

**A STUDY OF THE MATHEMATICS EDUCATION
PROGRAMMES IN THE TEACHER EDUCATION
UNIVERSITIES OF GHANA**

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(Abstract)



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Sr. No.	Abbreviations	Full Meaning
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AMMUSTED	Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development
AI	Artificial Intelligence
B.Ed	Bachelor of Education
BECE	Basic Education Certificate Examination
BSc	Bachelor of Science
CIPP	Context Input Process Product
CKT-UTAS	C. K. Tedam University of Technology and Applied Sciences
CoE	College of Education
GES	Ghana Education Service
GTEC	Ghana Tertiary Education Commission
ICT	Information and Communication Technology
JHS	Junior High School
KNUST	Kwame Nkrumah University of Science and Technology
LA	Learning Analytics
MEP	Mathematics Education Programme
MoE	Ministry of Education
MTE	Mathematics Teacher Education
NaSIA	National School Inspectorate Division
NPP	National Patriotic Party
NTC	National Tertiary Commission
OCTP	Off-Campus Teaching Practice
OECD	Organisation for Economic Cooperation and Development
PCK	Pedagogical Content Knowledge
PTPDM	Pre-tertiary Teacher Professional Development and Management
SDG – 4	Sustainable Development Goals – 4
SIP	Students Internship Programme
SMK	Subject Matter Knowledge
TE	Teacher Education
TEI	Teacher Education Institution
TEU	Teacher Education University
TES	Teacher Education System
TiT	Teachers in Training
TVTE	Technical and Vocational Teacher Education
UCC	University of Cape Coast
UDS	University of Development Studies
UEW	University of Education
UNESCO	United Nations Educational, Scientific and Cultural Organization
VHGTL	Van Hiele's Geometric thinking level
WAEC	West African Examination Council
WASSCE	West African Senior Secondary Certificate Examination
WPCK	Web Pedagogical Content Knowledge

Abbreviations Used and Their Meaning

1.0 Introduction

"Education is the process of facilitating learning or acquiring knowledge, skills, values, beliefs and habits" (UNESCO, 2015). Education provides the knowledge needed to integrate well into today's complicated society and serves as a lifelong companion for every person to achieve success. There cannot be a mention of education without teacher education. Teacher education is the backbone of education, producing the right professionals to implement educational policies. There is a need for quality teacher education to produce quality teachers who can deliver quality education.

A country cannot develop beyond the quality of its education system, and the quality of education depends on the quality of teachers (Adu-Pimpim, Frc, & Milonzho, 2011). The actual implementer of the educational policies of any nation is the teacher. The teacher has the responsibility of training the workforce of any country. That makes teacher education significant, empowering teachers with the knowledge to work effectively. According to Kapur (2018), the primary importance of teacher education is to provide training to teachers to achieve desired academic outcomes. The Sustainable Development Goals (SDG-4) aim to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (United Nations, 2021). Quality education is only made a reality with quality teachers, and quality teachers will not be available without quality teacher education. Pathak (2019) states that three processes govern quality educational input: curriculum, teaching-learning, and evaluation. The quality of education depends mainly on the above three indicators and applies to teacher education. There is a need to investigate how Teacher Education Institutions (TEIs) undertake the processes governing quality inputs to realise quality teacher education. The present study will attempt to study the Mathematics Education Programs (MEPs) in Ghana's Teacher Education Universities (TEUs).

1.1 Importance of Mathematics Education and Mathematics Teacher Education

Critical thinking skills are necessary for academic growth. Literature has it that critical thinking is an essential skill in all dispensations, which makes helping learners think critically very essential in the cycles of education. Critical thinking is a self-contained mental process that begins with addressing a problem or offering a solution by assessing the benefits and drawbacks of multiple options and choosing the most reasonable and suitable one. (Alsaleh, 2020). Mathematics is a subject known to invoke the ability of critical thinking in learners. In order to prepare young learners to make thoughtful decisions about learning

mathematics in their daily lives, it is advised that they get instruction and encouragement to think critically about their mathematical learning process (Sachdeva & Eggen, 2021). It is, therefore, essential that education systems place value on mathematics education. It is, therefore, not surprising that almost all education systems globally have made mathematics compulsory at the pre-tertiary level to enable learners to develop critical thinking skills. While mathematics is required in elementary and secondary education, it has become increasingly important in many natural and technological fields in post-secondary education (Kolar-Begović et al., 2017). Since mathematics is linked to the critical thinking abilities of learners, which contributes to their academic development, it is relevant that the best professionals are made to teach mathematics at the school level.

Teacher education prepares professional teachers to teach. Mathematics teacher education is meant to train mathematics teachers to teach mathematics at the school level. Mathematics teachers' education should be top-notch to produce the best teachers to teach mathematics at the school level. Teacher education and, for that matter, mathematics teacher education in Ghana has gone through several reforms over the years to improve the learning outcomes in mathematics by producing good professional mathematics teachers. Ghana cannot be exempted from the global trend of most nations making multiple attempts to equip their teaching workforce for the calibre of education provided in schools (Asare and Nti, 2014). Mathematics teacher education must be developed to meet the current demands of the 21st Century. This study explores mathematics education in Ghana and suggests the appropriate measures to ensure the best mathematics teachers are produced for the pre-tertiary stage of Ghana's education.

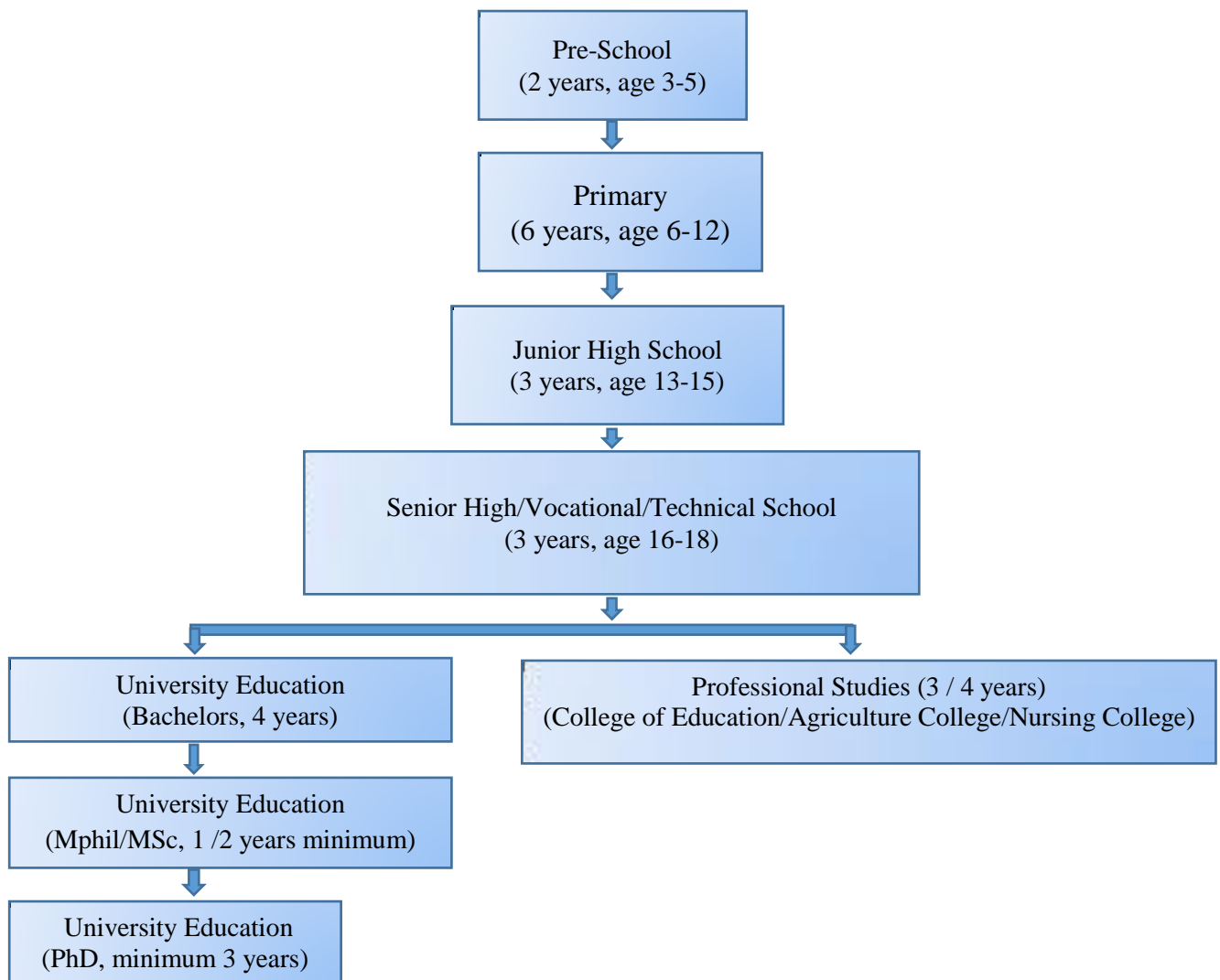
1.2 Education System in Ghana

Pre-tertiary Education in Ghana begins with early childhood, that is, pre-school (Crèche and Nursery, age 3-5), followed by basic education, six (6) years of primary Education (Class 1-6, age 6-12) and three (3) years of Junior High School education (JHS 1-3, age 13-15). Then, it continues with three (3) years of Senior High School education (SHS 1-3, age 16-18). Tertiary education follows a university degree (4 years), Teaching/Nursing/Agriculture College (4 or 3 years, depending on the study area). Mainly, Education in Ghana is free and compulsory from pre-school to Senior High School in all public institutions.

The Ministry of Education (MoE) formulates educational policies and ensures that all levels of education are functioning as expected (Ministry of Education, 2021). The MoE tasks the Ghana Education Service (GES) to oversee the day-to-day running of schools at the pre-tertiary level, from pre-school to senior high school (SHS).

In Ghana, the education system consists of public and private institutions at the pre-tertiary and tertiary levels. Private universities in Ghana are owned by individuals or corporate institutions rather than the government of Ghana. According to the Ghana Tertiary Education Commission (2022), there are 32 public and 127 private universities in Ghana (Ghana Tertiary Education Commission, 2022).

Figure 2.0 Structure of Education System in Ghana



Source: Kamran et al., 2019 (<https://wenr.wes.org/2019/04/education-in-ghana>)

1.3 Teacher Education and Mathematics Teacher Education in Ghana

Teaching the teacher how to teach is an essential job with a look at how relevant the teacher's work is. Teacher training in the advanced education division is immensely significant in advancing teachers' teaching abilities and acclimatising them to acquire new teaching procedures (Jamal, 2021). Member nations are urged by the Incheon Declaration to guarantee that educators and teachers are properly recruited, empowered, taught, professionally qualified, motivated, and supported within systems that are well-resourced, effective, and managed [As cited in UNESCO, 2016].

Teacher training in Ghana dates back to pre-independence (Antwi, 1992). Teacher education in Ghana has undergone numerous changes from pre-colonial to post-colonial. According to Graham (1971), by 1933, the Gold Coast's colonial government had significantly emphasised teachers' training.

The underlying principle of teacher education in Ghana is "to provide teachers with better knowledge and skills, together with better incentives to use their knowledge and skills for the benefit of children, through the creation of an accessible, integrated teacher education and training system which provides a structure for continuous professional development throughout their teaching careers" (MoE, 1993). According to the Report of the President's Committee on Review of Education Reform, teacher education aims to train and develop the correct type of teacher, one who is competent, committed and dedicated. Further, a good teacher should be:

- (i). Applying, extending and synthesising various forms of knowledge;
- (ii). Developing attitudes, values and dispositions that create a conducive environment for quality teaching and learning in schools;
- (iii). Facilitating learning and motivating individual learners to realise their potential fully;
- (iv). Adequately preparing the learner to participate fully in the national development effort (Republic of Ghana, 2002).

Teacher education in Ghana has two faces. Teacher Education Universities (TEUs) predominantly offer subject-specific area-based undergraduate (e.g. Bachelor of Education (B.Ed) in Mathematics, Bachelor of Education (B.Ed) in Science, Bachelor of Science (B.Sc) in Mathematics education etc.) and post-graduate programs. Colleges of Education (CoEs)

offer programs under B.Ed in Basic Education. The courses offered at the CoE level are B.Ed. Early Childhood Education, B.Ed Primary Education, and B.Ed J.H.S. Education. According to Communications Bureau (2018), the President of the Republic of Ghana, Nana Addo Dankwa Akufo Addo, stated that all CoEs, beginning from the 2018-19 academic year, would be upgraded to University Colleges to offer 4-year Bachelor of Education (B.Ed) degree programmes.

The most recent reform is the transformation of Colleges of Education into degree-awarding institutions. The Ministry of Education has, as of 2018, given CoEs the mandate to train and award four-year Bachelor of Education degrees to prospective teachers. Under this reform, the public Colleges of Education have been affiliated with public TEUs for support and development. Before this, there were three significant reforms, these are:

- (i) The Education Act of 2008 (Act-778) created the National Teaching Council to professionalise the teacher through licensing.
- (ii) The Colleges of Education Act of 2012 (Act-847) upgraded Colleges of Education into tertiary institutions.
- (iii) Pre-Tertiary Teacher Professional Development and Management (PTPDM) Policy in 2012 to design a career progression path for teachers in Ghana.

Mathematics Education Programmes (MEPs) in Ghana are meant to train mathematics teachers at the pre-tertiary level of the Ghana education system. Mathematics teachers' training for the pre-tertiary education level in Ghana happens at the CoEs and TEUs levels.

The CoEs run the B.Ed. Junior High Education (Mathematics and ICT) program to train pre-service Mathematics teachers for the basic level (Primary and Junior High School (JHS)) of school education. The TEUs run degree-in-education programs to train pre-service Mathematics teachers, mostly for teaching Mathematics at the SHS level of school education. Three of the TEUs (UCC, UDS, CKT-UTAS) run the Bachelor of Education (B.Ed) in Mathematics, two (UEW, AMMUSTED) run the Bachelor of Science (B.Sc) in Mathematics Education, SSD-UBIDS run the Bachelor of Education (B.Ed) in Accounting and Mathematics, UG runs the Bachelor of Science (B.Sc) in Education (Mathematics), and KNUST runs the BEd. Junior High School Education (Mathematics). These programs prepare pre-service teachers mainly for Mathematics but also have minor areas that offer the pre-service teachers expertise in teaching two subject areas. For example, the B.Sc Mathematics Education programme run by the UEW has Mathematics as its major area and

ICT as its minor. This means the program's graduates can teach Mathematics and ICT at the school level.

1.4 Quality Teacher Education

Teachers today must be thorough professionals with high academic standards, pedagogical abilities, ethical values, and moral principles. According to Clement and Rencewigg (2020), subject content knowledge, adequate communication abilities, and the ability to create an engaging classroom environment through humour are the most desirable characteristics of a quality teacher from students' points of view. Ensuring quality in education should not be just an issue of relevance but a necessity. The teacher's capacity to efficiently deliver as his profession demands is essential. Quality education is an enzyme for national development. The teacher may be the main element in providing quality education, making their training vital. "Quality" in the context of teacher education refers to the entirety of traits and qualities pre-service teachers acquire (Sharma, 2019). With the more prominent stakeholder being a nation, quality must be assured in the training of teachers to equip them to discharge their duties as expected.

The NTC has set standards for teachers in Ghana. The NTC expects TEIs to base their training on these standards to ensure teachers are given the best training in Ghana. The standards are categorised as follows:

- (i). Professional Values and Attitudes:** These include Professional Development and Community of Practice
- (ii). Professional Knowledge:** It includes Knowledge of Educational Frameworks and Curriculum and Knowledge of Learners
- (iii). Professional Practice:** It includes Managing the Learning Environment, Teaching and Learning, and Assessment (NTC, 2018).

From the NTC point of view, these standards guarantee the quality of teachers and teacher education. According to NTC (2018), when a teacher completes their four years of initial teacher training, these three domains and aspects, which include what teachers should value, know, and do, intersect to create a qualified teacher. The quality of teacher education goes a long way to influencing the quality of universal education that most countries crave. TEIs in Ghana must ensure these standards are met to provide quality TE.

According to Lakshmi and Chaudhari (2019), researchers have identified the critical quality indicators in TE, including curriculum design, curriculum transaction, evaluation system, research and development, infrastructure and learning resources, student support and progression, organisation and management, etc. A particular focus is also placed on the internship programme, although it falls under the broad curriculum umbrella.

1.5 Challenges of Teacher Education

The progress of an education system, particularly regarding quality, is highly dependent on consistent, adequately trained teachers. According to OECD (2009), teachers' initial education, both in quantity and quality, is undoubtedly significant in influencing their work once they begin teaching in schools. Although teacher training is substantial, as indicated earlier, the quantity and quality aspects of the training process face many challenges. Researchers have globally outlined challenges to TE at the university and college levels (Anamoah-Mensah, 2006; Mireku, 2019; Bhuiyan, 2013; Akyeampong, 2003). The teacher education system of Ghana has challenges that need addressing to improve the training process.

The inability to recruit pre-service students with the best academic qualifications appears to be one of the most prominent issues facing teacher training in Ghana (Akyeampong, 2003). Due to the poor reputation of teachers and poor service conditions, for example, poor remuneration and the absence of recognition for the teaching profession in Ghana, TEIs cannot attract the best students. The challenge of sourcing attachment programmes for pre-service Vocational and Technical teachers has also been a concern. As an aspect of Technical and Vocational Teacher Education (TVTE), industrial attachment is vital as it is the avenue to equip pre-service teachers with practical knowledge of concepts learnt in the classroom. Donkor, Nsoh and Mitchual (2009) outlined some perceived difficulties of industrial attachment: the cost of transportation to and from the workplace, the lack of access to tools and equipment, and the problem of finding a placement.

According to trend analysis, the cost of training a university student is currently the only expense that exceeds the cost of educating a teacher (Akyeampong, 2003). The cost of Teacher Education (TE) has been a challenge. Since the introduction of the "in-in-out" structure of TE, the extra space created due to the one year spent outside CoE campuses increased enrolment, which also increased the cost of TE. If Ghana is to fulfil its goal of TE and training, then UNESCO-sponsored research on TE in sub-Saharan Africa recommends, among other things, that staff numbers and quality should be severely

addressed (Adegote, 2003). It indicates that the quality of teacher educators and the quantity of teachers are challenges that need to be considered concerning TE.

The inability to maintain and follow a long-term national TE policy is one challenge that hinders its progress in Ghana. The system is at the mercy of the ruling political party. According to Ghana Education News (2022), in 2012, the government cancelled the payment of allowances to pre-service teachers of the CoEs of Ghana, but the NPP-led government, which was in opposition then, reinstated it after it took office in 2016. The TES's inability to produce enough teachers for school education is also a challenge in Ghana. Cobbold (2015) stated that Ghana has long struggled with a teacher shortage due to the country's expanding educational system, unfavourable socioeconomic and political conditions, and a high attrition rate.

Ineffective supervision is also a challenge to the teacher education system. During teaching practice, school supervisors do not work to assist the student-teacher in building their organisational skills, lesson plans, and other relevant abilities. Their lesson preparations are cursorily reviewed. The student-teacher is given many lessons to teach by their school supervisors and is seldom given any guidance. More time is used for teaching sessions instead of dedicating most of the time to discussing aspects where student teachers' performance during practice needs improvement. Akyeampong (2017) outlined that a significant obstacle to a successful practicum is the hierarchical relationship between teacher educators and classroom instructors. The author continued that this constrains the ability to change student teachers' conceptions of and approaches to teaching primary mathematics.

Lack of subject knowledge on the part of pre-service teachers is also a concern. According to Akyeampong (2003), raising the academic entry requirement may seem like the best course of action to resolve the issue of most student teachers' weak academic knowledge background, but doing so could endanger supply.

Of all the challenges identified, one of the most prevalent is the inability of teacher training institutions to train quality Mathematics teachers for the education system of Ghana. This claim is on the premise that, over the years, students' performance during the Basic Education Certificate Examination (BECE) and West African Senior School Certificate Examination (WASSCE) in Mathematics has not been as expected. Smith (2021) mentioned the analysed Mathematics results of Senior High School pupils and revealed that many failed to achieve the grade C-6 as a cut-off point for university admission. The author disclosed that 45.89% of candidates received grades between D7 and F9 in Mathematics. NSID (2021) from their three (3) years (2018-2020) BECE results analysis of the three core subjects –

English, Mathematics, and Science revealed that in the area of Mathematics, 81.6% of students fell within the unsatisfactory category while 12.0%, 4.0% and 2.4% fell within the satisfactory, Good and outstanding categories respectively. The Mathematics Teacher Education Programs (MEPs) are meant to train Mathematics teachers for the school system of Ghana. If students' performance in mathematics at the school level is poor, then there is a need to assess the quality of mathematics teachers' training.

In this context, as part of the present study, the researcher closely studied the following aspects to understand the actual scenario of Mathematics teacher education at the Teacher Education Universities of Ghana.

i). Academic Standards of the MEPs of the TEUs

The standard an institution upholds for its graduates and transactions is essential. High academic standards ensure that institutions make the necessary efforts to give their students the best of everything. Academic standards, such as the complexity of the curriculum and the difficulty of examinations, serve as benchmarks for educational quality and excellence.

ii). Curriculum Design, Development and Implementation

The curriculum of an institution is fundamental to its achievement of goals. It dictates what has to be done to attain an institution's objectives. An academic institution's curriculum design, development and implementation are as significant as the institution itself.

iii). Evaluation Procedures

Evaluation procedures need to be integral in the curriculum of an academic institution. Teacher educators need to be aware of the procedures to evaluate their students and how they will be evaluated at the end of a program. Most importantly, the evaluation procedures must be towards the achievement of the programme's objectives.

iv). Resources Available to the MEPs – Human and Material

Resources available to an educational institution form an integral part of its success. Human and Material resources are essential to the smooth running of educational institutions. According to Dangara (2016), all human, material, audio-visual school environments, and community materials available in an academic environment aiding school administration and simplifying the teaching-learning process are referred to as educational resources.

v). Learning culture

A learning culture is described as a culture that promotes and facilitates learning among its employees (Schmitz et al., 2014). According to Shen and Tian (2012), institutional academic culture consists primarily of academic outlooks, academic spirits, academic ethics, and academic settings.

vi). Academic Leadership Practices

Leadership in academic institutions is relevant to achieving the institution's goals. How an educational institution's leaders effectively steer the affairs of the institution goes a long way in determining the achievement of set objectives. According to Alberto (2015), leadership is the interaction of influence when certain individuals accept someone as their leader in a given environment to attain mutual aims.

vii). Challenges of Mathematics Teacher Education

It is imperative that MEPs of Ghana also face some challenges in training Mathematics pre-service teachers. Challenges can come from various aspects of the makeup of an academic institution.

1.6 Models of Programme Evaluation

Academic programmes are meant to effectively produce products with the needed quality for a specific field of endeavour. Though stakeholders and experts, through various rigorous streamlined procedures, ensure that academic programmes are appropriately set up with the necessary activities for the utmost outcomes, it is still necessary for academic programmes to be regularly evaluated to ensure they serve the purpose for which they were instituted. "Evaluation is the systematic assessment of the operations and/or the outcomes of a programme or policy, compared to a set of explicit standards, as a means of contributing to the improvement of programme or policy" (Wiess 1998, p. 4-5). According to Msila and Setlhako (2013), Good programme evaluation can result in future improvements and project delivery.

Program evaluation models assess the effectiveness, efficiency, relevance, and impact of programs, projects, policies, or interventions. Several models are used in program evaluation, each with strengths and weaknesses. Here are some commonly used program evaluation models

1.6.1 The Logic Model

The Logic Model approach to evaluation pays special attention to the connections made between the program's components and how those connections relate to the program's setting, which indicates system theory's influence (Frechtling, 2007). The logic model of evaluation has four components: inputs, activities, outputs, and outcomes. It helps stakeholders understand the logical connections between program activities and intended outcomes.

1.6.2 Stufflebeam's CIPP Model

Stufflebeam's Context, Input, Process, Product (CIPP) Model is a comprehensive evaluation framework developed by Daniel Stufflebeam. Its goal is to evaluate programmes' efficacy and quality by looking at four connected parts:

Context Evaluation: This component focuses on understanding the environmental factors surrounding the program, including the needs, resources, and constraints within the program's operating context.

Input Evaluation: Input evaluation assesses the adequate, appropriate, and effectively utilised resources allocated to the program, including human, financial, and material resources.

Process Evaluation: Process evaluation focuses on implementing program activities and procedures.

Product Evaluation: Product evaluation assesses the outcomes and impacts of the program.

1.6.3 Kirkpatrick's Four Levels of Evaluation

Kirkpatrick's Four Levels of Evaluation is a widely used model for evaluating training and development programs. The model consists of four hierarchical levels, each focusing on different aspects of program evaluation:

Level 1: Reaction (or Satisfaction): Participants' responses and degree of satisfaction with the course are assessed at this stage.

Level 2: Learning (or Knowledge): This stage assesses how much of the training program's new information, abilities, or attitudes the participants have picked up.

Level 3: Behavior (or Transfer): This stage assesses how well participants integrate the knowledge and abilities they acquired during the training programme into their day-to-day tasks or employment.

Level 4: Results (or Impact): This stage assesses the training program's overall effect on the aims and objectives of the organisation.

Based on the above evaluation models, the researcher conducted the study by concentrating on the programmes' context, inputs, process, and outcomes, mostly reminiscent of Stufflebeam's CIPP Model. The researcher concentrated on assessing the programmes' objectives, resources available to the programmes, implementation of activities of the programmes, challenges of the programmes, and the programmes' status of achievement of their objectives.

1.7 Rationale for the Study

The need for quality education is a necessity to drive the developmental agenda of nations. There must be quality teachers for quality education as teachers are the primary implementers of educational policies, and quality teachers result from quality teacher education. To achieve the aim of quality education for all, the government of Ghana and other foreign agencies have funded teacher education reforms on various occasions. There have also been several curriculum reforms and changes financed by the government of Ghana, especially at the school level, to give the Ghanaian populace quality education to meet global educational standards.

Teachers' training at the CoEs and TEUs has its difficulties and challenges. There may be no particular recognised reform for all TEUs. Still, there are always updates and changes in individual universities and the various TEU departments to produce teachers who can deliver as expected in the classroom. Notably, the University of Education, Winneba, beginning with the 2013 completing year batch, initiated the one-semester off-campus teaching practice (internship), which was an update on the previous two-semester off-campus teaching practice aimed at increasing the content knowledge of pre-service teachers. At the University of Education, Winneba (UEW), the first semester of the fourth year is utilised for the "Student Internship Program" (SIP), which is otherwise called "Off-Campus" Teaching Practice (Esiya-Donkoh, Amihere and Addison, 2015).

Mathematics has always been the centre of all learning. It is essential for an individual's academic growth, making it a compulsory subject at the elementary and

secondary levels of education in almost all countries worldwide. Makondo and Makondo (2020) posited that mathematics encourages logical reasoning and prepares one for the future world, which is why several countries make mathematics a compulsory subject at the O'level (high school), as it is such an essential subject in human existence. Since Mathematics education is linked to MTE, the concern for quality Mathematics teachers worldwide has increased. According to Iwuanyanwu (2021), from primary to post-secondary school levels, educating students in Mathematics requires not only the teacher's Mathematical expertise but also their talent, methodology of delivery, and, last but not least, how they handle the feedback mechanisms.

Although there has been a realisation of how vital mathematics is, students' performance has not been as expected. Ansah, Quansah, and Nugba (2020) stipulated that major stakeholders are concerned about the dismal performance of mathematics in Ghana's SHS. According to the Ministry of Education (2018), results from the West African Senior Secondary Certificate Examination (WASSCE), particularly in 2015, have shown poor performance in core and optional Science and Mathematics subjects. According to Smith (2021), from data issued by the WAEC, approximately half of those who took the WASSCE in 2021 failed. They could not meet the qualifying mark in core Mathematics. 45.89% received D7 to F9. Candidates for higher education should have scores ranging from A1 to C6 in core Mathematics. The results meant that out of 446,352 candidates, approximately 204,831 would be unable to obtain higher education due to weak Mathematics performance. The chief examiners' report on Mathematics stated a decline in students' general performance in Mathematics (WAEC, 2021). Abreh, Owusu, and Amedehe (2018) reported that teachers' inability to complete the syllabus, inappropriate methodologies, and lack of qualified teachers affect students' mathematics performance. Since students' performance can be affected by teaching-learning procedures and teaching-learning activities depending on the quality of the teacher, there is a need to investigate the quality of the training given to Mathematics teachers.

A program's ability to serve its purpose is vital to assessing the quality of an educational program, especially from the consumers' point of view. This is also more than necessary for teacher education. It is essential to know the quality of the training given to teachers who are supposed to train the future generation of a country. As previous submissions show, Mathematics is vital for students' academic growth. Students' Mathematics performance in the WASSCE has not been as expected. Since the quality of Mathematics teachers affects students' performance, knowing the quality of the training

Mathematics teachers receive is necessary to improve the training process. Although there is much research on TE, especially at the CoE level, there is limited research on TE at the TEU level. The researcher has yet to come across any study specifically on the MEPs at the TEUs of Ghana. This study aims to assess the integrated MEPs by public TEUs meant to produce mathematics teachers for the Ghana school system.

1.8 Research Questions

1. What is the current status of Mathematics Education Programs at Teacher Education Universities in Ghana?
2. What is the future direction of Mathematics Education Programs of Teacher Education Universities in Ghana?
3. How relevant are the curriculums of Mathematics Education Programs of TEUs to classroom practice?
4. How does curriculum transaction take place in Mathematics Education Programs of Teacher Education Universities in Ghana?
5. How do evaluation processes take place in Mathematics Education Programs of Teacher Education Universities in Ghana?
6. What are the perceptions of the pre-service teachers and teacher educators concerning the learning culture, evaluation procedure, and resources of the Mathematics Education Programs of Teacher Education Universities in Ghana?
7. What challenges do Mathematics teacher educators encounter in the training process?
8. How can the training process of the Mathematics Education Programs in the Teacher Education Universities of Ghana be improved?

1.9 Statement of the Problem - Title of the Study

A study of the Mathematics Education Programmes in the Teacher Education Universities of Ghana

1.10 Objectives of the Study

1. To study the Mathematics Education Programs in the Teacher Education Universities of Ghana with respect to their purpose, present status, and future direction.

2. To study the Mathematics Education Programs in the Teacher Education Universities of Ghana with respect to:
 - a) Academic standards
 - b) Curriculum design, development, and implementation
 - c) Evaluation procedures
 - d) Resources at the TEUs – Human and Material
 - e) Academic Leadership practices
3. To study the learning culture in the Mathematics Education Programs of Ghana's Teacher Education Universities.
4. To identify the challenges encountered in training pre-service Mathematics teachers in Teacher Education Universities.
5. To seek recommendations to improve the training process of the Mathematics Education Programmes in the Teacher Education Universities of Ghana.

1.11 Delimitation of the Study

The study was delimited to the Education Schools/Faculties/Departments of Mathematics of the public TEUs offering four-year undergraduate MEPs (B.Ed mathematics, BSc Mathematics Education, B.Ed in Accounting and Mathematics, B.Sc in Education (Mathematics)) of the 2022/2023 academic year.

1.12 Explanation of the Terms Used

- a) **Academic Standard** concerning this work refers to the benchmark for quality by the GTEC with respect to pre-service teachers' entry characteristics, teacher educators' qualifications, and pedagogical procedures.
- b) **Curriculum** refers to the standard structured educational experience that pre-service teachers of the MEPs practice to achieve a level of competency in content, pedagogical, and applied learning skills required to graduate as Mathematics teachers.
- c) **Evaluation Procedure** refers to the process of gathering information to be in a position to understand the strengths and weaknesses of pre-service teachers of the MEPs concerning their understanding of concepts and acquisition of intended skills. For this study, the evaluation procedure will include the assessment criteria and examination process of the MEPs of TEUs.

d) Challenges refer to situations faced by Teacher Educators and pre-service teachers that hinder the successful training of pre-service teachers of the MEPs of TEUs of Ghana.

e) Learning Culture refers to institutional-oriented concepts, including approaches to learning, learning style, learning habits, and classroom interactions.

d) Academic leadership practices refer to activities undertaken by the leadership of the MEPs of TEUs of Ghana to guide teacher educators and pre-service teachers in achieving the ultimate aim of producing quality mathematics teachers.

1.13 Operationalisation of Terms Used

a) Mathematics Education Programmes refer to four-year integrated TEU programs (B.Ed Mathematics, BSc Mathematics Education, B.Ed in Accounting and Mathematics, B.Sc in Education (Mathematics)) meant to train Mathematics teachers for school education in Ghana.

2.0 Review of Related Literature

Several studies have been conducted in the area of education. Some studies are subject-specific and domain-specific, such as teacher education, mathematics teacher education, teaching, and higher education. For this study, the researcher concentrated on studies on general education and specifically on mathematics teacher education and mathematics teaching at the school level. The researcher reviewed 119 studies in total. The reviewed studies have been divided into these categories:

A. Review of Related Studies Conducted Abroad

1. General Teacher Education
2. Mathematics Teacher Education
3. Teaching Mathematics at the School Level

B. Review of Studies Conducted in Ghana

1. Studies Conducted on General Teacher Education in Ghana
2. Studies conducted on Mathematics Teacher Education in Ghana
3. Studies were conducted on mathematics teaching at the school level in Ghana.

2.1 Overview of the Review of Literature Review

In foreign studies, there are several studies on teacher education and Mathematics teacher education compared to studies in Ghana. Though there are studies on teacher education in Ghana, the researcher came across a few studies on Mathematics teacher education. It was also realised that most of the studies conducted on teacher education concentrated on teacher education at the College of Education level. Most of the studies found that the researcher observed that teacher education institutions experienced challenges in finance, infrastructure, resources, and the lack of female gender in mathematics education programmes. The studies recommended the provision of infrastructure and resources, formulation of good policies towards mathematics teacher retention, and teachers to involve technology in the teaching and learning process.

2.2 Methods and Designs of the Reviewed Related Literature

The review revealed that the researchers have used both qualitative and quantitative methods. The reviews had varied research methods and designs, including descriptive survey, explanatory sequential, descriptive survey and correlation, experimental, and ex-post-facto designs. The most commonly used research design was the descriptive survey design. The researchers utilised various kinds of sampling; the most used sampling technique was random sampling. Data collection was done using different techniques by the researchers, including quantitative and qualitative methods. Some of the data collection tools used were questionnaires, interview schedules and exam items. The researchers predominantly utilised questionnaires for data collection. Most of the collected data were analysed quantitatively using the Statistical Package for Social Sciences (SPSS). Others were analysed qualitatively. Some also used both quantitative and qualitative analysis. Some of the authors used both quantitative and qualitative methods in their studies.

2.3 Implications of the Reviewed Related Literature for the Present Study

A thorough review of various studies was done to understand how researchers have paid attention to assessing the quality of teaching and teacher education and how researchers have approached the research process in Ghana and abroad.

The studies on teacher education programmes generally investigated quality issues as far as teacher education is concerned, as well as the challenges and suggestions as to how the challenges can be dealt with to improve teacher education.

The researcher did not find many studies on Ghana's Mathematics teachers' education. Although some studies have been conducted on mathematics teacher education, they do not assess MTE programmes at the TEU level. Although teacher education in Ghana is at the University and College of Education levels, researchers concentrate mainly on CoEs, neglecting the TEUs. The researcher did not find any study focusing on Mathematics Teacher Education Programmes in the TEUs of Ghana. With the vital part TEUs play in training mathematics teachers and the realisation of the neglect of research on MTE programmes of the TEUs, especially on the quality of the training process, the researcher embarked on this study.

3.0 Research Methodology

The methodology adopted by the researcher to realise the present study's objectives is outlined below.

3.1 Research Design

The present study employed the descriptive survey method. The study employed qualitative and quantitative methods of data collection.

3.2 Population

Eight public TEUs in Ghana run four-year bachelor of education programmes in Mathematics. The Departments of Mathematics Education of all TEUs offering four-year undergraduate MEPs were part of the study. The heads of department, teacher educators, and final-year pre-service teachers (Students) of the MEPs form part of the population of the present study.

3.3 Sample for the Study:

The study employed different sampling styles at various stages of data collection. The researcher purposively selected the UEW, the UCC, and the UDS for the study. These universities (UCC, UEW, and UDS) are the oldest universities offering four-year integrated undergraduate MEPs in Ghana. Most practising mathematics teachers at the SHS level are the products of these universities. Table 1.0 shows the sampling of participants for the study.

Table 1.0: Sampling of participants for the various data collection activities

Stage	Type of Sampling	Universities	Teacher Educators	Pre-service teachers (Students)	Data Collection Technique
I	Purposive sampling	Three public Universities (UCC, UEW, UDS)			
II	Random sampling		Teacher Educators	Nine (9) pre-service teachers, three (3) from each school 329 Final – year Pre-service teachers 28 Teacher educators	Semi-structured interview Semi-structured interview Answering a 5-point Likert scale questionnaire Answering a 5-point Likert scale questionnaire

3.4 Description of Tools

The researcher used the tools below to collect data to achieve the study's objectives.

- I. **Questionnaire:** The researcher constructed questionnaires, namely 'Questionnaire for Students (Pre-service Mathematics Teachers)' and 'Questionnaire for Teacher Educators' based on the data collection.
- II. **Interview Schedules:** The researcher designed two (2) semi-structured interview schedules for teacher educators and pre-service teachers. The semi-structured interview schedule for pre-service teachers was based on the evaluation procedures of the MEPs, whilst the schedule for teacher educators was based on the purpose, present status, and future directions of the TEUs MEPs.

III. Classroom Observation Schedule: The researcher developed an observation schedule to observe the classroom interaction of the selected TEUs MEPs.

IV. Learning Culture Observation Schedule: The researcher developed an observation schedule to study the learning culture of the TEUs MEPs.

V. Resource Observation Schedule: The researcher developed a schedule to aid in the observation of the resources (Human and Material) in the TEUs' MEPs.

3.5 Validation of Research Tools

The prepared tools were presented to eight Mathematics Education and General Education experts for validation. The experts analysed and scrutinised the tools prepared by the researcher in terms of content appropriateness and relevance to the study. The language employed was also analysed for ambiguity, comprehension, and understanding of the questions by indicating the appropriateness of the items and providing comments and suggestions. Based on the expert's suggestions, the tools were modified. The finalised validated tools were included in the appendix.

3.6 Data Collection Procedure

The researcher obtained an introductory letter from his guide at the Department of Education, The Maharaja Sayajirao University of Baroda, to seek permission from the sampling universities' authorities and respondents. The researcher collected all the data for the study. Initially, the researcher sought permission from the MEP departments to collect the data. After permission was granted, a notification was sent to the departments to alert all the teacher educators and administrative staff of the researchers' presence, purpose, and permission to collect quantitative and qualitative data. The questionnaires were administered personally to the respondents. The researcher personally collected the data using questionnaires, observation schedules and interview schedules within a period of three months (June to August 2023). Documents (Curriculum material and departmental handbook) were also collected for analysis.

3.7 Data Presentation and Analysis

The data collected from the respondents were analysed quantitatively and qualitatively using descriptive analysis techniques (Frequencies, percentages and means), inferential analysis techniques (Mann Whitney U test and Kruskal Willis Test), and thematic analyses to achieve the study objectives.

4.0 Major Finding

The study's major findings are presented below:

Demographic Characteristics of the Sample

1. **Male Dominance:** 83.6% of pre-service teachers are male, while 16.4% are female.
2. **High-Performing Applicants:** The MTE programmes attracts high-performing applicants, with the lowest admission aggregate score being 29.

Status and Future Direction

3. **Programmes Doing Well:** The programmes are doing well and are up to their mandate, but there is room for improvement.
4. **International Recognition:** The programmes have international recognition, with majority of the graduates gaining employment and admissions worldwide.

Academic Standards

5. **Regular Academic Activities:** Academic activities are regularly organized to equip teacher educators and pre-service teachers with current knowledge in mathematics education.
6. **Commitment to Professional Development:** Teacher educators are committed to their professional development, with 39.1% attending at least seven professional development programmes and 53.6% publishing at least seven journal articles over the last five years.

Curriculum Design, Development, and Implementation

7. **Multidisciplinary Curriculum:** The curriculum is designed on the principles of multidisciplinary, professionalism, innovation, and ethics, aligning with national goals and priorities.
8. **Content Knowledge:** The curriculum has enough content knowledge to equip pre-service teachers with the needed knowledge for classroom application.

Evaluation Procedures

9. Satisfaction with Internal Evaluations: Pre-service teachers are satisfied with the evaluation of internal examinations but not with the evaluation of external examinations.

Resources

10. Availability of Learning Resources: Pre-service teachers reported the availability of learning resources for effective academic work.
11. Lack of Basic Resources: Observations revealed that some departments lacked basic resources, such as lecture hall desks and lecture halls.

Academic Leadership Practices

12. Enhancing Teacher Educator Supervision: The findings revealed that the supervision of teacher educators did not meet expected standards. Strengthening this supervision is essential to improving the quality of learning experiences.
13. Dissatisfaction of Leadership Appointment: The analyses revealed that, the teacher educators were not satisfied with the appointment of the leadership of the department and the university as a whole.

Learning Culture

14. Learning Culture: There is generally a learning culture in the MEPs of the TEUs of Ghana that engages students to collaborate and share.
15. Approachable Teacher Educators: Teacher educators are approachable and encourage group discussion among pre-service teachers.

Challenges Encountered

16. Resource Challenges: Pre-service teachers face several resource challenges, including few lecture halls, lack of computers, and poor functioning of counselling centres.
17. Economic Challenges: Pre-service teachers face economic challenges, including high cost of food, high living expenditure, expensive accommodation, and high financial obligations towards the programme.

Suggestions for Improvement

18. **Emphasis on ICT Integration:** Emphasis should be placed on ICT integration. ICT tools, including SMART boards, projectors, computers and educational software, should be provided for easy incorporation by teacher educators and pre-service teachers.
20. **Balance between Content and Pedagogy:** There should be a balance between content and pedagogy. The curriculum should be designed to sufficiently accommodate pedagogy and content to ensure pre-service teachers have the best experience during their training.

5.0 Implications of the Findings

The following educational implications have been drawn from the study findings.

1. The results directly show that there is a significant deficit in the infrastructure of the MEPs of the TEUs. The necessary infrastructure must be provided to develop quality and enough Mathematics teachers for Ghana's education system.
2. Supervision of teachers in tertiary institutions should be enforced.
3. Students should be allowed to appraise teachers' activities in tertiary institutions. This will prompt teacher educators to ensure the best services are rendered to the students.
4. Tertiary education teachers should be encouraged to utilise TLMs and ICT tools in their delivery to enhance content understanding. It also aids prospective teachers in integrating these tools into the classroom.
5. More efforts should be put in place to ensure that the female gender gains interest in science, mathematics, and engineering programmes, especially at the highest level of education.
6. The necessary measures should be implemented to ensure that graduates of the MEPs remain in Ghana to serve the education system.
7. Leadership selection and appointment in educational institutions should be devoid of all forms of interference. All qualified persons should be given equal opportunities to be selected.
8. Measures should be implemented to ease students' and teachers' challenges in tertiary institutions. Providing basic needs such as accommodation and transportation can ease some economic challenges students and teachers face.

9. The MEPs should include industrial internships in their curriculum to enhance pre-service teachers' chances of employment in non-education sectors.
10. Collaboration between industries, schools, and universities should be established to improve the curriculum for training suitable graduates for the employment world.
11. There should be exchange programmes with national and international institutions to expose graduates to global needs, requirements and cultural differences.
12. A fair and transparent evaluation committee should be enacted to ensure that the needs and grievances of learners and teachers are addressed fairly and equally.
13. A recognition and reward system should be implemented to encourage hard-working teacher educators and learners to encourage others.
14. The research culture in tertiary institutions should be orchestrated to be creative in enhancing the training of Mathematics teachers.
15. The various TEUs should cooperate to improve each other's curriculum to ensure that the best Mathematics teachers are trained for the education of Ghana.
16. Quality enhancement programmes in the form of workshops and seminars should be regularly organised to keep teacher educators and pre-service teachers informed of the current happenings in Mathematics teacher education.

5.1 Suggestions for further research

Though the researcher has done everything possible to produce a good study, there is always room for improvement. The following suggestions will be appropriate for further research.

- The study did not involve private universities that run MEPs. A study involving the private universities' MEPs would make it more generalisable.
- A case study of each of the selected MEP departments can be conducted for an in-depth analysis of the MEPs of each of the TEUs
- A comparative study of the different MEPs of the TEUs can be conducted to provide insight into the differences and similarities of the training process.
- The study utilised a survey predominately to investigate the study's variables. An experimental study can be conducted on the study variables.

- Another study can be conducted as a follow-up to find out graduates of the programmes' perceptions of the benefits they have derived from their training.
- The inclusion of a new population, such as employers and parents, may allow further dimensions and insights into the study's findings.
- A longitudinal study involving the study's variables over time may provide a different dimension regarding the study's outcomes.

5.2 Conclusion

The study addressed a gap in existing knowledge concerning the training of Mathematics teachers in Ghana's TEUs. Qualitative and quantitative methods were utilised in the study to gain an in-depth knowledge of the study variables. The study will contribute uniquely to the field of Mathematics Education, especially TEUs who train Mathematics teachers. It will serve as a reference source for policymakers, universities, the Ghana Education Service, and the Ministry of Education in decision-making about mathematics teachers and their training in Ghana's universities. The findings show that though there are various positives in the preparation of Mathematics teachers, such as good leadership practices, good curriculum implementations, suitable curriculum structures, and good learning culture, the primary challenge of the MEPs of the TEUs is an infrastructural deficit. Basic infrastructure such as lecture halls, computers, computer labs and materials such as lecture hall desks are lacking in the MEPs of the TEUs of Ghana.

References

- Abonyi, U. K., Awhireng, D., & Luguterah, A. W. (2021). Motivations of pre-service teachers in the colleges of education in Ghana for choosing teaching as a career. *Cogent Education*, 8(1). <https://doi.org/10.1080/2331186x.2020.1870803>
- Abreh, M. K., Owusu, K. A., & Amedahe, F. K. (2018). Trends in performance of WASSCE candidates in the science and mathematics in Ghana: Perceived contributing factors and the way forward. *Journal of Education*, 198(1), 113-123. <https://doi.org/10.1177/0022057418800950>
- Adu-Gyamfi, K., & Otami, C. D. (2020). In search of an effective teacher: Ghana's move towards achieving sustainable education through teacher education reforms. *International Journal of Higher Education*, 9(4), 216. <https://doi.org/10.5430/ijhe.v9n4p216>
- Adu-Pimpim, N., Frc, B., & Milonzho, K. (2011). Teacher Education and Training for Africa in the 21st Century: What Form Should it Take? *Educational Research and Review*, 1-16.
- Agyei, E., Darko Agyei, D., & Benning, I. (2022). In-service mathematics teachers' preparedness, knowledge, skills, and self-efficacy beliefs of using technology in lesson delivery. *Cogent Education*, 9(1). <https://doi.org/10.1080/2331186x.2022.2135851>
- Akayuure, P., Nabie, M. J., & Sofo, S. (2013). Ghanaian Prospective Mathematics Teachers' Perceived Self-Efficacy towards Web Pedagogical Content Knowledge. *International Journal of Liberal Arts and Social Science*, 1(3), 132-140. www.ijlass.org
- Akyeampong, K. (2003). Teacher Training in Ghana - Does it Count? *ResearchGate*, 1-136. [Multi-Site Teacher Education Research Project \(MUSTER\), Country Report One](#)
- Akyeampong, K. (2017). Teacher educators' practice and vision of good teaching in the teacher education reform context in Ghana. *Educational Researcher*, 46(4), 194–203.
- Alberto, S. (2015). What is Leadership? *Journal of Business Studies Quarterly*, 8(1), 1-5.
- Alberto, S. (2015). What is Leadership? *Journal of Business Studies Quarterly*, 8(1), 1-5.
- Alsaleh, N. J. (2020). Teaching Critical Thinking Skills: Literature Review. *The Turkish Online Journal of Educational Technology*, 9(1), 21-39. <https://files.eric.ed.gov/fulltext/EJ1239945.pdf>

- Amoo, S. A., & Disu, A. B. (2012). School Environmental Factors and Mathematics Teaching Effectiveness: Implication for E-Learning. *Library Philosophy and Practice*, 1-8.
- Ampadu, E. (2012). *Investigation into the Teaching and Learning of Mathematics in Junior Secondary Schools: The Case of Ghana* [Doctoral dissertation].
- Anamuah-Mensah, J. (2006). Teacher Education in Ghana: Theory and Practice. *Educational Issues for Sustainable Development in Africa*, 28.
- Ansah, J. K., Quansah, F., & Nugba, R. M. (2020). 'Mathematics Achievement in Crisis': Modelling the Influence of Teacher Knowledge and Experience in Senior High Schools in Ghana. *Open Education Studies*, 2, 265-276. <https://doi.org/10.1515/edu-2020-0129>
- Antwi, M. K. (1992). *Education, society, and development in Ghana*. Accra, Ghana: Unimax Publishers.
- Appiahene, P., Opoku, M., Akweitley, E., Adoba, E., & Kwarteng, R. (2014). Assessing the Challenges of Learning and Teaching of Mathematics in Second Cycle Institutions in Ghana. *International Journal of Innovation and Applied Studies*, 6(3), 362-368. <http://www.ijias.issr-journals.org/>
- Armah, R. B., & Kissi, P. S. (2019). Use of the van Hiele theory in investigating teaching strategies used by College of Education geometry tutors. *EURASIA Journal of Mathematics, Science and Technology Education*, 15(4). <https://doi.org/10.29333/ejmste/103562>
- Arthur, Y., Addo, S., & Annan, J. (2015). Student mathematics interest in Ghana: The role of parent interest, gender, basic school attended and fear of basic school mathematics teacher. *Advances in Research*, 5(5), 1-8. <https://doi.org/10.9734/air/2015/19889>
- Asare, K. B., & Nti, S. K. (2014). Teacher education in Ghana. *SAGE Open*, 4(2), 215824401452978. <https://doi.org/10.1177/2158244014529781>
- Adegoke, K. A. (2003). *Capacity Building of Lead Teacher Training Institutions in Sub-Saharan Africa: Ghana*, UNESCO sponsored project – 4500007474.
- Bhuiyan, R. S. (2013). *Primary Teacher Education in Bangladesh* [Doctoral dissertation]. <https://shodhganga.inflibnet.ac.in/>

- Blankson, G. (2022). *Program Evaluation of Music Teacher Education in Ghana: Implications for Practice, Policy, And Research* [Doctoral dissertation]. <https://egrove.olemiss.edu/etd>
- Cerezci, B. (2020). The impact of the quality of early mathematics instruction on mathematics achievement outcomes. *Journal of Childhood, Education & Society*, 1(2), 216-228. <https://doi.org/10.37291/2717638x.20201248>
- Clement, A., & Rencewigg, R. (2020). Qualities of Effective Teachers: students' Perspectives. *International Journal of Advances in Engineering and Management* 2, 2(10), 365-368. <file:///C:/Users/Hp/Downloads/QualitiesofTeachers.pdf>
- Cobbold, C. (2015). Solving the Teacher Shortage Problem in Ghana: Critical Perspectives for Understanding the Issues. *Journal of Education and Practice*, 6(9), 71-79.
- Cole, Y. A. (2011). *Mathematical Knowledge for Teaching: Exploring its Transferability and Measurement in Ghana* [Doctoral dissertation].
- Communications Bureau. (2018, June 16). "Colleges of education to be upgraded to University colleges in September" – President Akufo-Addo. <https://presidency.gov.gh/index.php/briefing-room/news-style-2/695-colleges-of-education-to-be-upgraded-to-university-colleges-in-september-president-akufo-addo>
- Dangara, U. Y. (2016). Educational Resources: An Integral Component for Effective School Administration in Nigeria. *Research on Humanities and Social Sciences*, 6(13), 27-37. <https://files.eric.ed.gov/fulltext/ED578024.pdf>
- Dangara, U. Y. (2016). Educational Resources: An Integral Component for Effective School Administration in Nigeria. *Research on Humanities and Social Sciences*, 6(13), 27-37. <https://files.eric.ed.gov/fulltext/ED578024.pdf>
- Donkor, F., Nsoh, S. N., & Mitchual, S. J. (2009). Organisational issues and challenges of supervised industrial attachment of a technical and vocational teacher education program in Ghana. *International Journal of Work-Integrated Learning*, 10(1), 39.

- Enu, J. (2021). *An exploration of mathematics teacher educators' understanding and practices of formative assessment: A case of three Colleges in Ghana* [Doctoral dissertation].
- Enu, J. (2022). Connecting knowledge and practice: Mathematics teacher educators' knowledge and use of formative feedback in Ghana. *Journal of Education*, 2022, (87), 71-92. <http://dx.doi.org/10.17159/2520-9868/i87a04>
- Esia-Donkoh, K., Amihere, A. K., & Addison, A. K. (2015). Assessment of Student Internship Programme by 2013/2014 Final Year Students of the Department of Basic Education, University of Education, Winneba, Ghana. *Humanities and Social Sciences Letters*, 105-120.
- Fletcher, J. A. (1997). *A Study of the Appraisal of Mathematics Teachers in Ghana* [Doctoral dissertation].
- Frechtling, J. A. (2007, March 9). *Logic Modeling Methods in Program Evaluation*. John Wiley & Sons. http://books.google.ie/books?id=rRygDwAAQBAJ&printsec=frontcover&dq=Logic+Modeling+Methods+in+Program+Evaluation&hl=&cd=1&source=gbs_api
- Frye, A. W., & Hemmer, P. A. (2013). *Program evaluation models and related theories*. An International Association for Medical Education. <https://jcesom.marshall.edu/media/53474/program-evaluation-models-and-related-theories.pdf>
- Ghana Education News. (2022). *Teacher Training Allowance is a Wasteful Policy, Stop it Now*. GhanaEducation.org. <https://ghanaeducation.org/teacher-trainee-allowance-is-a-wasteful-policy/>
- Ghana Tertiary Education Commission. (2022). *Accredited Institutions*. GTEC | Home. <https://gtec.edu.gh/>
- Graham, C., K. (1971). *The History of Ghana in Education: From the Earliest Times to the Declaration of Independence*. Frank Cass & Co. limited
- Gumiero, B. S., & Pazuch, V. (2020). Collaborative work in mathematics teacher education. *Jornal Internacional de Estudos em Educação Matemática*, 12(3), 275-283. <https://doi.org/10.17921/2176-5634.2019v12n3p275-283>
- Hine, G., & Herbert, S. (2022). Shifting pre-service teachers' views of teaching secondary mathematics. *Issues in Educational Research*, 32(2), 533-554.

- Iwuanyanwu, P. N. (2021). Contemporary Problems of Teaching and Learning in Mathematics Education. *Mathematics Teaching Research Journal*, 13(2), 23-35. <http://www.hostos.cuny.edu/mtrj/>
- Jamal, U. (2021, December 09). *Importance of Teacher Training in Higher Education*. Retrieved December 09, 2021, from Rising Kashmir: <https://www.risingkashmir.com/Importance-of-teacher-training-in-higher-education-96723>
- Johnson, D. Y. (2020). Mathematics Teacher Identity: The Case of a Black Male Pre-service Teacher. *Journal of African American Males in Education*, 11(1), 58-80.
- Kamran, M., Liang, Y., & Trines, S. (2019, April 16). *Education in Ghana*. WENR. Retrieved June 1, 2022, from <https://wenr.wes.org/2019/04/education-in-ghana>
- Kapu, R. (2018). Concept of Teacher Education. *Research Gate*, 1-13.
- Kolar-Begović, Z., Kolar-Šuper, R., & Matic, L. J. (2017). *Mathematics Education As A Science And A Profession*. Josip Juraj Strossmayer University of Osijek. <https://files.eric.ed.gov/fulltext/ED577935.pdf>
- Lakshmi, R., & Chaudhari, M. (2019). Quality Indicators in Teacher Education Programmes. *The International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences*, 7(2), 57-59. <https://www.ijirmeps.org/>
- Mäkipää, T., Hildén, R., & Samulin, T. (2022). The Perceptions of Student Teachers of Online Pedagogical Courses and Assessment Practices in Finnish Subject Teacher Education. *Education Science*, 1-16
- Makondo, P. V., & Makondo, D. (2020). Causes of Poor Academic Performance in Mathematics at Ordinary Level: A Case of Mavuzani High School, Zimbabwe. *International Journal of Humanities and Social Science Invention (IJHSSI)*, 9(6), 1-9. www.ijhssi.org
- Mensah, B. (2023). Pedagogical competencies in minor subjects of Ghanaian pre-service geography teachers and their implications for teacher education. *Humanities and Social Sciences Communications*, 10(1). <https://doi.org/10.1057/s41599-023-01713-y>
- Mereku, D. K. (2019). Sixty Years of Teacher Education in Ghana: Successes, Challenges and the Way Forward. *African Journal of Educational in Mathematics and Sciences*, 1-7.

- Ministry of Education. (1993), *National Commission on Teacher Education in Ghana*. Accra: Ghana. Ministry of Education Publication.
- Ministry of Education. (2018). *Education Sector Analysis 2018*. <https://sapghana.com/data/documents/Ghana-Education-Sector-Analysis-2018.pdf>
- Ministry of Education. (2021). *About the Ministry of Education*. Retrieved December 08, 2021, from Ministry Of Education, Republic of Ghana: <https://moe.gov.gh/about-us/>
- Moh'd, S. S., Uwamahoro, J., Joachim, N., & Orodho, J. A. (2021). Assessing the Level of Secondary Mathematics Teachers' Pedagogical Content Knowledge. *EURASIA Journal of Mathematics, Science and Technology Education*, 17(6), 1-11. <https://doi.org/10.29333/ejmste/10883>
- Morkoyunlu, Z., & Altun, S. D. (2022). The effect of error-based activities on the reflective thinking skills of pre-service elementary education mathematics teachers. *Acta Didactica Napocensia*, 15(1), 156-168. <https://doi.org/10.24193/adn.15.1.13>
- Msila, V., & Setlhako, A. (2013, December). Evaluation of Programs: Reading Carol H. Weiss. *Universal Journal of Educational Research*, 1(4), 323–327. <https://doi.org/10.13189/ujer.2013.010408>
- NTC. (2018). *National Teacher's Standards for Ghana: Guidelines*. National Teaching Council.
- NSID. (2021). *2021 School Performance Plus Inspection Aggregate Report on 1000 Inspected GALOP Schools*. NATIONAL SCHOOLS INSPECTORATE AUTHORITY, MINISTRY OF EDUCATION. https://www.nasia.gov.gh/wp-content/uploads/Aggregate_Report_GALOP_School-Performance-Plus-Inspections_22SEP2021.pdf
- Organisation for Economic Co-Operation and Development (OECD). (2009). *Creating Effective Teaching and Learning Environments*. OECD. <http://www.oecd.org/publishing/corrigenda>
- Pathak, S. P. (2019). *Life Skills Oriented Teacher Education*. Center for Advanced Study in Education
- Pauwels, K., Loon, H. V., Tanghe, E., & Schelfhout, W. (2022). Motives of Student Teachers in Academic Teacher Education for Secondary Education: Research in Flanders

- (Belgium) on the Motivation to Become and to Remain a Teacher. *Education Science*, 12, 1-19
- Republic of Ghana. 2002. *Meeting the challenges of education in the twenty-first Century: Report of the President's Committee on Review of Education Reforms in Ghana*. Accra: Adwinsa Publications
- Sachdeva, S., & Eggen, P. (2021). Learners' critical thinking about learning mathematics. *International Electronic Journal of Mathematics Education*, 16(3), em0644. <https://doi.org/10.29333/iejme/11003>
- Salas-Pilco, S. Z., Xiao, K., & Hu, X. (2022). Artificial Intelligence and Learning Analytics in Teacher Education: A Systematic Review. *Education Sciences*, 12(569).
- Schmitz, S., Rebelo, T. M., Gracia, F. J., & Tomas, I. (2014). Learning culture and knowledge management processes: To what extent are they effectively related? *Journal of Work and Organisational Psychology*.
- Sharma, R. (2019). Ensuring Quality in Teacher Education. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 5(10), 21-24. <file:///C:/Users/Hp/Downloads/EPRAARTICLE.pdf>
- Shen, X., & Tian, X. (2012). Academic culture and campus culture of universities. *Higher Education Studies*, 2(2), 61.
- Shen, X., & Tian, X. (2012). Academic culture and campus culture of universities. *Higher Education Studies*, 2(2), 61.
- Smith, F. (2021, December 9). *2021 WASSCE: 45 percent failures in core maths and English, a time bomb – Adam bona*. MyJoyOnline.com. <https://www.myjoyonline.com/2021-wassce-45-percent-failures-in-core-maths-and-english-a-time-bomb-adam-bona/>
- Tinh, P. T., Le, T. T., Nguyen, P., Le, C. D., Nguyen, M., & Nguyen, T. (2021). Preparing pre-service teachers for mathematics teaching at primary schools in Vietnam. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(5), em1966. <https://doi.org/10.29333/ejmste/10863>
- UNESCO. (2015). *Sustainable Development Goals*. New York: United Nations.
- UNESCO. (2016). *Education 2030*. Republic of Korea: United Nations.

United Nations. (2021). *Sustainable Development Goals*. UN General Assembly.

WEAC. (2021). *Chief Examiners' Report*.

WAEC. <https://www.waecgh.org/uploads/examinersReport/2021/MathematicsW21.pdf>

Weiss, C. H. (1998). *Evaluation: Methods for Studying Programs and Policies* (2nd ed.). Prentice Hall, 1998.

Yarkwah, C. (2020). Female students' participation in mathematics education at the university level in Ghana.

Záhorec, J., Hašková, A., & Hrmo, R. (2022). Concept mapping in teaching mathematics in Slovakia: Pedagogical experiment results. *Mathematics*, 10(12), 1965. <https://doi.org/10.3390/math10121965>