), Teachers Registration Council of Nigeria (TRCN) and was recently certified by La Plage Mata Verse, an international institute, as an educator with skills in the use of artificial intelligence for curriculum development.

**Ekpenyong Effiong Ibok** is a lecturer in Department of Mathematics and Computer Science Education, Faculty of Science Education, University of Calabar, Calabar. He obtained Ph.D in Mathematics Education from University of Calabar. He is a qualified Licensed Teacher with publications in International and National Journals, a registered member of Teachers Registration Council of Nigeria (TRCN), Mathematical Society of Nigeria (MSN) and Mathematical Association of Nigeria (MAN). Dr. Ibok is a Mathematics pedagogy, Research consultant and Data analytics.

**Idaka Etta Idaka** is a lecturer in the Department of Curriculum and teaching University of Calabar, Calabar. She obtained PhD in Curriculum Studies, Elementary Education from University of Calabar. She is a qualified Licensed Teacher with publications in International and National Journals, a registered member of Teachers Registration Council of Nigeria (TRCN), Curriculum Organization of Nigeria (CON). World Council for Curriculum and instruction (WCCI).

**Iwuala Patricia Ebere Chilebe** is a lecturer in the Department of Curriculum & Teaching University of Calabar, Calabar. She had her PhD from Abia State University Uturu. She has many publications in International and National Journals published to her credits. As a trained teacher, she's registered with Teachers Registration Council of Nigeria (TRCN), a member of Curriculum Organization of Nigeria (CON).

**Nweke Phina Amaka** is a lecturer in the Department of Educational Foundations. School of Education, Federal College of Education (Tech) Asaba, Delta State. She obtained her M.ED in Educational supervision and planning from the National Open University of Nigeria in the year 2017. She is a member of Teachers Registration Council of Nigeria (TRCN), Nigerian Association for Educational Administration and Planning (NAEAP). She has made contributions in many chapters in a book and journals. She has attended conferences where she has presented papers.

**Emmanuel C. Onyekwe** is a lecturer in the Department of Educational Foundations, School of Education, Federal College of Education (Technical), Asaba, Delta State, Nigeria. He obtained his M.Ed in Educational Administration from Delta State University Abraka, Delta State Nigeria, in the year 2010. He has contributed in book chapters and Journals. He is a member of some learned societies such as Philosophical Association of Nigeria (PEAN) and Teacher's Registration Council of Nigeria (TRCN).

**Iwenzu Ngozi Caroline** is a lecturer in the department of educational foundation in school of Education, Federal College of Education (Tech) Asaba, Delta state. Mrs Ngozi has contributed in some books chapters, journals and also attended conferences where she has presented papers. She is a member of learned societies such as Teachers registration council of Nigeria (TRCN), Nigerian Association for Educational Administration and planning (NAEAP), and Association of Educational management and policy practioners (AMEAPP).

**Uloaku. V. Egbuchiwe** is a lecturer in the Department of Educational Foundations, school of Education, Federal College of Education (Technical) Asaba, Delta State, Nigeria. She obtained her M.Ed in Education Management and planning from Imo state university, Owerri in the year 2023. She is a seasoned scholar who has contributed in many book chapters and journals. She has attended conferences where she has presented papers. She is a member of Teachers Registration Council of Nigeria (TRCN), Nigerian Association for Educational Administration and planning (NAEAP).

**Regina Ijeamasi Enebechi** is a lecturer in the Department of Science Education, Nnamdi Azikiwe University, Awka. She holds a Ph. D in Science Education/ Biology from the University of Nigeria Nsukka, she has a multidimensional experience in research. She is a seasoned scholar and a prolific writer who has authored many articles in reputable local and international journals, published many textbooks and contributed in many book chapters. She is a member of editorial board of many local and international journals. She has been actively involved in both conducting and reviewing academic work. She has produced many science teachers and educators with various degrees (NCE, B.Sc(Ed) and M.Sc(Ed) who are currently teaching at primary, secondary and tertiary levels of education. She is a member of science teachers association of Nigeria (MSTAN), Member Teachers' Registration Council of Nigeria, Fellow Corporate Administrative Institute (FCAI). Dr. Enebechi has received so many awards.

**Ehumadu Rophina Ifeyinwa Chima** is a lecturer in the department of Home Economics Education, Federal College of Education (Technical), Umunze. She obtained her Ph.D in Home Science Education from the department of Agricultural/ Vocational Education, Micheal Okpara University of Agriculture, Umudike in the year 2021. She has to her credit published articles in reputable journal sites. Dr. Ehumadu Rophina Ifeyinwa Chima has attended conferences where she has presented papers. She is a licensed teacher with teacher registration council of Nigeria (TRCN) and a member of Home Economics professional association of Nigeria (HPAN).

**James C. Ogoke** is a lecturer in the Department of mathematics, School of Sciences, Alvan Ikoku University of Education Owerri, Imo State, Nigeria. He obtained his PhD in Mathematics Education from Nnamdi Azikiwe University, Awka, Anambra State in Nigeria in the year, 2022.

He is a seasoned scholar who has contributed in many book chapters and journals. Dr. Ogoke to his credit, has attended conferences where he has presented papers. He is a member of many learned societies such as Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), Science Educator Association of Nigeria (SEAN).

**Tina Uchenna Otumegwu** is a lecturer in the Department of Educational Psychology, Guidance and Counseling, Federal College of Education (Technical), Omoku, Rivers State, Nigeria. She holds a Ph.D. and M.Ed. in Measurement and Evaluation from Imo State University, Owerri, and a B.Sc. (Ed.) in Mathematics from the University of Nigeria, Nsukka. She has several years of teaching experience at the secondary school level in Imo State and worked as an examiner for the West African Examinations Council (WAEC) and the National Examinations Council (NECO) for seven years. Dr. Otumegwu has published widely in both local and international journals and has contributed chapters to academic books. She has also presented papers at various academic conferences. She is a member of several professional bodies, including TRCN, ASSEREN, and IAIIEA.

**Achugamonu Pius Chukwuma** is a lecturer in the Department of Mathematics Education in Faculty of Science Alvan Ikoku Federal University of Education Owerri, Imo State. He obtained his PhD in statistics from Imo State University Owerri, Imo State. He is a seasoned lecturer who collaborated with others in production of different textbooks in his area and courses in mathematics education too. He has presented papers in different conferences, Journal publications and in chapter contributions too. Currently he is a member of World Bank Analytics fellowship committee in community development in Nigeria. Achugamonu Pius C**.** had run so many programs with the world Bank Analytics fellowship.

**Nwankwo Glory U** is a lecturer in the Department of Integrated Science Education, School of sciences, Federal College of Education (Technical) Umunze, Anambra State, Nigeria. She is a graduate of Science Education (Integrated science option), holds a Master's degree and PhD in same option. She is a certified educator with skills in leading health, safety and environment and an experienced scholar who has co-authored numerous textbooks, contributed in many book chapters and journals. To her values, Dr. Nwankwo has attended a lot of conferences, seminars, and workshops so as to boost her career. She is a member of many professional associations such as Teachers Registration Council of Nigeria, Science Teachers Association of Nigeria (FSTAN – membership).

**Suleiman Dambai Mohammed** is a Reader in Science Education Department of Science Education Faculty of Education Federal University of Lafia, Nasarawa State. I obtained my Ph.D in University of Abuja-Nigeria in 2016. I'm a registered member with STAN; TRCN; and National Research Institute (NRI).I have over 30(thirty) publications in National and International Journals; Text books and Chapter contributions in both Local and International. I'm married with children.

**Perekeme Peresuode** is a lecturer in the Department of Mathematics, School of Science, College of Education, Warri, Delta State, Nigeria. He obtained his PhD in Mathematics Education from Nnamdi Azikiwe University, Awka, Anambra State, Nigeria, in 2024. He is a seasoned scholar who has contributed to many book chapters, proceedings, and journals. Dr. Perekeme has also attended conferences where he presented papers. He is a member of several learned societies, including the Mathematical Association of Nigeria (MAN), Teachers' Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN), Nigerian Mathematical Society (NMS), Computer Science Association of Nigeria (COAN), Association for the Promotion of Academic Researchers and Reviewers (APARR), Nigeria Statistical Association (NSA), Forum for Academic and Educational Advancement, and the Association of Science Educators Anambra (ASEA).

**Ifeoma B. Okafor** is a lecturer in the department of Biology Education, School of Sciences, Federal College of Education (Technical), Umunze Anambra State, Nigeria. She obtained her Ph.D. in Science Education (Biology) from Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. She is a seasoned scholar who has co-authored numerous textbooks, contributed in many book chapters and journals. She is a member of the editorial board of Anambra State STAN Journal. Dr. Ifeoma Blessing Okafor to her credit has attended seminars, workshops and conferences where she has presented papers. She is a member of many learned societies such as Teachers Registration Council of Nigeria (TRCN), Organisation of Women in Science for the Developing World (OWSD), Women in Colleges of Education (WICE) and Fellow, Science Teachers Association of Nigeria (FSTAN). She is the National Secretary STAN Basic Science Panel Junior. She is also the treasurer of STAN Anambra State Chapter.

**Chukwuma C. Ekechukwu** a lecturer in Biology Department, School of Secondary Education (Science), Federal College of Education (Technical), Asaba, Delta State, Nigeria. He is currently a post graduate student at Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, Nigeria.

**Caroline I. Okorie** is a lecturer in the Department of Computer Science Education. Faculty of Education and Arts Madonna University Nigeria Okija, Anambra State. She obtained her Ph.D in Education Measurement and Evaluation from Imo State University (IMSU) in Nigeria in the year 2017. She is a seasoned scholar who has contributed in many Book chapters and Journals. Dr. Okorie to her credit, has attended conferences where she has presented papers. She is a member of many learned societies such as: Association for Academic Review and Development (AARD) African Journal of Science Technology and Mathematics Education (AJSTME) Association of Education al Researchers and Evaluators of Nigeria (ASSEREN) Primary and Tertiary Teacher Education Association of Nigeria (PATTEAN).

**Tukur Madu Yemi** is a distinguished academic in Mathematics Education at the Federal University of Kashere, Gombe State, Nigeria. With over two decades of experience in teaching, research, and academic leadership, he has made significant contributions to the advancement of mathematics education and educational policy in Nigeria. He earned his Ph.D in Mathematics Education from Universiti Utara Malaysia (UUM), a globally recognized institution renowned for its academic innovation and excellence. His research interests include mathematics pedagogy, curriculum development, educational research methodology, and higher education reform. Dr. Yemi has served in various academic and administrative capacities, including Deputy Dean, Head of Department, and Chair of several university committees. He actively mentors both undergraduate and postgraduate students and has published widely in reputable national and international Journals. Beyond academia, he is a committed public intellectual who contributes regularly to national discourse through opinion pieces in leading Nigerian newspapers. Notable among his recent writings are:

“Delayed Salary Payment for Nigerian University Staff: A Matter of Urgency and Dignity”

“The Almajiri Crisis: Rethinking Education for Northern Nigeria”

“Time Management in Academic Research: A Guide for Postgraduate Students”

Dr. Yemi is a frequent participant in national and international conferences, where he shares research-based insights on improving educational access, quality, and governance.

**Emmanuel C. Nwigboji** is a lecturer in the Department of Science Education, Alex Ekwueme Federal University, Ndufu-Alike, Ebonyi State, Nigeria. He holds a Master’s degree in

Mathematics Education from Nnamdi Azikiwe University, Awka, Anambra State, which he obtained in 2017. He is currently pursuing his Ph.D. in Mathematics Education at the same institution. A dedicated scholar and researcher, Mr. Nwigboji has made significant contributions to academia through his authorship of numerous book chapters and scholarly journal articles. He has actively participated in academic conferences, where he has presented insightful papers on contemporary issues in science and mathematics education. Mr. Nwigboji is a registered and active member of several professional and academic bodies, including the Teachers Registration Council of Nigeria (TRCN), the Science Teachers Association of Nigeria (STAN), the Mathematical Association of Nigeria (MAN), and the Science Educators Association of Nigeria (SEAN). His commitment to advancing science and mathematics education in Nigeria underscores his professional engagements and academic endeavors.

**Uzoamaka Chimuanya Okafor-Agbala** is a lecturer in the Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. She obtained her PhD in Mathematics Education from Nnamdi Azikiwe University, Awka, Anambra State in Nigeria in the year 2023. She has to her credit published articles in reputable Journal sites. Dr. Okafor-Agbala have attended conferences where she has presented papers. She is a licenced teacher with Teachers Registration Council of Nigeria (TRCN) and a member of Science Teachers Association of Nigeria (STAN).

**John B. Moses** is a lecturer in the Department of Science Education, Faculty of Education, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria. He obtained his PhD in Science Education from Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. He is a seasoned scholar who has contributed in many book chapters and journals. Dr. Moses to his credit has attended many conferences where he has presented papers. He is a member of many learned societies such as Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN).

**Tamaraudeiyefa Tobi** is a Post Graduate student in the Department of Science Education, Faculty of Education, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.

**Madu Cletus Ifeanyi** is a lecturer in Department of Mathematics FCE(T), Bichi. Obtained PhD in Pure Mathematics from ABU Zaria. He is a qualified Licensed Teacher with publications in International and National Journals, a registered member of Teachers Registration Council of Nigeria (TRCN), Mathematical Society of Nigeria (MSN) and Mathematical Association of Nigeria (MAN).

**Abur Cletus Terhemba** is a lecturer in the Department of Mathematics, Federal College of Education (Technical) Bichi Kano State Nigeria. He obtained his Masters Degree in Mathematics Education from Benue State University Makurdi, Nigeria in the year 2018. He has to his credit published articles in reputable journal sites. Mr. Abur Cletus Terhemba has attended conferences where he has presented papers. He is a licensed teacher with Teachers Registration Council of Nigeria (TRCN) and a member of Mathematical Association of Nigeria (MAN).

**Maxwell Chukwunazo Obikezie** is a distinguished academic who lectures at the Department of Science Education, Nnamdi Azikiwe University, Awka. He is an active member of the Science Teachers' Association of Nigeria (STAN) and holds a valid registration with the Teachers' Registration Council of Nigeria (TRCN), reflecting his commitment to professional excellence and ethical standards in teaching. A prolific scholar, Dr. Obikezie has authored numerous articles and book chapters in the fields of chemistry, chemistry education, science education, and general education. His research work is widely recognized in both domestic and international academic circles, and he has attended many conferences globally, where he has presented and published papers on various educational and scientific topics. In addition to his research and teaching

pursuits, Dr. Obikezie is a reputable reviewer and editor for several scholarly journals, contributing significantly to the advancement of scientific and educational scholarship. He is known for his expertise as a sound chemistry teacher and a dedicated researcher, with a focus on improving science education and fostering innovative teaching methodologies. His dedication to academia, research, and teacher development makes him a highly respected figure in the fields of chemistry and science education.

**Fadip Audu Nannim** is a Postdoctoral Research Fellow at the University of the Free State, Bloemfontein, South Africa, and a Lecturer in the Department of Computer and Robotics Education at the University of Nigeria, Nsukka. He earned his Ph.D. in Computer and Robotics Education from the University of Nigeria, Nsukka. Dr. Nannim is a dedicated scholar with a strong publication records, having co-authored textbooks and numerous peer-reviewed journal articles. He serves as a reviewer and editor for various local and international academic journals. Dr. Nannim is an active member of several professional bodies, including the Teachers Registration Council of Nigeria (TRCN), the Computer Educators Association of Nigeria (CEAN), the South African Education Research Association (SAERA), and the Nigerian Institute of Management (NIM) Chartered.

**Moeketsi Mosia** is Associate Professor and ETDP-SETA Research Chair in Mathematics Education at the University of the Free State, where he also serves as Vice-Dean: Teaching & Learning. A leading scholar of mathematics education and higher-education policy, he sits on the ministerial task team drafting a national "teaching mathematics for understanding" framework, the Umalusi Assessment Standards Committee, and the CHE Accreditation Committee. Formerly Director of the UFS Centre for Teaching and Learning and Head of Natural Science Teaching at Sol Plaatje University, Prof Mosia pairs rigorous research with strategic leadership to advance mathematics teaching, curriculum quality, and student success across South Africa.

**Maria Tsakeni** is an Associate Professor and Head of the Mathematics, Natural Sciences and Technology Education Department in the Faculty of Education at the University of the Free State in South Africa. She is an NRF (South Africa) C2 rated researcher. Her area of research is in instructional and curriculum innovations in STEM classrooms. She is a member of the SAARMSTE and SAERA conferences, and she was the Chairperson of the Local Organising Committee for SAARMSTE 2023. She was also a member of the SAERA 2024 Local Organising Committee. She attends international conferences such as the ESERA, IOSTE, ECE, AERA and WERA.

**Stephen Chinedu Nwafor** is currently a postdoctoral Research Fellow in the Department of Mathematics, Natural Sciences, and Technology Education at the University of the Free State's Faculty of Education in South Africa. He teaches at Nnamdi Azikiwe University in Awka, Anambra State, Nigeria, in the Department of Science Education. He is a member of the Teacher Registration Council of Nigeria (TRCN), the Science Teachers Association of Nigeria (STAN), and the International Forum of Researchers and Lecturers (IFRL). He has participated in both national and international conferences. His research interests include understanding the psychological aspects of learning among science students, Gender issues in STEM, Pedagogical and technological innovations in STEM, and entrepreneurship in STEM.

**Mohammed Idris** is a lecturer in the Department of Biology Education, Alvan Ikoku Federal University of Education Owerri, Imo State, Nigeria. He obtained his master's in Science Education from University of Ilorin, Nigeria. He is a seasoned scholar who has contributed in many journals. Mr Mohammed to his credit, has attended a deluge of conferences where he has presented papers. He is a member of many learned societies such as Teachers Registration Council of Nigeria, (TRCN) and Science Teacher Association of Nigeria (STAN).

**Abel Idoko Onoja** is the current Head of Department of Basic Science, Alvan Ikoku Federal University of Education Owerri, Imo State, Nigeria. He is a Lion and obtained his higher degrees, Ph.D and Master's in Science Education Biology from Benue State University, Makurdi, Nigeria. He is a renowned scholar who has contributed over 40 journal articles to different academic body. Abel Idoko Onoja to his credit, has attended several conferences and workshops where he presented scholarly articles in science education and general science. He has authored many books and contributed many book chapters in edited books and book of readings. He is a licenced teacher and member of many learned societies such as Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN), Curriculum Organization of Nigeria (CON), World Council for Curriculum and Instruction (WCCI), Gender Studies Association of Nigeria (GSAN) and Educational Assessment and Research Network in Africa (EARNIA). As a staunch member of Alvana Volunteer Services, he has facilitated in many community service outreach to enhance the usage of 21st Century Instructional Strategies by Primary and secondary school teachers. Dr Abel Idoko Onoja is a research consultant and member of various Editorial Board such as Alvana Journal of General Studies (AJOGS) and Wukari Journal of Educational studies. The author has a keen interest in the development of science process skills in learner to facilitate the acquisition of knowledge which guarantees academic freedom.

**JohnBosco Onyekachukwu Okekeokosisi (MSTAN)** is a lecturer in the Department of Computer Science Education, School of Secondary Education (Science), Federal College of Education (Technical) Asaba, Delta State, Nigeria. He obtained his PhD in Computer Science Education from Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. He is a seasoned scholar who has co-authored numerous textbooks, contributed in many book chapters and journals. He is a member of editorial board of many local and international Journals. Dr Okekeokosisi, to his credit, has attended a deluge of conferences where he has presented papers. He is a member of many learned societies such as Teachers Registration Council of Nigeria, Science Teachers Association of Nigeria (STAN) and Association of Science Educators Anambra (ASEA). He is the Vice-Chairman, Science Teachers Association of Nigeria (STAN), Anambra State Chapter.

**MaryAnn Chigozie Ofordum** is a lecturer in the department of Physical and Health Education in Federal College of Education (Technical), Umunze. Dr. M.C. Ofordum obtained her Ph.D. in Public Health Education from Enugu State University of Science and Technology, Enugu (ESUT) in the year 2021. She has attended many conferences and presented many papers. She has twenty -three journal publications with reputable bodies and has one published textbook. Dr. M.C. Ofordum is a member of many professional bodies such as Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (MSTAN), Nigeria Association for Health Educators (NAHE), Science Educators of Nigeria (MSEAN), Women in Colleges of Education (MWICE) among others.

**Odunayo Abigael Bamisebi** is a chemistry educator at Sharpstown High School, Houston Independent School District, Houston , Texas, United States. She obtained her Bachelor's degree in Chemistry Education in 2014 and her Master’s degree in Chemistry Education in 2018, both from the University of Lagos, Akoka, Yaba, Nigeria. She is a seasoned teacher and educational leader with years of experience across both Nigeria and the United States. She has taught Chemistry, Biology, mathematics, and Integrated Science at the secondary and college levels, and served as a part-time lecturer in Science Education at Awori District College of Education, Ota Campus. Odunayo has made significant contributions to science education. She also served as the STAN COVID-19 Education Project Coordinator, leading a groundbreaking remote learning initiative that impacted over 5,000 students during the pandemic. She has presented papers at conferences and served as a keynote speaker at educational forums. Her interests include inquiry-based learning, blended learning, STEM education, and teacher training. She is a member of several professional bodies, including the Science Teachers Association of Nigeria (STAN), and

has been nominated for the prestigious STAN Fellowship, Teachers Registration Council of Nigeria (TRCN), ROYAL FELLOW member of the International Organization for Academic and Scientific Development (IOASD), member of National Science Teaching Association (NSTA), member National Education Association Texas, member Texas State Teacher Association (TSTA). She is also a passionate advocate for teen empowerment, career development, and spiritual growth among youths.

**Nkiru Naomi C. Samuel,** a Fellow of Science Teachers Association of Nigeria (Fstan) and a distinguished educator in Chemistry Education, in the Department of Science Education at Nnamdi Azikiwe University, Awka. She has dedicated her life to the pursuit of knowledge and the advancement of science education. She is renowned for her dedication and contribution to education and the broader educational community. Dr. Nkiru Naomi C. Samuel's contributions extend beyond the classroom; she has published numerous journal articles, contributed in several book chapters and delivered many commissioned papers in workshops, seminars cum in-service trainings for secondary school teachers and has attended several professional conferences, shared her insights and expanded her influence in science education both within Nigeria and internationally. Known for her warm personality and commitment to academic excellence, she remains an inspiration to her students and colleagues alike. She is a member of many learned societies such as Teachers Registration Council of Nigeria ( TRCN), Science Teachers Association of Nigeria (STAN), Royal Society of Chemistry (RSC), Women in Chemistry (WIC). She is the current Secretary of Science Teachers Association of Nigeria (STAN), Anambra State Chapter.

**Melody Otimize Obili** is a multifaceted individual currently pursuing a PhD in Science Education with a research focus in Integrated Science at Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, Nigeria. Beyond her academic pursuit, Melody has a diverse range of skills. She has attended several conferences and contributed to journals. Melody, is currently the secretary of Police Officers' Wives' Association, a member of Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN) and Association of Science Educators Anambra (ASEA).

**Prof. Nneka Rita Nnorom** is a professor of science education at Chukwuemeka Odumegu Ojukwu University, Igbarim, Anambra State. She was one time Head of department and dean of faculty. She has over 50 publications and members of various educational bodies.

**Anyachor Charles N.** is a lecturer in the Department of Agricultural Education, School of Agricultural and Home economics Education, Federal College of Education (Technical), Umunze, Anambra State, Nigeria. He obtained his master's degree (M.Sc) in Agricultural Economics from Imo State University (IMSU) Owerri and presently running his doctoral degree (P.h.D) Programme from the same University. He is a seasoned scholar who has co-authored numerous textbooks, contributed in many book chapters and journals. He has also attended and presented papers in a deluge of local and international conferences. Anyachor, C.N is a member of so many professional bodies such as Teachers Registration Council of Nigeria (TRCN) and Science Teachers Association of Nigeria (STAN) Anambra State chapter.

# DEDICATION

This book is dedicated to educators in the world

# CHAPTER 7

# INQUIRY-BASED LEARNING IN MATHEMATICS CLASSROOM: A GUIDE FOR TEACHERS

**Ogoke Chinemeze James**
**Tina Uchenna Otumegwu**
**Achugamonu Pius C**

**Abstract**
Inquiry-based learning (IBL) is a pedagogical approach that emphasizes student-centered, active, and experiential learning. By encouraging students to explore real-world questions and problems, IBL fosters critical thinking, creativity, and problem-solving skills. This chapter provides an overview of the theoretical foundations of IBL, its key principles and practices, and its applications in various educational settings. We discuss the benefits of IBL, including improved student engagement, motivation, and learning outcomes, as well as its potential to promote deeper understanding, transfer of learning, and development of essential skills for the 21st century. We also address the challenges and limitations of implementing IBL, and provide practical strategies and examples for educators to integrate IBL into their teaching practices. By adopting an IBL approach, educators can create learning environments that are more collaborative, inclusive, and responsive to the needs of diverse learners, and that better prepare students for success in an increasingly complex and rapidly changing world.

**Keywords:** Inquiry-based learning, Student-centered learning, Critical thinking, Creativity, Problem-solving

## Introduction

Inquiry-based learning (IBL) is an educational approach that emphasizes student-centered, active learning, and critical thinking. It involves students exploring real-world problems and questions, gathering and analyzing data, and constructing their own understanding of concepts and principles (Kuhlthau, 2015; Tan, 2017). IBL is grounded in the idea that students learn best when they are actively engaged in the learning process, and that learning is a constructive, iterative process (Hmelo-Silve**r,** 2004**).**

The term ‘inquiry’ generally signifies the process of acquiring or obtaining information by investigation, often personally and voluntarily carried out by the person who is eager to know the phenomenon in question. Hiang’s (2005) elaboration of inquiry includes investigation of a problem; finding truth or knowledge that requires thinking critically, making observations, asking questions, doing experiments and stating conclusions; and thinking creatively and using intuition. Inquiry is a process of understanding the characteristics of science through scientific experiments. It is through try outs, testing and further information search those individuals begun to see patterns or connections, often leading to discoveries. Discovery purposes to obtain knowledge, concepts and generalization. Meanwhile, experiences serve as the core in which both inquiry and discovery processes occur whilst simultaneously allowing the development of science process skills and fact gathering to take place. Aksela et al. (2010) elaborates the importance of competencies enhanced through IBSE (Inquiry Based Science Education) which are decision making, critical thinking, adaptability, tolerance and autonomy.

Inquiry teaching approach complements traditional instruction by providing a vehicle extending and applying the learning of students in a way that connects with their interests within a broad thematic framework. It is a method used in Science and Mathematics teaching that includes the way of questioning, seeking knowledge, information or finding out about phenomena; it involves investigating data and arriving at a conclusion (Sola & Ojo, 2007). In inquiry situation, students learn not only concept but also self-direction, responsibility and social communication. It also permits students to assimilate and accommodate information. Thus, inquiry method is expected to improve the achievement of students in mathematics.

**Statement of the Problem**

The traditional teaching methods in mathematics classrooms often focus on rote memorization and procedural fluency, which can lead to a superficial understanding of mathematical concepts. Many students struggle to apply mathematical knowledge to real-world problems, their critical thinking and problem-solving skills are not adequately developed. Furthermore, mathematics teachers face challenges in implementing effective teaching strategies that cater to diverse learning needs and promote deep understanding of mathematical concepts. Despite the recognized benefits of inquiry-based learning (IBL) in enhancing students' critical thinking, problem-solving skills, and deep understanding of mathematical concepts, many mathematics teachers in secondary schools struggle to effectively implement IBL approaches in their classrooms. This challenge is often due to limited knowledge of IBL strategies, inadequate resources and the pressure to meet curriculum requirements.

**Objectives of the Study**

The objectives of this study on Inquiry-Based Learning (IBL) in Mathematics Classroom: A Guide for Teachers are;

1. To investigate the effectiveness of IBL in enhancing students' understanding and achievement in mathematics.
2. To develop a comprehensive guide for teachers on implementing IBL in mathematics classrooms.
3. To enhance teacher professional development by providing them with the necessary skills and knowledge to design and implement IBL activities in mathematics.
4. To promote critical thinking and problem-solving skills in mathematics students through IBL.
5. To foster a student-centered learning environment in mathematics classrooms.

**Forms of Inquiry based learning:** In mathematics, IBL can take many forms, including:

- Problem-based learning: Students are presented with a real-world problem, and they work to develop a mathematical solution (Savery, 2015).
- Inquiry-based mathematics: Students explore mathematical concepts and principles through open-ended investigations and explorations (Artigue, 2017).
- Mathematical modeling: Students use mathematical models to describe and analyze real-world phenomena (Blum, 2015).

**History of Inquiry Based Learning**

Inquiry-based learning (IBL) has its roots in various educational philosophies and movements that emphasize student-centered, active, and experiential learning. The concept of inquiry has its roots in ancient Greece and Rome, where philosophers like Socrates, Plato, and Aristotle used the term to describe the process of questioning and seeking knowledge (Bruner, 1960). This idea of inquiry as a means of seeking truth and understanding was central to the development of Western philosophy. During the Middle Ages, the term "inquiry" took on a more formal sense, referring to a formal investigation or examination, often conducted by a court or a royal authority (Kaye, 1998). This sense of inquiry as a formal process of investigation and examination continued through the Renaissance and into the modern era (Hacking, 1975). With the rise of modern science in the 16th and 17th centuries, the term "inquiry" began to take on a more scientific connotation, referring to the systematic investigation of natural phenomena (Bacon, 1620). Scientists like Francis Bacon and René Descartes used the term to describe their methodical approaches to understanding the natural world (Kuhn, 1962). This sense of inquiry as a systematic and methodical process of investigation has had a profound impact on the development of modern science (Lakatos, 1970). In the 20th century, the term "inquiry" began to be used in educational contexts, particularly in the 1960s and 1970s, as educators like Jerome Bruner and John Dewey emphasized the importance of student-centered, active learning approaches (Bruner, 1960). This sense of inquiry as a student-centered and active process of learning has become increasingly popular in modern education, as educators seek to encourage critical thinking, creativity, and problem-solving skills in their students (Wiggins & McTighe, 2005). Today, the term "inquiry" is widely used in a variety of contexts, from science and education to business and philosophy (Paul & Elder, 2006). It refers to a process of questioning, investigation, and critical thinking, and is seen as an essential skill for success in a rapidly changing and increasingly complex world (Barnett, 2004).

**Benefits of Inquiry based learning**

Inquiry-based learning (IBL) is an educational approach that offers numerous benefits for students, particularly in mathematics education. Some of the key benefits of IBL include;

- Promoting Critical Thinking: IBL encourages students to think critically and analytically, as they are presented with open-ended problems and questions that require them to evaluate evidence, analyze data, and draw conclusions (Kuhlthau, 2015).
- Developing Problem-Solving Skills: IBL helps students develop problem-solving skills, including the ability to identify problems, analyze data, and develop mathematical models to solve real-world problems (Smith, 2020).
- Deepening Understanding of Mathematical Concepts*: IBL allows students to explore mathematical concepts in a more meaningful and contextualized way, leading to a deeper understanding of mathematical principles and concepts (Larkin, 2018).
- Encouraging Collaboration and Communication: IBL promotes collaboration and communication among students, as they work together to solve problems and present their findings (Savery, 2015).
- Fostering Creativity and Curiosity: IBL encourages students to think creatively and explore mathematical concepts in a more innovative and curious way (Tan, 2017).
- Preparing Students for Real-World Applications: IBL helps students develop skills that are essential for real-world applications, such as problem-solving, critical thinking, and communication (Blum, 2015).
- Developing Mathematical Literacy: IBL helps students develop mathematical literacy, including the ability to read, write, and communicate mathematical ideas (NCTM, 2014).
- Enhancing Student Engagement and Motivation: BL can enhance student engagement and motivation, as students are more likely to be interested in learning when they are presented with real-world problems and challenges (Artigue, 2017).

**Key Characteristics of Inquiry-Based Learning**

- Student-Centered: IBL is student-centered, meaning that students take an active role in the learning process, and the teacher acts as a facilitator or guide (Savery, 2015).
- Open-Ended Questions: IBL involves open-ended questions that encourage students to explore, investigate, and think critically about real-world problems and phenomena (Tan, 2017).
- Investigation and Research: Students engage in investigation and research to gather data, information, and evidence to support their learning (Artigue, 2017).
- Critical Thinking and Analysis: IBL promotes critical thinking and analysis, as students evaluate evidence, analyze data, and draw conclusions (Larkin, 2018).
- Collaboration and Communication: IBL encourages collaboration and communication among students, as they work together to solve problems, share ideas, and present their findings (Smith, 2020).
- Real-World Applications: IBL involves real-world applications, as students explore problems and phenomena that are relevant to their lives and the world around them (Blum, 2015).
- Flexibility and Autonomy: IBL provides students with flexibility and autonomy, as they take ownership of their learning, make choices, and work at their own pace (Kuhlthau, 2015).
- Reflection and Self-Assessment: IBL promotes reflection and self-assessment, as students reflect on their learning, identify areas for improvement, and set goals for future learning (Savery, 2015).

**Types of Inquiry-Based Learning**

Inquiry-Based Learning (IBL) can be categorized into three main types: Open-Ended Inquiry, Guided Inquiry, and Structured Inquiry. Each type of inquiry has its own unique characteristics, advantages, and disadvantages.

**Open-Ended Inquiry:** Open-Ended Inquiry is the most student-centered approach to IBL. Students are presented with a broad, open-ended question or problem, and they are expected to explore, investigate, and find solutions on their own with minimal guidance from the teacher (Kuhlthau, 2015). This type of inquiry encourages students to think critically, be creative, and take ownership of their learning.

**Advantages**

1. Encourages critical thinking and creativity
2. Develops problem-solving skills
3. Fosters independence and self-directed learning

**Disadvantages**

- Can be challenging for students who lack prior knowledge or experience
- May lead to frustration or confusion if students are not properly supported

**Guided Inquiry:** Guided Inquiry is a more teacher-directed approach to IBL. Students are still presented with an open-ended question or problem, but the teacher provides more guidance and support throughout the inquiry process (Savery, 2015). This type of inquiry helps students to develop their critical thinking and problem-solving skills while still receiving support and feedback from the teacher.

**Advantages**

i. Provides students with more structure and support
ii. Helps students to develop their critical thinking and problem-solving skills
iii. Encourages collaboration and communication among students

**Disadvantages**

i. May not be as effective in developing independence and self-directed learning
ii. Can be more time-consuming for teachers to provide guidance and support

**Structured Inquiry**: Structured Inquiry is the most teacher-directed approach to IBL. Students are presented with a specific, well-defined problem or question, and they are expected to follow a predetermined procedure or protocol to find the solution (Blum, 2015). This type of inquiry is often used in science and mathematics education, where students need to follow a specific methodolo**gy** to collect and analyze data.

**Advantages**

1. Provides students with a clear and well-defined problem or question
2. Helps students to develop their critical thinking and problem-solving skills in a more structured environment.

**Disadvantages**

1. May not be as effective in developing creativity and independence
2. Can be too rigid and limiting for students who prefer more open-ended inquiry

In conclusion, each type of inquiry has its own strengths and weaknesses, and teachers should consider their students' needs, prior knowledge, and learning styles when choosing the most appropriate type of inquiry. By incorporating IBL into their teaching practices, teachers can help students to develop critical thinking, problem-solving, and collaboration skills, which are essential for success in the 21st century.

Here are some examples of inquiry-based learning in mathematics education. These examples illustrate how inquiry-based learning can be applied to various mathematical concepts and topics, and how it can help students develop critical thinking, problem-solving, and collaboration skills.

**Example 1: Open-Ended Inquiry**

**Problem:** How many different ways can you make change for $1 using coins?

**Student Task:** Students work in groups to explore and find different combinations of coins that add up to $1.

**Teacher Role:** Provides guidance and support as needed, but allows students to take ownership of the problem-solving process.

**Mathematical Concepts**: Addition, subtraction, multiplication, and division of decimals and fractions.

E**xample 2: Guided Inquiry**

**Problem:** What is the relationship between the number of sides of a polygon and its internal angles?

**Student Task:** Students work in pairs to investigate and collect data on the internal angles of different polygons.

**Teacher Role**: Provides a guiding question and some initial support, but allows students to design and conduct their own investigation.

Mathematical Concepts: Geometry, measurement, and data analysis.

**Example 3: Structured Inquiry**

**Problem:** How does the height of a ramp affect the distance a marble roll?

**Student Task:** Students work in groups to design and conduct an experiment to investigate the relationship between ramp height and marble distance.

**Teacher Role:** Provides a clear procedure and guidelines for the experiment, but allows students to collect and analyze their own data.

**Mathematical Concepts:** Measurement, data analysis, and graphing.

**Example 4: Real-World Application**

**Problem:** A local bakery is having a sale on bread. If a loaf of bread normally costs $2.50, but is on sale for 15% off, how much will you pay for 2 loaves of bread?

**Student Task:** Students work individually to calculate the sale price of 2 loaves of bread.

**Teacher Role:** Provides the problem and some initial guidance, but allows students to apply mathematical concepts to a real-world scenario.

**Mathematical Concepts:** Percentages, decimals, and multiplication.

**Example 5: Mathematical Modeling**

**Problem:** A population of rabbits is growing at a rate of 20% per year. If there are currently 100 rabbits, how many will there be in 5 years?

**Student Task:** Students work in groups to develop a mathematical model to predict the population of rabbits after 5 years.

**Teacher Role:** Provides some initial guidance and support, but allows students to design and develop their own mathematical model.

**Mathematical Concepts**: Exponential growth, percentages, and algebra.

**Implementing Inquiry based learning in the classroom**

Implementing inquiry-based learning (IBL) in a mathematics classroom requires careful planning, execution, and assessment. Here are some strategies and tips to help you implement IBL in your mathematics classroom:

a. Start with a clear goal: Identify the mathematical concept or topic you want to teach using IBL. Ensure that the goal is specific, measurable, achievable, relevant, and time-bound (SMART).
b. Develop an inquiry question: Create an open-ended question that encourages students to explore and investigate the mathematical concept. The question should be thought-provoking, relevant, and challenging.
c. Create a supportive learning environment: Establish a classroom culture that encourages curiosity, creativity, and critical thinking. Ensure that students feel comfortable sharing their thoughts, ideas, and questions.
d. Use real-world contexts: Use real-world examples, case studies, or scenarios to contextualize the mathematical concept. This helps students see the relevance and application of the concept.
e. Encourage student autonomy: Allow students to take ownership of their learning. Provide them with choices, and encourage them to explore and investigate the mathematical concept at their own pace.
f. Provide scaffolding: Offer guidance and support as needed, but avoid giving away answers or solutions. Use scaffolding techniques, such as think-alouds, peer discussions, and formative assessments, to help students stay on track.

g. Foster collaboration: Encourage students to work in pairs or small groups to explore and investigate the mathematical concept. This promotes peer-to-peer learning, communication, and problem-solving.
h. Use technology: Leverage technology to support IBL in mathematics. Utilize digital tools, such as graphing calculators, geometry software, and online resources, to facilitate exploration and investigation.
i. Assess student learning: Use formative and summative assessments to evaluate student learning. Ensure that assessments are aligned with the learning goals and objectives.
**j.** Reflect and refine: Reflect on the IBL process, and refine it as needed. Gather feedback from students, peers, and mentors to improve the implementation of IBL in your mathematics classroom.

**Inquiry based learning: Lesson Plan Templat**e

To help you plan and implement IBL in your mathematics classroom, consider using the following lesson plan template. By using this template and following the strategies and tips outlined above, you can create an effective IBL lesson plan that promotes student engagement, critical thinking, and deep understanding of mathematical concepts:

**Inquiry Question:** What is the open-ended question that will guide student inquiry? How does the question relate to the mathematical concept or topic?

i. Learning Goals: What are the specific learning goals and objectives for the lesson? How will students demonstrate their understanding of the mathematical concept?
ii. Introduction: How will you introduce the inquiry question and mathematical concept? What real-world context or scenario will you use to contextualize the concept?
iii. Exploration: What activities, tasks, or experiments will students complete to explore and investigate the mathematical concept? How will you provide scaffolding and support during the exploration phase?
iv. Collaboration: How will students work together to explore and investigate the mathematical concept? What opportunities will you provide for peer-to-peer learning and communication?
v. Assessment: What formative and summative assessments will you use to evaluate student learning? How will you provide feedback to students during the lesson?
**vi.** Conclusion: How will you summarize the key findings and takeaways from the lesson? What opportunities will you provide for students to reflect on their learning and identify areas for improvement?

**Case Studies and examples of Inquiry based learning**

**Case Study 1**: Inquiry-Based Learning in a High School Mathematics Classroom
**Context:** A high school mathematics classroom in the United States
**Inquiry Question**: How can we use mathematical modeling to optimize the design of a roller coaster?
**Methodology:** Students worked in groups to design and build a model of a roller coaster, using mathematical concepts such as quadratic equations and optimization techniques.
**Results:** Students demonstrated a deep understanding of mathematical concepts and were able to apply them to a real-world problem. (Larkin, 2018)

**Case Study 2:** Inquiry-Based Learning in an Elementary School Mathematics Classroom
**Context:** An elementary school mathematics classroom in Australia
**Inquiry Question:** How can we use measurement and geometry to design a dream bedroom?
**Methodology:** Students worked in pairs to design and create a model of their dream bedroom, using mathematical concepts such as measurement and geometry.
**Results:** Students demonstrated an improved understanding of mathematical concepts and were able to apply them to a real-world problem. (Smith, 2020).

In Nigeria, inquiry-based learning (IBL) is also being implemented in mathematics education, although it may face some unique challenges due to the country's educational context. Here are a few examples:

**Example 3**: Inquiry-Based Learning in a Nigerian Secondary School.

**Context:** A secondary school in Lagos, Nigeria
**Inquiry Question:** How can we use mathematical modeling to optimize the design of a water filtration system for a rural community?
**Methodology:** Students worked in groups to design and build a model of a water filtration system, using mathematical concepts such as algebra and geometry.
**Results**: Students demonstrated a deep understanding of mathematical concepts and were able to apply them to a real-world problem (Ogunniyi, 2017)

**Example 4:** Inquiry-Based Learning in a Nigerian Universities
**Context:** A university in Abuja, Nigeria
**Inquiry Question:** How can we use mathematical modeling to understand the spread of malaria in Nigeria?
**Methodology:** Students worked in groups to develop a mathematical model of the spread of malaria, using concepts such as differential equations and epidemiology.
**Results**: Students demonstrated a deep understanding of mathematical concepts and were able to apply them to a real-world problem. (Adebayo, 2019)

C**hallenges facing IBL in Nigeria include**
**Limited resources:** Many schools in Nigeria lack the necessary resources, such as textbooks, technology, and infrastructure, to support IBL.
**Large class sizes:** Class sizes in Nigeria can be very large, making it difficult for teachers to implement IBL effectively.
**Cultural and societal factors:** In some cases, cultural and societal factors may hinder the adoption of IBL, as it may be seen as unconventional or Western.

W**ays to promote IBL in Nigeria**
1. Teacher training programs: Some organizations, such as the Nigerian Mathematical Society, offer teacher training programs to promote IBL in mathematics education.
2. Curriculum reform: The Nigerian government has implemented curriculum reforms aimed at promoting IBL and problem-solving skills in mathematics education.
3. Technology integration: Some schools in Nigeria are incorporating technology, such as mobile devices and online resources, to support IBL in mathematics education.

**Conclusion**
Inquiry-based learning (IBL) is a powerful approach to mathematics education that can help students develop a deeper understanding of mathematical concepts and their applications to real-world problems. By using IBL, students can develop critical thinking, problem-solving, and communication skills, which are essential for success in mathematics and other areas of life. In this discussion, we explored the concept of IBL, its benefits, and its implementation in mathematics education. We also examined case studies and examples of IBL in different educational settings, including secondary schools in Nigeria.

**Suggestion for Improvement**
To further promote the adoption and effective implementation of IBL in mathematics education, the following future directions are recommended;

1. Teacher Training and Support: Provide teachers with training and support to develop their skills and confidence in implementing IBL in their classrooms.
2. Curriculum Reform: Reform mathematics curricula to incorporate more IBL-based activities and projects that promote critical thinking, problem-solving, and communication skills.
3. Technology Integration: Leverage technology to support IBL in mathematics education, including the use of online resources, simulations, and educational software.
4. Assessment and Evaluation: Develop and use assessments and evaluations that align with the goals and objectives of IBL, including the use of performance tasks and project-based assessments.

5. Research and Development: Conduct research and development to improve our understanding of IBL in mathematics education, including its impact on student learning outcomes and its implementation in different educational settings.
6. Collaboration and Partnerships: Foster collaboration and partnerships between educators, researchers, and industry partners to promote the adoption and effective implementation of IBL in mathematics education.

By pursuing these future directions, we can promote the adoption and effective implementation of IBL in mathematics education, ultimately improving student learning outcomes and preparing students for success in an increasingly complex and rapidly changing world.

**References**


Adebayo, A. (2019). Mathematical modeling of malaria transmission in Nigeria. *Journal of Mathematical Modeling and Application, 8(*1); 1-15.

Artigue, M. (2017). The role of inquiry in mathematics education. *Educational Studies in Mathematics, 96(*2); 161-175.

Bacon, F. (1620). Novum Organum.

Barnett, R. (2004). *The purposes of higher education and the changing face of academia*. London: SRHE.

Blum, W. (2015). Mathematical modeling in mathematics education. *Journal of Mathematical Modeling and Application, 4(1),* 1-15.

Bruner, J. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Hacking, I. (1975). *The emergence of probability: A philosophical study of early ideas about probability, induction and statistical inference.* Cambridge: Cambridge University Press.

Hmelo-Silver, C. E. (2004). Problem-based learning: *What and how do students learn? Educational Psychology Review, 16(3);* 235-266.

Kaye, J. (1998). *The science of man: An introduction to the history of anthropology.* London: Routledge.

Kuhlthau, C. C. (2015). Guided inquiry: A framework for learning. Libraries Unlimited.

Lakatos, I. (1970). Criticism and the methodology of scientific research programmes. *Proceedings of the Aristotelian Society, 69,* 149-186.

Larkin, K. (2018). The impact of inquiry-based learning on students' mathematical understanding. *Mathematics Education Research Journal, 30(2);* 147-163.

National Council of Teachers of Mathematics. (2014). Principles to actions: Ensuring mathematical success for all. NCTM.

Ogunniyi, M. B. (2017). Inquiry-based learning in Nigerian secondary schools: A case study. *Journal of Educational Research and Practice, 7(1);* 1-12.

Paul, R. W., & Elder, L. (2006). Critical thinking: The nature of critical and creative thought. *Journal of Developmental Education, 30(2),* 34-41.

Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-Based Learning, 9(1);* 1-14.

Smith, C. (2020). The effects of inquiry-based learning on students' problem-solving skills in mathematics. *Journal of Mathematics Teacher Education, 23(2);* 147-163.

Tan, A. (2017). Inquiry-based learning in mathematics education: *A review of the literature. Mathematics Education Research Journal, 29(1),* 1-15.

Wiggins, G., & McTighe, J. (2005). *Understanding by design.* Alexandria, VA: ASCD.