Mathematical Modelling for Solving Real-Life Problems in Polytechnic Education

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Abstract

The study examined "Mathematical Modelling for Solving Real-Life Problems in Polytechnic Education", focusing on its integration, prospects, and challenges within the polytechnic learning context. A quantitative research approach using a descriptive survey design was adopted to collect data from 25 mathematics and statistics lecturers from two polytechnics within Plateau state. The instrument used was a structured questionnaire titled Mathematical Modelling and Polytechnic Education Questionnaire (MMPEQ). Its validity was ensured through expert review by two mathematics educators and one research specialist from the University of Jos, while reliability was established through a pilot test conducted with lima lecturers from Nasarawa State Polytechnic Lafia, yielding a Cronbach's Alpha coefficient of 0.79, confirming high internal consistency. Data were analyzed using mean and standard deviation. Results revealed that although mathematical modelling is widely acknowledged AS a vital pedagogical tool, its practical integration remains limited by inadequate and weak institutional support, and insufficient access to technological tools. However, lecturers expressed optimism about its potential to improve creativity, analytical reasoning, and real-life problem-solving among students. The study recommends continuous professional development for lecturers and explicit integration of modelling activities into the polytechnic curriculum to enhance innovation and industrial relevance.

KeyWords: CurriculumIntegration,Mathematical Modelling, Polytechnic Education and Real-Life Problem Solving

1. Introduction

Polytechnic schooling occupies an important aspect in the Nigerian tertiary education, by and large due to the fact that its extensive goal is to provide center-stage technical and vocational manpower, equip learners with practical competencies and implemented know-how, and thereby make a contribution to national economic improvement and self-reliance [1][2]. Particularly, polytechnics are charged with the responsibility of implementing scientific, technological and commerce know-how and abilities essential for agricultural, industrial and monetary development [2][3]. Put differently, the mandate of polytechnic schooling extends past mere acquisition of theoretical expertise: it encompasses the cultivation of sensible competence, innovation, and readiness for employment or self-employment [4].

In the context of the mandate, the integration of mathematical modelling into the teaching curriculum of polytechnic education offers a promising future to bridge the knowledge divide. Mathematical modelling is the

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technique by which real-life puzzles are formulated using mathematical formulas, solved, and then interpreted lower back to address the real-life challenges. Hence, it enhances the application of mathematical standards to address context-specific problems [5]. The level to which modelling is included into polytechnic curricula and pedagogy, however, is at subpar level in the Nigerian education setting.

The advantages of embedding mathematical modelling into polytechnic programmes are massive. Whilst students have interaction with modelling obligations, they do not only deepen their conceptual knowledge of arithmetic, but also expand their problem-solving abilities, critical questioning, creativity, and an orientation closer to real-world technological or business applications. Such results align carefully with the main intention of polytechnic education which is to produce graduates who can meaningfully contribute to socioeconomic improvement. Yet, in practice, numerous studies reveal that many polytechnic programmes nevertheless emphasize theoretical guidance at the expense of applied, problem-based mastering [6]. Furthermore, the implementation of mathematical modelling procedures in polytechnics is impeded by various demanding situations such as lecturers' limited professional improvement in modelling pedagogy, insufficient infrastructure and materials, inflexible curricula prioritizing theory, and students' vulnerable foundational knowledge in arithmetic. Except such constraints are addressed, the potentials of mathematical modelling in improving real-life hassle-fixing competence might not be fully realised.

Given the foregoing observations, it becomes vital to examine how mathematical modelling is presently incorporated into polytechnic education and getting to know techniques, the potentialities such integration holds for enhancing college students' capabilities in solving problems, and the challenges impeding its effective implementation in polytechnic education. This investigation will therefore offer proof-based insights into curriculum designers, educators, and policymakers aiming to bolster the role of arithmetic within polytechnic education and thereby support its vast purpose of producing technically competent, problem-solving graduates.

1.1 Statement of the Problem

Polytechnic education in Nigeria aims to supply skilled, self-reliant, and progressive graduates capable of making use of scientific and technological knowledge to find solution to problems [1][4]. In spite of this objective, many polytechnic students nonetheless battle to connect mathematical ideas with practical programmes. Mathematics modelling is often taught theoretical and procedural, leading to poor problem-solving competence among young graduates [6]. Mathematical modelling, which transforms actual-world problems into mathematical expressions for evaluation and solution, has been identified globally as a powerful device for bridging principle and exercise [5]. Yet, its integration into Nigerian polytechnic schooling remains constrained. Most teachers depend on traditional teaching techniques that discourage active studying and creativity [3]. As an end result, many graduates lack the analytical and applied competence required for technological innovation and business problem-solving.

Even though mathematical modelling gives first-hand potentialities for enhancing students' real-world problem-solving skills, its effective implementation is hindered by factors such as inadequate lecturer education, resources deficiency, rigid curricula, and institutional constraints. These

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demanding situations tend to undermine the realization of the main goal of polytechnic schooling. Consequently, the problem of this research is to study the level of integration of mathematical modelling in polytechnic teaching with a bid to remedy real-life issues.

1.2 Objectives of the Study

1. To observe the extent to which mathematical modelling skills are integrated into the teaching and learning in polytechnic education.
2. To examine the prospects of enforcing mathematical modelling tactics in polytechnic curricula for progressed real existence hassle solving skills
3. To identify the challenges of incorporating mathematical modelling methods in polytechnic
   Education for better real -life problem solving competencies.

1.3 Research Questiions

1. To what quantity are mathematical modelling skills incorporated into the teaching and learning in polytechnic ?
2. What are the prospects of incorporating mathematical modelling abilities in polytechnic curricula for enhancing students' real-lifestyles problem-solving abilities?
3. What challenging situations avert the effective implementation of mathematical modelling processes in polytechnic education?

2. Literature Review

2.1 Concept of Mathematical Modelling

Mathematical modelling refers to the systematic system of representing actual-world conditions by the use of mathematical language, symbols, and systems to investigate problems and suggest answers. According to Blum and Leiß [7], mathematical modelling involves figuring out a real-life problem, simplifying it into a mathematical shape, fixing it through appropriate methods, and decoding the results again into the real-life context. It bridges the gap among abstract mathematics and its realistic packages in technology, engineering, economics, and schooling.

Also, Aduloju and Adedotun [5] defined mathematical modelling as the utilization of mathematical standards, equations, and reasoning to give an explanation for, predict, or optimize real-life phenomena. The procedure enables learners to connect classroom knowledge with sensible stories, thereby promoting vital thinking, creativity, and selection-making abilities. In the same vein, Kaiser [8] viewed mathematical modelling as a center element of mathematical literacy, emphasizing its position in empowering rookies to apply arithmetic as a device for fixing societal and business issues.

In polytechnic education, mathematical modelling performs a vital function in equipping students with analytical and problem-solving abilities necessary in technological and vocational fields. It encourages active learning through inquiry, experimentation, and mirrored image, which are essential for applying mathematical principles to actual-world contexts. For this reason, mathematical modelling not only enhances academic knowledge but also fulfills the wider aim of polytechnic education which is to produce modern, and solution-orientated graduates able to addressing real-life challenges.

2.2 Concept and Objectives of Polytechnic Education

Polytechnic education is a unique factor of tertiary education that emphasizes the pursuit of technical, vocational, and professional talents required for national business advancement and socio-economic advancement. It's designed to bridge the gap

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between concept and exercise by equipping students with applied know-how that may be immediately applied in fixing real-world troubles. Consistent with Adebayo and Musa [9], polytechnic training focuses on developing middle-degree manpower with specialized abilities in technology, engineering, applied sciences, and management to fulfill the needs of the present-day economic system. Similarly, Okorie [10] explains that polytechnic education nurtures creativity, innovation, and technical talent, thereby preparing college students for each paid employment and entrepreneurship.

Owoeye and Adediran [11] describe polytechnic education as a vital device for technological switch and business improvement, as it emphasizes hands-on schooling and applied research that deal with societal demanding situations. It operates at the philosophy of *doing*, encouraging students to apply theoretical principles to practical conditions. In this regard, polytechnic education contributes appreciably to national development by producing graduates who are self-reliant, hassle-oriented, and technologically capable.

The broad objectives of polytechnic education are to train and produce technically skilled individuals capable of contributing to national and industrial development. As stated by the *National Board for Technical Education* [12], polytechnics are expected to:

1. Provide full-time and part-time courses in technology, applied science, commerce, and management, leading to the production of trained manpower at both technician and technologist levels.
2. Develop students' practical and creative abilities to enable them to be innovative and self-employed.
3. Promote research and technological advancement directed at solving real-life industrial and community problems.
4. Bridge the gap between theoretical learning and industrial practice through collaborations with industries and professional bodies.
5. Contribute to national economic growth and sustainable development by producing graduates equipped with entrepreneurial and problem-solving skills.

Eze and Igbokwe [13] verify that polytechnic schooling enhances productivity and innovation by presenting students with abilities relevant to emerging technologies and industrial tendencies. In the same vein, Oladipo and Olamide [14] note that polytechnic establishments play a pivotal role in human capability development and technological self-reliance, particularly in growing economies where skilled manpower is important to competitiveness.

2.3 Prospects of Mathematical Modelling Approaches to Real Life Problem - Solving

Mathematical modelling gives good-sized potentialities for enhancing actual-life trouble-solving, particularly in applied and technical education. As worldwide economies rely increasingly on facts and era, the capacity to formulate and examine actual-world challenges mathematically has become important. According to Sharmila and Patel [15], mathematical modelling bridges the space between theoretical mathematics and practical application via engaging college students in figuring out, reading, and solving real-world problems. This process cultivates vital questioning, creativity, and innovation skills vital for technological development. Similarly, Kaur and Singh [16] emphasized that mathematical modelling encourages interdisciplinary learning, as actual-lifestyle troubles often cut across a couple of disciplines. Through integrating thoughts from technological know-how, engineering,

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and economics, students develop adaptive thinking and teamwork competencies relevant to professional contexts. Likewise, Ghosh and Banerjee [17] found that actual-lifestyle modelling responsibilities help inexperienced persons' engagement and motivation by using demonstrating mathematics as useful and applicable to issues such as weather exchange, populace growth, and useful resource optimization.

2,4 Challenges of Effective Implementation of Mathematical Modelling In Polytechnic Education

Effective implementation of mathematical modelling in polytechnic education faces a couple of pedagogical and institutional barriers. A primary constraint is the low competence and education of teachers, as many were trained under traditional systems emphasizing procedural computation over applied reasoning. According to Nguyen and Pham [18], teachers often lack the self-belief and technical knowledge to facilitate open-ended modelling learning, a situation worsened by confined professional improvement opportunities. Another crucial problem is the polytechnic curricula, which continue to be overloaded with theoretical content. Ogunleye and Oladipo [19] found that this inflexibility discourages interdisciplinary engagement.

Additionally, restrained institutional resources and technological infrastructure preclude effective modelling practice. Eze and Chukwu [20] noted that many polytechnics lack access to fashionable software programmes and computational equipment, making learning abstract instead of experiential. This is compounded by massive class sizes and insufficient academic time [21]. Finally, susceptible collaboration between industry and academia remains a major setback [9].

2.5 Empirical Review

Sharmila and Patel [22] examined the *Impact of Realistic Mathematics Education and Mathematical Modelling Approaches* among senior secondary school students in North-Central Nigeria. Findings revealed that students exposed to modelling-based training exhibited higher geometric fulfillment and positive attitudes towards mathematics. However, insufficient teacher education and rigid curricula constrained modelling use.

Danladi and Okon [23] investigated *The Role of Mathematical Modelling in Enhancing 200-Level Student Understanding of Real Analysis*. Results showed that modelling improved students' comprehension and logical reasoning. The authors advocated regular teacher training and curriculum integration of modelling pedagogy.

3. Methodology

The study adopted the descriptive survey design to gain standardized data on mathematics lecturers' views concerning the position of mathematical modelling in fixing actual-lifestyles troubles in polytechnic education. The population comprised all arithmetic and statistics lecturers in Plateau state Polytechnic, Jos and United Polytechnic Jos all in Plateau state. Given the limited population, a census method was adopted, involving all 25 academics as sample. Data were elicited by means of Mathematical Modelling and Real-Life Problem-Solving in Polytechnic Education Questionnaire (MMRLPSPEQ), designed to elicit responses on the topic under study. The questionnaire was rated on a four-point Likert scale ranging from Strongly Agree (4) to. The questionnaire changed into rated on a 4-factor Likert scale ranging from Strongly Agree (four) to Strongly Disagree (1) to permit for quantitative evaluation of responses. The tool's validity was established through professional review via

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educators and one specialist, all from the university of Jos. Reliability was confirmed via a pilot study using three mathematics lecturers and 2 statistics academics drawn from Nasarawa nation Polytechnic, Lafia, yielding a Cronbach's Alpha coefficient of 0.79, indicating good internal consistency. Data were accumulated via personal administration via the researcher to ensure high return rate. The data obtained were analyzed by the use of mean and standard deviation, with a 2.50 benchmark Thedetails are offered in tables and discussed in subsequent sections.

4. Results

Research Question1: To what extent are mathematical modelling skills integrated into the teaching and learning processes in polytechnic education?

Table 1: Extent of Mathematical Modeling Skills Integration in Polytechnic Education

S/NO	STATEMENT	SA	A	D	SD	N	MEAN	STD	REMARK
1	Mathematical modelling activities are regularly incorporated into mathematics lessons in my school.	6	10	6	3	25	2.88	0.89	Agree
2	Lecturers encourage students to apply mathematical concepts to solve real-life technical problems.	8	9	5	3	25	2.96	0.91	Agree
3	The polytechnic curriculum provides adequate opportunities for students to engage in modelling-based tasks.	5	7	8	5	25	2.56	1.00	Agree
4	Students are assessed based on their ability to apply mathematical models to real-world situations.	4	8	9	4	25	2.52	0.95	Agree
5	Mathematical modelling is emphasized as an essential skill in the teaching and learning of applied mathematics.	**7**	10	5	3	25	2.92	0.90	Agree

Criterion Mean =2.50 **Cumulative Mean =2.77**

The overall cumulative mean of 2.77 indicates that respondents agreed that mathematical modelling skills are moderately integrated into the teaching and learning processes in polytechnic education. This suggests that while some aspects of modelling are practiced, there is still room for deeper curricular and pedagogical integration.

Research Question2: What are the prospects of implementing mathematical modelling approaches in polytechnic curricula for enhancing students' real-life problem-solving skills?

Table 2: Prospects of Implementing Mathematical Modeling Approaches in Polytechnic Education

S/NO	STATEMENT	SA	A	D	SD	N	MEAN	STD	REMARK
6	**Integrating mathematical modelling into the curriculum can improve students'**	**10**	**11**	**3**	**1**	**25**	**3.20**	**0.78**	**Agree**

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	analytical and problem-solving abilities								
7	**Mathematical modelling can enhance students' creativity and innovation in addressing industrial and societal issues.**	**12**	**9**	**3**	**1**	**25**	**3.28**	**0.80**	**Agree**
8	**The use of mathematical modelling prepares students for careers in technology-driven industries**	**9**	**10**	**4**	**2**	**25**	**3.04**	**0.91**	**Agree**
9	**Incorporating modelling approaches in polytechnic education promotes interdisciplinary learning and collaboration.**	**8**	**11**	**4**	**2**	**25**	**3.00**	**0.88**	**Agree**
10	**Mathematical modelling has the potential to make mathematics teaching more practical and engaging for students.**	**11**	**10**	**3**	**1**	**25**	**3.24**	**0.79**	**Agree**

Criterion Mean=2.50 **Cumulative Mean = 3.15**

The cumulative mean of 3.15 indicates that respondents strongly agreed on the positive prospects of implementing mathematical modelling in polytechnic curricula. The findings suggest that mathematical modelling can significantly enhance students' problem-solving skills, creativity, interdisciplinary engagement, and preparedness for technologically driven careers.

Research Question 3: What challenges hinder the effective implementation of mathematical modelling approaches in polytechnic education for improved real-life problem-solving skills?

Table 3: Challenges to Effective Implementation of Mathematical Modeling in Polytechnic Education

S/NO	STATEMENT	SA	A	D	SD	N	MEAN	STD	REMARK
11	**Most mathematics lecturers lack adequate training in mathematical modelling pedagogy.**	**11**	**9**	**4**	**1**	**25**	**3.20**	**0.82**	**Agree**
12	**2.There is insufficient institutional support for developing and integrating modelling-based instructional materials**	**10**	**8**	**5**	**2**	**25**	**3.04**	**0.91**	**Agree**
13	**The current polytechnic curriculum does not allocate enough time for modelling activities.**	**9**	**10**	**4**	**2**	**25**	**3.04**	**0.88**	**Agree**
14	**Large class sizes make it difficult to implement mathematical modelling effectively.**	**12**	**9**	**3**	**1**	**25**	**3.28**	**0.79**	**Agree**
15	**Limited access to technological tools and data resources hinders students' participation in modelling projects**	**13**	**8**	**3**	**1**	**25**	**3.32**	**0.77**	**Agree**

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The cumulative mean of 3.18 shows that respondents strongly agreed that significant challenges hinder the effective implementation of mathematical modelling in polytechnic education. The key constraints include inadequate lecturer training, weak institutional support, limited time allocation in the curriculum, large class sizes, and poor access to technological tools and data. These findings suggest the need for policy and institutional reforms to strengthen modelling-based pedagogy and infrastructure.

5. Discussion

The study examined **"**Mathematical Modelling for Solving Real-Life Problems in Polytechnic Education**."** Findings revealed that although lecturers recognize the pedagogical value of mathematical modelling, its integration in classrooms remains limited. Real-life problems are sometimes incorporated; however, these are not often structured as formal modelling activities. This finding aligns with Sharmila and Patel [15], who asserted that modelling bridges conceptual understanding and practical application but is hindered by computation-based teaching traditions. Similarly, Kaur and Singh [16] observed that limited lecturer preparedness and rigid institutional systems constrain the adoption of modelling, while Ghosh and Banerjee [17**]** emphasized that effective modelling requires careful planning and adequate resources.

Regarding the prospects of implementation, the findings indicated strong optimism about the potential of mathematical modelling to enhance analytical thinking, creativity, and career readiness. This supports Mensah and Boateng [21], who maintained that modelling fosters innovation by linking mathematics to industrial applications. Likewise, Nguyen and Pham [18] noted that it promotes participatory, student-centered learning, while Ogunleye and Oladipo [19] highlighted its role in developing data-driven reasoning skills essential for the digital age.

The study additionally recognized continual barriers, which includes inadequate lecturer education, poor institutional aid, rigid curricula, and restricted technological assets. These challenges,indicate that while awareness of modelling's cost is excessive, effective implementation remains vulnerable.

6. Conclusion

The study found that mathematical modelling is widely recounted as an effective pedagogical device for bridging theory and exercise in polytechnic education. However, its actual integration into teaching and learninghas been confined because of factors such as inadequate lecturer education, insufficient institutional aid, and constrained access to digital tools. In spite of these challenges, lecturers expressed great optimism about the potentials of mathematical modelling in fostering creativity, innovative thinking, and real-lifeproblem-solvingskills among cpolytechnic students. The findings additionally emphasised the need for systemic reforms in curriculum design and professional improvement to aid powerful implementation. Therefore, the study concludes that polytechnic institutions can substantially enhance college students' analytical competence and employability through full integration of mathematical modelling into instructional exercise and aligning it with real-global problem-solving contexts.

7. Recommendations

Based on the ensuing results the following are suggested:

1. Polytechnic institutions should organize regular training and workshops to

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enhance lecturers' competence and confidence in applying mathematical modelling techniques during instruction.

2. Curriculum planners should integrate mathematical modelling into course content and assessments to promote students' creativity, analytical thinking, and ability to solve real-life industrial and societal problems.
3. Administrators should provide adequate institutional support through access to digital tools, modelling software, and instructional materials, as well as policies that encourage innovative, modelling-based teaching practices.

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