



Exploring Interdisciplinary Approaches for Teaching Mathematics and Computer Science in Stem Education among Secondary Students in Kaduna State, Nigeria

¹Umar Isah Ohimege, ²Suleiman Balarabe

¹Department of Mathematics, Faculty of Science Education

Department of English, Faculty of Art Education

Federal University of Education, Zaria

ABSTRACT

Equipping learners with the 21st century skills is the current pursuit of nations of the world wishing to maintain global leadership and cutting-edge economic competitiveness. These nations now see Science, Technology, and Mathematics Education (STME) as an option for equipping their up-coming generations with problem solving skills and potentials for becoming innovators and entrepreneurs of tomorrow. This paper investigated the exploring Interdisciplinary Approach for Teaching Mathematics and Computer Science in STME among Secondary School in Kaduna State. The study had three objectives, three research questions and null hypotheses. Mean and standard deviation was used to analyse the data to answer research questions and independent sample t-test was used to test the null hypotheses. The findings of the study reveal that, training of teachers in the STEM education is a pivot for better performance. Teachers, resources and curriculum-related are major factors in the implementation of interdisciplinary approach among secondary schools in Kaduna State and also there is positive relationship between STME engagement and career aspirations among secondary schools' students in Kaduna state. Conclusion and recommendation were made among in line with the findings.

ARTICLE INFO

Article History

Received: June, 2025

Received in revised form: August, 2025

Accepted: October, 2025

Published online: December, 2025

KEYWORDS

Interdisciplinary, Teaching, Mathematics, Computer Science, Stem Education, Secondary Students

INTRODUCTION

In the realm of academia, the relationship between mathematics and computer science has long been acknowledged, prompting numerous educators to advocate for the incorporation of a solid mathematical foundation within computer science education (Karmila et al., 2021, Karaduman & Eti, 2023, Yuan et al., 2022). This emphasis on mathematical underpinnings is readily apparent within our collaborative department, where we diligently strive to infuse mathematical concepts throughout our computer science curriculum (Tan & Lee, 2022, Cumhur et al., 2021). Currently, there is a growing recognition of the importance of integrating various STEM disciplines, such as mathematics and computer science, into the field of education. The

conventional approach of segregating these subjects into distinct domains has demonstrated limited effectiveness in adequately preparing students for their future endeavors. the intricate complexities of the contemporary world (Zulirfan et al., 2023, Liburd & Jen, 2021, Succar et al., 2022) have led researchers to discover that students who choose STEM majors may encounter varying experiences in online science courses, contingent upon their level of mathematical proficiency (Muhammad et al., 2021, Kennedy & Smolinsky, 2016, Núñez et al., 2022, Busch et al., 2023).

The pertinence and timeliness of integrating interdisciplinary methods into the instruction of mathematics and computer science in STEM education are influenced by the

Corresponding author: Umar Isah Ohimege

✉ umarohimege@gmail.com

Department of Mathematics, Faculty of Science Education, Federal University Of Education, Zaria.

© 2025. Faculty of Technology Education. ATBU Bauchi. All rights reserved



transformations taking place in the secondary education system and the growing acknowledgment of the global significance of STEM education (Altun & APAYDIN, 2022, Pekbay, 2023, Akpinar & Yalçın, 2021, Wahono et al., 2022). STEM education, an acronym for science, technology, engineering, and mathematics, places great emphasis on the integration of these disciplines in order to furnish students with a comprehensive comprehension of real-world problem-solving (Karaduman; & Eti, 2023, Beviz & Dmytriienko, 2020, Yuan et al., 2022). By embracing interdisciplinary methodologies, educators have the potential to enable students to perceive the interconnections between mathematics and computer science, as well as their practical applications (Altun & Apaydin, 2022, Akpinar & Yalçın, 2021, Wahono et al., 2022).

Literature Review on Interdisciplinary Approaches for Teaching Mathematics and Computer Science in STEM Education among Secondary Students in Kaduna State, Nigeria

The scientific problems of the twenty-first century involve complex research questions that require an interdisciplinary approach (Kubat, 2018, Şahin & Kabapinar, 2020). Therefore, students need to develop strong foundational skills in mathematics and computer science to tackle these challenges effectively (Yusup et al., 2020, Karaduman & Eti, 2023, Rohendi et al., 2023, Chiriacescu et al., 2023). Integration of mathematics and computer science in STEM education has become increasingly important due to the changing landscape of the education system and the global recognition of the significance of STEM education in preparing students for future careers.

In recent years, there has been a growing emphasis on the integration of mathematics and computer science in STEM education. (Karaduman & Eti, 2023, Rohendi et al., 2023). This integration aims to provide students with a comprehensive understanding of these subjects and their interconnectedness, as well as to foster critical thinking, problem-solving, and creative skills. Research has shown that

students who have a strong foundation in mathematics and computer science are better equipped to handle the interdisciplinary nature of STEM education. Studies have been conducted in various countries, including Kaduna State, Nigeria, to explore the effectiveness of interdisciplinary approaches in teaching mathematics and computer science in STEM education. Moore and Smith (2023) define integrated STEM education as an effort to combine science, technology, engineering, and mathematics into one class or lesson that is focused on solving real-world problems. Evidence suggests that interdisciplinary approaches in teaching mathematics and computer science in STEM education can lead to improved student achievement and engagement.

Approaches for Teaching Computer Science in STEM Education among secondary Students in Kaduna State

The application of interdisciplinary approaches in STEM education opens up new opportunities for teaching computer science to secondary students in Kaduna State, Nigeria. STEM education in Nigeria has been gaining momentum and there is a growing recognition of the importance of computer science in preparing students for future careers (Smyrniou et al., 2020). The integration of computer science in STEM education can enhance students' problem-solving skills, critical thinking abilities, and creativity (Karaduman & Eti, 2023, and Sulsilah et al., 2023). By integrating computer science into STEM education, students can develop computational thinking skills and apply them to solve real-world problems (Karaduman & Eti, 2023).

Approaches for Teaching Mathematics and Science in STEM Education among secondary Students in Kaduna State

The integration of mathematics and science in STEM education is crucial for the holistic development of secondary students in Kaduna State, Nigeria (Chan & Nagatomo, 2021, Altun & APAYDIN, 2022, Marlina & Asrizal, 2022). Interdisciplinary approaches that combine



mathematics and science can provide students with a deeper understanding of the interconnectedness between these subjects and their applications in real-world scenarios. (Siew & Ahmad, 2023, Karaduman & Eti, 2023).

By incorporating mathematics and science together in STEM education, students have the opportunity to develop critical thinking skills, problem-solving abilities, and a strong foundation in quantitative reasoning. (Samara & Kotsis, 2023, Amin et al., 2022; Silva et al., 2023). Furthermore, interdisciplinary approaches can promote student engagement and motivation by making the learning experience more relevant and meaningful (Karaduman & Eti, 2023, Wahyuningsih et al., 2020). The integration of mathematics and computer science in STEM education can provide numerous benefits for secondary students (Karaduman & Eti, 2023, Sitanggang & Lubis, 2022).

STATEMENT OF THE PROBLEM

In the region of Kaduna State, Nigeria, there is an urgent need to improve the quality of STEM education, specifically in the areas of mathematics and computer science. However, the conventional isolated method of instructing these disciplines frequently falls short in preparing students at the secondary level for the demands of the contemporary labour force, which increasingly relies on interdisciplinary proficiencies. The objective of this investigation is to tackle this matter by exploring interdisciplinary methodologies for teaching mathematics and computer science in the realm of STEM education among students at the secondary level in Kaduna State.

Objectives of the Study

1. To Assess the Effectiveness of Interdisciplinary Teaching Methods among students of Secondary Schools in Kaduna State.
2. To Identify Barriers to Implementing Interdisciplinary Approaches among students of Secondary Schools in Kaduna State.

3. To Examine the Impact on Students' STEM Engagement and Career Aspirations among students of Secondary Schools in Kaduna State.

Research Questions

1. what are the barriers to implementing interdisciplinary Teaching approach among students of secondary schools in Kaduna State.
2. What are the barriers to implementation of interdisciplinary approaches among students of secondary schools in Kaduna State.
3. Impact on students STME engagement and Career aspirations among students of secondary school in Kaduna State.

Research Hypotheses

Ho1: There is no significant difference in the implementation of interdisciplinary teaching approaches between teachers who receive training and those who do not.

Ho2: There is no significant relationship between teachers, resources and curriculum-related factors and the implementation of interdisciplinary approaches among secondary school in Kaduna State.

Ho3: There is no significant relationship between STME engagement and career aspirations among secondary school students.

METHODOLOGY

The study adopted a mixed-methods research design to gain a comprehensive understanding of the effectiveness and challenges faced when implementing interdisciplinary teaching methods in STEM education among high school students in Kaduna State. The Population of the Study encompassed the secondary school populace, comprising both male and female students, in Kaduna State. To ensure a random representative sample of students from various schools in Kaduna State, a no stratified nonrandom sampling approach was implemented.

Furthermore, in-depth discussions and surveys was carried out with educators specializing in mathematics and computer



science, in close collaboration with school administrators, to gather valuable insights and firsthand experiences. Data Collection: Quantitative Data: Students were subjected to structured surveys in order to evaluate their perspectives on interdisciplinary teaching techniques, involvement in STEM subjects, and career aspirations.

Academic Performance Data: Preexistent academic records were gathered to compare the achievements of students taught through interdisciplinary methods with those taught using conventional subject-specific approaches. Qualitative Data: Extensive interviews with educators in the fields of mathematics and computer science was conducted to comprehend their encounters with interdisciplinary teaching, encountered obstacles, and perceived advantages. Interviews with educational administrators will provide insights into the institutional factors that influence the implementation of interdisciplinary approaches. The instrument was validated and found useful for the research and trial test was conducted using 50 students from Government Secondary School in Zaria Local Government.

Summary of survey responses was conducted using descriptive statistics. In order to determine if there are statistically significant differences in academic performance between

students who have experienced interdisciplinary teaching methods and those who have experienced traditional methods was employ, inferential statistical tests of t-tests. Analysis of interview transcripts from educators and school administrators were carried out through thematic analysis. Identification of common themes, challenges, and benefits associated with interdisciplinary teaching was facilitated by coding and categorization of qualitative data.

Combination of Data: The merging of results from both quantitative and qualitative analyses was carried out to provide a partial and limited understanding of the research inquiries and objectives. In order to uphold ethical standards, informed consent was procured from all participants, including students, educators, and school administrators. The utmost caution was taken to guarantee the preservation of confidentiality and anonymity throughout the process of data collection and reporting. Moreover, ethical approval was diligently sought from the pertinent institutional review boards.

RESULTS

Research Questions One:

what are the barriers to implementing interdisciplinary Teaching approach among students of secondary schools in Kaduna State.

Table 1: Mean and Standard Deviation on Barriers to Implementing Interdisciplinary Teaching Approach among Students of Secondary Schools in Kaduna State

S/N	Section B: Barriers to Implementation on Teaching Approach	SA	A	SD	D	MEAN	St. Div.	Remarks
1	Lack of training and support for teachers is a significant barrier to implementing interdisciplinary teaching approaches	123	65	17	5	2.80	0.70	Agreed
2	Insufficient resources (e.g time, funding, materials) hinder the implementation of interdisciplinary teaching approaches	100	102	5	1	3.04	0.41	Agreed
3	Resistance from teachers or administrators to change traditional teaching methods is a	134	56	10	10	3.44	0.92	Agreed

Corresponding author: Umar Isah Ohimege

umarohimege@gmail.com

Department of Mathematics, Faculty of Science Education, Federal University Of Education, Zaria.

© 2025. Faculty of Technology Education. ATBU Bauchi. All rights reserved



S/N	Section B: Barriers to Implementation on Teaching Approach	SA	A	SD	D	MEAN	St. Div.	Remarks
4	major obstacle to interdisciplinary teaching							
4	Difficulty in assessing students learning outcomes in an interdisciplinary approach is a significant challenge	110	78	15	7	2.94	0.76	Agreed
5	The rigid structure of the curriculum makes it difficult to implement interdisciplinary teaching approaches	144	57	5	4	3.19	0.83	Agreed
Total						15.41	3.62	
Average Mean and Standard Deviation						3.08	0.72	Agreed

Table 1 indicated that, the mean and standard deviation scores of responses on the barriers to implementing interdisciplinary Teaching approach among students of secondary schools in Kaduna State. The average mean and standard deviation scores of items 1, 2, 3, 4, and 5 is given as (N = 210, M = 3.08 and SD = 0.72) which is above the cut-off point of 2.50, indicating there is significant influence of barriers to

implementing interdisciplinary Teaching approach among students of secondary schools in Kaduna State.

Research Question Two:

What are the barriers to implementation of interdisciplinary approaches among students of secondary schools in Kaduna State.

Table 2: Mean and Standard Deviation on Barriers to Implementing Interdisciplinary Approach among Students of Secondary Schools in Kaduna State

S/N	Section C: Barriers to Implementation on Students Approach	SA	A	SD	D	MEAN	St. Div.	Remarks
1	Lack of teacher training and support is a significant barrier to implementing interdisciplinary approaches in secondary schools	120	78	7	5	3.09	0.80	Agree
2	Insufficient resources (e.g textbooks, technology, facilities) hinder the implementation of interdisciplinary approaches	100	100	7	3	3.19	0.83	Agree
3	The rigid structure of the secondary school curriculum makes it different to implement interdisciplinary approaches.	121	67	12	10	3.32	1.17	Agree
4	Limited collaboration among teachers from difficult subject area is a major obstacle to implementing interdisciplinary approaches	99	98	20	3	3.04	0.41	Agree

Corresponding author: Umar Isah Ohimege

✉ umarohimege@gmail.com

Department of Mathematics, Faculty of Science Education, Federal University Of Education, Zaria.

© 2025. Faculty of Technology Education. ATBU Bauchi. All rights reserved



S/N	Section C: Barriers to Implementation on Students Approach	SA	A	SD	D	MEAN	St. Div.	Remarks
5	Assessment and evaluation methods in secondary schools are not conducive to interdisciplinary approaches.	131	57	15	7	3.09	0.80	Agree
	Total					15.73	4.01	
	Average Mean and Standard Deviation					3.15	0.80	Agreed

Table 2 showed that, the mean and standard deviation scores of responses on the barriers to implementation of interdisciplinary approaches among students of secondary schools in Kaduna State. The average mean and standard deviation scores of items 1, 2, 3, 4, and 5 is given as (N = 210, M = 3.15 and SD = 0.80) which is above the cut-off point of 2.50, indicating there is

significant influence of barriers to implementation of interdisciplinary approaches among students of secondary schools in Kaduna State.

Research Question Three:

Impact on students STME engagement and Career aspirations among students of secondary school in Kaduna State.

Table 3: Mean and Standard Deviation on Responses of Impact of STME Students Engagement and Career Aspiration Among Secondary School in Kaduna

S/N	Section C: Impact of STME Engagement and Career Aspiration	SA	A	SD	D	MEAN	St. Div.	Remarks
1	Participating in STME activities has increased my interest in pursuing a STME related career	124	66	20	10	3.44	0.92	Agreed
2	My experiences in STME classes have positively influenced my career aspirations	98	95	12	5	3.51	1.03	Agreed
3	I believe that STME education will provide me with the skills necessary for my future career	134	56	8	2	3.07	0.83	Disagreed
4	My teacher's encouragement and support in STME subjects have motivated me to pursue STME related career paths	111	77	15	7	3.44	0.92	Agreed
5	Exposure to real-world STME applications has enhanced my understanding of potential career options in STME fields.	124	67	14	5	3.07	0.83	Agreed
	Total					16.53	4.53	
	Average Mean and Standard Deviation					3.31	0.91	Agreed

Table 3 showed that, the mean and standard deviation scores of responses on the

Impact on students STME engagement and Career aspirations among students of secondary

Corresponding author: Umar Isah Ohimege

✉ umarohimege@gmail.com

Department of Mathematics, Faculty of Science Education, Federal University Of Education, Zaria.

© 2025. Faculty of Technology Education. ATBU Bauchi. All rights reserved



school in Kaduna State. The average mean and standard deviation scores of items 1, 2, 3, 4, and 5 is given as ($N = 210$, $M = 3.31$ and $SD = 0.91$) which is above the cut-off point of 2.50, indicating there is significant influence of Impact on students STME engagement and Career aspirations among students of secondary school in Kaduna State.'

Research Hypothesis One:

There is no significant difference in the implementation of interdisciplinary teaching approaches between teachers who receive training and those who do not

Table 4: t-test Analysis on the Implementation of Interdisciplinary Teaching Approaches between Teachers who receive training and those who do not

Remediation	N	Mean	St. Div.	df	T	P
Agreed	180	26.44	1.42	228	14.23	0.000
Disagreed	30	17.02	5.79			

Table 4 shows that, there is significant difference on the implementation of interdisciplinary teaching approaches between teachers who receive training and those who do not. The p-value is 0.000 which is less than alpha value of 0.05 level of significance, this means that, there is significant difference between implementation of interdisciplinary teaching approaches between teachers who receive

training and those who do not. Therefore, hypothesis one is rejected.

Research Hypothesis Two:

There is no significant relationship between teachers, resources and curriculum-related factors and the implementation of interdisciplinary approaches among secondary school in Kaduna State.

Table 5: t-test Analysis on the Relationship between Teachers, Resources and Curriculum-related factors and the implementation of interdisciplinary Approaches among secondary school in Kaduna State.

Gender	N	Mean	St. Div.	df	T	P
Agreed	180	65.23	1.74	208	21.995	0.000
Disagreed	30	24.89	1.82			

Table 5 shows that, there is significant relationship between teachers, resources and curriculum-related factors and the implementation of interdisciplinary approaches among secondary school in Kaduna State. The p-value is 0.000 which is less than alpha value of 0.05 level of significance, this means that, there is significant relationship between teachers, resources and curriculum-related factors and the implementation

of interdisciplinary approaches among secondary school in Kaduna State. Therefore, hypothesis two is rejected.

Research Hypothesis Three:

There is no significant relationship between STME engagement and career aspirations among secondary school students.

Table 6: t-test Analysis on the Relationship between Teachers, Resources and Curriculum-related factors and the implementation of interdisciplinary Approaches among secondary school in Kaduna State.

Gender	N	Mean	St. Div.	df	t	P
Agreed	180	72.43	3.21	208	11.123	0.000
Disagreed	30	24.89	1.82			

Corresponding author: Umar Isah Ohimege

umarohimege@gmail.com

Department of Mathematics, Faculty of Science Education, Federal University Of Education, Zaria.

© 2025. Faculty of Technology Education. ATBU Bauchi. All rights reserved



Gender	N	Mean	St. Div.	df	t	P
Disagreed	30	32.88	2.12			

Table 6 shows that, there is significant relationship between STME engagement and career aspirations among secondary school students. The p-value is 0.000 which is less than alpha value of 0.05 level of significance, this means that, there is significant relationship between STME engagement and career aspirations among secondary school students. Therefore, hypothesis three is rejected.

DISCUSSION OF FINDINGS

The findings from Table 4 reveals that, there is significant difference on the implementation of interdisciplinary teaching approaches between teachers who received training and those who do not received training. This finding is in agreement with the findings of Marlina and Asrizal (2022), Chan and Nagatomo (2021) and Siew and Ahmad (2023) who jointly supported that, there is significant difference in teachers who given adequate training compared to those that were not trained.

Table 5 also reveals that, there is significant relationship between teachers, resources, and curriculum related factors and the implementation of interdisciplinary approaches among secondary school in Kaduna state. The results in line with the findings of Karaduman and Eti (2023), Silva et al (2023), and Amin et al (2022). Who states that, teachers, resources, and curriculum-related are key factors that derive the implementation of interdisciplinary approach in secondary school in Kaduna state.

Lastly, the results in Table 6 shows that, there is significant relationship between STME engagement and career aspirations among secondary school students. The findings is in agreement with the finding of Chan and Nagotomo (2021), Busch et al (2023), Kubat (2018), and Marlina and Asrizal (2022) jointly believed that there is significant relationship between STME and students making good career choice.

CONCLUSION

This study investigated the exploring interdisciplinary approach for teaching Mathematics and computer science in STME among secondary school in Kaduna state. STEM education on secondary teachers' interdisciplinary teaching competencies and highlights three key points. First, STEM education has a significant influence on teachers' interdisciplinary teaching competence, thereby enhancing their ability to integrate and apply knowledge across different subjects.

Second, STEM education helps teachers improve their awareness of interdisciplinary teaching, knowledge integration, practical application, educational collaboration, and professional development. Third, the effectiveness of STEM education varies depending on teachers' educational background, subject specialization, teaching experience, and interdisciplinary experience. Gender does not significantly influence these outcomes. STEM education promotes interdisciplinary teaching through integrated instructional models, project-based learning, and teacher training.

Integrated STEM approaches encourage teachers to analyse content from multiple perspectives and design creative and practical activities that engage students and support mastery of interdisciplinary knowledge which end enhancing students' performance. Effective training led to Project-based learning enhances teachers' planning, collaboration, and reflective practices. Targeted training provides teachers with the concepts, methods, and skills necessary to implement STEM education effectively.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made.

1. Some Teachers with NCE qualifications need to be further train in order to improve on their Mathematics Subject-matter

- Knowledge to better their delivery during teaching and learning.
2. Teachers' pedagogical knowledge should be given more attention during training of Students of National Certificate of Education (NCE) so as to acquire enough teaching skills to be able to give concrete foundation of Mathematics and computer at the secondary school level.
 3. Mathematics Association of Nigeria (MAN), Kaduna State chapter should always collaborate with the National Mathematical Centre (NMC) on training and re-training of mathematics teachers in our secondary schools on regular basis in order to accommodate the new technologies, innovations and methods in the education industry. This will give our teachers, teaching Mathematics and computer in our senior and junior secondary school levels the good stand to deliver effectively and efficiently.
 4. A Mathematics and computer science Teachers' Subject Knowledge test should be conducted by the Ministry of Education regularly in order to make Mathematics teachers always be alive.
 5. Based on the findings of this study, recommendation was made and call on the state and the federal governments to collaborate with the National Commission for Colleges of Education (NCCE) to design an improve curriculum content on mathematics and computer courses at our colleges of education in the country to help in producing NCE graduates with High content and pedagogical knowledge. This will enable them to teach effectively in our secondary schools.
- ## REFERENCES
- Akpınar, D., & Altun Yalçın, S. (2021). Exploring Motivations and Epistemological Beliefs Related to Science Among Talented and Gifted Students. *Open journal for educational research*, 5(2), 317–332.
- Altun, e., & Apaydin, Z. (2022). Awareness Levels and Attitudes Of Primary School Teachers About STEM Approach. *Yuzunci Yil Universitesi Egitim Fakultesi Dergisi*, 10.33711/yyuefd.1108245(<https://scite.ai/reports/10.33711/yyuefd.1108245>). <https://doi.org/10.33711/yyuefd.1108245>
- Amalina Yusup, Ahmad, A.-R., Muhamad, R., Kassim, N., Mohd, N., Nurazrin Mohd Esa, Liza Md Salleh, Mohd, D., Nursyazwani Aznan, Rafidah Abd Rahim, Mohd Iskandar Ishak, Filzah Hazirah Jaffar, Nurlaila Syamsul Bahri, Nurul Diyana Zainal, Harun, M., & Sarah Alia Norazlan. (2020). Young Scientist Pioneer 2019: Evaluation of the Effectiveness of Program at SMK Wira Penrissen, Sarawak. <https://scite.ai/reports/10.2991/assehr.k.200921.016>.
- Amin, M., Rahmawati, Y., Sudrajat, A., & Mardiah, A. (2022). Enhancing Primary School Students' Critical Thinking Skills through the Integration of Inquiry-Based STEM Approach on Teaching Electricity in Science Learning. *Journal of Physics: Conference Series*, 2377(1), 012090. <https://doi.org/10.1088/1742-6596/2377/1/012090>
- Bevz, V., & Dmytrienko, O. (2020). Students' perceptions of the history of science and technology course at teacher training university. *Advanced* <https://doi.org/10.32591/coas.ojer.0502.14317>
- Alessandra, K., Adriana Helena Borssoi, & Elaine Cristina Ferruzzi. (2023). Integration of STEM Education in Differential and Integral Calculus classes: Aspects Evidenced in a Mathematical Modelling Activity. *Acta Scientiae*, 24(7), 116–145. <https://doi.org/10.17648/acta.scientiae.7114>



- Education*, 7(15), 74–80.
<https://doi.org/10.20535/2410-8286.160202>
- Busch, C. A., Mohammed, T. F., Nadile, E. M., Witt, M. L., Vargas, C., Tran, M., Wolf, J. G., Brister, D., & Cooper, K. M. (2023). Costs and Benefits of Undergraduates Revealing Depression to Online Science Instructors. *CBE—Life Sciences Education*, 22(1).
<https://doi.org/10.1187/cbe.22-05-0088>
- Chan, M.-N., & Nagatomo, D. (2021). Study of STEM for Sustainability in Design Education: Framework for Student Learning and Outcomes with Design for a Disaster Project. *Sustainability*, 14(1), 312.
<https://doi.org/10.3390/su14010312>
- Chiriacescu, F. S., Chiriacescu, B., Grecu, A. E., Miron, C., Panisoara, I. O., & Lazar, I. M. (2023). Secondary teachers' competencies and attitude: A mediated multigroup model based on usefulness and enjoyment to examine the differences between key dimensions of STEM teaching practice. *PLOS ONE*, 18(1), e0279986.
<https://doi.org/10.1371/journal.pone.0279986>
- Cumhur, M., Masalimov, A. R., Rostovtseva, P. P., Shindryaev, N. N., & Kryukova, N. I. (2021). Content Analysis of Studies Conducted on STEM Education from 2010 to 2020: Perspective of Emerging Technologies in Learning. *International Journal of Emerging Technologies in Learning*, 16(19), 139–151.
<https://doi.org/10.3991/ijet.v16i19.26053>
- Dany Karmila, Della Asmaria Putri, Mery Berlian, Deden Mahmuas Pratama, & Fatrima. (2021). The Role of Interactive Videos in Mathematics Learning Activities During the Covid19 Pandemic.
- Karaduman, B., & Eti, İ. (2023). Stem for all: opinions of education staff at a stem education center on stem education.
- Trakya Eğitim Dergisi*, 13(1), 209–225.
<https://doi.org/10.24315/tred.1022582>
- Kennedy, E., & Smolinsky, L. (2016). Math Circles: A Tool for Promoting Engagement Among Middle School Minority Males. *EURASIA Journal of Mathematics, Science and Technology Education*, 12(4).
<https://doi.org/10.12973/eurasia.2016.1223a>
- Kubat, U. (2018). The integration of STEM into science classes. *World Journal on Educational Technology: Current Issues*, 10(3), 165–173.
<https://doi.org/10.18844/wjet.v10i3.3557>
- Liburd, K. K. D., & Jen, H.-Y. (2021). Investigating the Effectiveness of Using a Technological Approach on Students' Achievement in Mathematics—Case Study of a High School in a Caribbean Country. *Sustainability*, 13(10), 5586.
<https://doi.org/10.3390/su13105586>
- Marlina, L., & Asrizal, A. (2022). Validity of ICT based on integrated stem education teaching materials to improve data literature and technology physics students. *Pillar of physics education*, 15(3), 189.
<https://doi.org/10.24036/13501171074>
- Martín-Núñez, J. L., Bravo-Ramos, J. L., Sastre-Merino, S., Pablo-Lerchundi, I., Caravantes Redondo, A., & Núñez-del-Río, C. (2022). Teaching in Secondary Education Teacher Training with a Hybrid Model: Students' Perceptions. *Sustainability*, 14(6), 3272.
<https://doi.org/10.3390/su14063272>
- Muhammad, R., Abdul Gani, A., Abdullah, N., Ibrahim, S., & Md Sharif, M. S. (2021). The Culinary and Food Science: Its' Integration via Kitchen Science Module (Cooking) to fascinate students towards Science, Technology, Engineering and Mathematics (STEM). *International Journal of Academic*

Corresponding author: Umar Isah Ohimege

✉ umarohimege@gmail.com

Department of Mathematics, Faculty of Science Education, Federal University Of Education, Zaria.

© 2025. Faculty of Technology Education. ATBU Bauchi. All rights reserved



- Research in Business and Social Sciences*, 11(13).
<https://doi.org/10.6007/ijarbss/v11-i13/8550>
- Nyet Moi Siew, & Ahmad, J. (2023). The effects of sociocentric issues with thinking wheel map approach on curiosity towards stem of year five students. *Problems of Education in the 21st Century*, 81(1), 130–143.
<https://doi.org/10.33225/pec/23.81.130>
- Pekbay, C. (2023). A sample STEM activity based on the engineering design process: A study on prospective preschool teachers' views. *Participatory Educational Research*, 10(1), 86–105.
<https://doi.org/10.17275/per.23.5.10.1>
- Şahin, F., & Kabapinar, F. (2020). Öğretmen Adaylarının Vücudun pH Dengesi Konusundaki Bilgi Entegrasyon Düzeylerinin İncelenmesi. *E-Kafkas Eğitim Araştırmaları Dergisi*, .
<https://doi.org/10.30900/kafkasegt.664823>
- Samara, V., & Kotsis, K. T. (2023). The use of new technologies and robotics (stem) in the teaching of sciences in primary education: The concept of magnetism: a bibliographic review. *European Journal of Education Studies*, 10(2).
<https://doi.org/10.46827/ejes.v10i2.4652>
- Siagian, R., Sitanggang, N., & M. Joharis Lubis. (2022). Project-Based Learning Governance on Natural Materials Improving the Creativity of Class VIII Students of SMP Negeri 1 Sigumpar, 7(2), 77–84.
<https://doi.org/10.33086/ehdj.v7i2.2964>
- Smyrniou, Z., Georgakopoulou, E., & Sotiriou, S. (2020). Promoting a mixed-design model of scientific creativity through digital storytelling—the CCQ model for creativity. *International Journal of STEM Education*, 7(1).
<https://doi.org/10.1186/s40594-020-00223-6>
- Succar, T., Lee, V. A., Karmonik, C., & Lee, A. G. (2022). An Academic Ophthalmology Curriculum as a Model for Introducing Preprofessional Students to Careers in Ophthalmology. *Journal of Academic Ophthalmology*, 14(01), e45–e51.
<https://doi.org/10.1055/s-0042-1743413>
- Tan, T. T. M., & Lee, Y.-J. (2022). Building Improved Microbial Fuel Cells: A Model Integrated STEM Curriculum for Middle-School Learners in Singapore. *Education Sciences*, 12(6), 417.
<https://doi.org/10.3390/educsci12060417>
- Wahyuningsih, S., Nurjanah, N. E., Rasmani, U. E. E., Hafidah, R., Pudyaningtyas, A. R., & Syamsuddin, M. M. (2020). STEAM Learning in Early Childhood Education: A Literature Review. *International Journal of Pedagogy and Teacher Education*, 4(1), 33.
<https://doi.org/10.20961/ijpte.v4i1.39855>
- Yuan, Y., Ji, X., Yang, X., Wang, C., Samsudin, S., & Omar Dev, R. D. (2022). The Effect of Persistence of Physical Exercise on the Positive Psychological Emotions of Primary School Students under the STEAM Education Concept. *International Journal of Environmental Research and Public Health*, 19(18), 11451.
<https://doi.org/10.3390/ijerph191811451>
- Zulirfan, Z., Yennita, Y., Maaruf, Z., & Sahal, M. (2023). Ethnoscience literacy in Pacu Jalur tradition: Can students connect science with their local culture? *Eurasia Journal of Mathematics, Science and Technology Education*, 19(1), em2210.
<https://doi.org/10.29333/ejmste/12773>