CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter provides a detailed description of the research design and methodology used in the study. The research design and methods offer suitable guidance in any study. It entails methodical, step-by-step processes that begin with problem identification and end with conclusions.

3.1 Methodology

The present study employed the descriptive survey method. The study utilised qualitative and quantitative data collection methods. By examining a population sample, a survey design can test for associations between variables in the population or provide a quantitative description of its trends, attitudes, and opinions (Creswell and Creswell, 2018). The quantitative and qualitative methods employed in the study allowed for an in-depth understanding of the study variables. Using qualitative data can be advantageous in obtaining additional insights to investigate and ascertain novel impacts and outcomes of research initiatives, thus elevating the calibre of quantitative findings (Taherdoost, 2021). Data lacking a quantifiable measure are classified as qualitative (Hall, 2020). The author further asserted that such information could be observational, like a description of kids playing on a playground, visual, like a photo or clip from a movie, or textual, like a former student's assessment of a teacher's efficacy. The quantitative data was collected using Likert-type scale survey questions, while the qualitative data was collected through interviews, naturalistic campus observations, classroom observations, resource observations, and analyses of documents relevant to the study. The Likert scale represents one of the most fundamental and widely used statistical instruments in educational and social science research (Joshi et al., 2015). Based on themes found in the literature, thematic analysis was performed on the data collected through interviews, content analyses were used to analyse the documents, and descriptive statistics for the results from the observation schedules were used with the support of the field notes taken during the observation. Psychological data can be collected in various ways, including behavioural observations and in-person interviews (Jebb et al., 2021). The quantitative data (Likert scale questionnaire responses) were analysed employing

descriptive statistics (frequencies, percentages and means) and inferential statistics (Mann Whitney U test and Krauskal Willis test).

3.2 Statement of the Problem

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

3.3 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:
   - Academic standards
   - Curriculum design, development and implementation
   - Evaluation procedures
   - Resources at the TEUs – Human and Material
   - 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.

3.4 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.

3.5 Operationalisation of Terms Used

a) **Mathematics Education Programmes** refer to four-year integrated TEU programmes (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.

3.6 Delimitation of the Study

According to Simon and Goes (2013), a study's delimitations stem from its scope, boundaries, and intentional exclusions and inclusions during planning. Among the limitations that the researcher was able to identify during the study include;

1. The study was delimited to the Departments of Mathematics Education of the public TEUs offering four-year undergraduate MEPs (B.Ed mathematics, BSc Mathematics Education) for the 2022/2023 academic year.
2. The researcher selected three (3) TEUs for the study out of eight (8).
3. Final year (8-semester) pre-service teachers of the MEPs of the TEUs of Ghana were sampled for participating in the study.

Despite these limitations, the researcher strongly believes that the study was conducted with all the care and necessary measures in place to ensure the findings will be beneficial to policymakers, teacher educators, pre-service teachers, the Ministry of Education, the TEUs departments, educationists, supervisors and future

investigators to ensure that the best mathematics teachers are produced for the education system of Ghana.

3.7 Hypothesis

i. There exists no significant relationship between the male and female pre-service teachers' responses concerning the academic standards of the TEUs of the TEUs.

ii. There exists no significant relationship between the pre-service teachers of CKT-UTAS, UCC, and UEW's responses concerning the academic standards of the MEPs of the TEUs.

iii. There exists no significant relationship between the male and female teachers' educators' responses concerning academic standards in the MEPs of the TEUs.

iv. There exists no significant relationship between the male and female pre-service teachers' responses concerning curriculum design, development and implementation of the TEUs of the TEUs.

v. There exists no significant relationship between the pre-service teachers of CKT-UTAS, UCC, and UEW's responses concerning the curriculum design, development and implementation of the MEPs of the TEUs.

vi. There exists no significant relationship between the male and female teachers and educators' responses concerning curriculum design, development, and implementation in the MEPs of the TEUs.

vii. There exists no significant relationship between the male and female teacher educators' responses concerning academic leadership in the MEPs of the TEUs.

viii. There exists no significant relationship between the male and female pre-service teachers' responses concerning the learning culture of the MEPs of the TEUs.

ix. There exists no significant relationship between the pre-service teachers of CKT-UTAS, UCC, and UEW's responses concerning the learning culture of the MEPs of the TEUs.

x. There exists no significant relationship between the male and female pre-service teachers' responses concerning challenges encountered in the MEPs of the TEUs.

xi. There exists no significant relationship between the pre-service teachers of CKT-UTAS, UCC, and UEW's responses concerning the challenges encountered at the MEPs of the TEUs.

xii. There exists no significant relationship between the male and female teachers educators' responses concerning challenges encountered in the MEPs of the TEUs.

3.8 Population

The group on which the results or findings of a study can be applied is termed the population of the study (Shukla, 2020). 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 pre-service teachers (Students) of the MEPs form part of the population of the present study. There were about 4,000 students pursuing MEPs and around 120 teacher educators in the various Education Schools/Faculties/Departments of Mathematics of the public TEUs offering four-year undergraduate MEPs during the study.

3.8.1 Target Population

"The complete collection of observations we want to study" (Lohr, 2021, p. 3). The target population for the study was teacher educators (approximately 1215) and final-year MEPs pre-service teachers (approximately 120) of all the MEPs of TEUs of Ghana. The target population is a subset of a broader population that is the primary focus of a study, intervention, or marketing campaign (Willie, 2023).

3.8.2 Study Population

The study population constitutes teacher educators and final-year pre-service teachers of the three selected TEUs (UEW, UCC and CKT-UTAS). About 615 final-year pre-service teachers were enrolled in the MEPs of the selected TEUs, and 46 teacher educators were employed to facilitate the programmes. The study population is a portion of the target population used to choose the sample (Michalos, 2014).

Based on mandate and needs, the MEPs offered at the bachelor's level by the TEUs include B.Sc in Education (Mathematics) BEd. Junior, High School Education (Mathematics), BSc Mathematics Education, BSc Mathematics Education, BEd. Mathematics, BSc. Mathematics Education, BEd. Mathematics, B.Ed Accounting and

Mathematics are offered at Education Schools/Faculties/Departments of Mathematics at the TEU campuses.

Student admissions are based on passing the SHS final-year school-level examination through the WASSCE examination, mature entrance, or a diploma in a mathematics-related area. Teacher educators are also recruited following the national procedures for personnel recruitment into public offices.

Academic management is done by academic administrators, including administrators, deans of faculties, and heads of departments, who are present at the head office and on each campus. The highest office of management in universities in Ghana is the vice-chancellor. Thus, the main participants of this study comprise all the final-year pre-service teachers of the MEPs of Education Schools/Faculties/Departments of Mathematics of the TEUs campuses in Ghana and the concerned teacher educators. Table 3.0 below is a description of the study population.

Table 3.0: Description of the Study Population.

Ser. No.	Population Type	Description	Estimated Number
1.	Population	The Departments of Mathematics Education of all TEUs offer four-year undergraduate MEPs. The administrative staff, heads of department, teacher educators, and pre-service teachers (Students) of the MEPs form part of the population of the present study.	4000 pre-service teachers and 120 teacher educators
2.	Target Population	The target population for the study was teacher educators and final-year MEPs pre-service teachers of all the MEPs of TEUs of Ghana.	1215 final-year pre-service mathematics teachers and 120 teacher educators
3.	Study Population	The study population constitutes teacher educators and final-year pre-service teachers of the three selected TEUs (UEW, UCC and CKT-UTAS).	658 pre-service teachers and 46 teacher educators

3.9 Sample and Sampling for the Study

Sampling is picking a sample from an individual or a significant population group for a specific research objective (Bhardwaj, 2019). The study employed different sampling techniques 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. These universities trained most practising Mathematics teachers at the SHS level. The researcher sampled teacher educators and pre-service Mathematics teachers (students) of the MEPs for the present study. A sample is a specified group from which a researcher obtains data (Obilor, 2023).

The sampling techniques utilised by the researcher for the study are as follows:

1. Random sampling was employed to select final-year pre-service teachers who answered the 5-point Likert scale questionnaire.
2. Random sampling was used to select teacher educators who answered the 5-point Likert scale questionnaire.
3. Random sampling was utilised to select twelve (12) final-year pre-service teachers for semi-structured interviews.
4. Purposive sampling was used to select three (3) teacher educators for semi-structured interviews.

Table 3.1 represents the sampling and sample of participants used for the study.

Table 3.1: 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 (3) public Universities (UCC, UEW, UDS)			
			Three(3) Teacher Educators		Semi-structured interview
II	Random sampling			Nine (9) pre-service teachers, three (3) from each university	Semi-structured interview
				329 Final – year Pre-service teachers	Responding to a 5-point Likert scale questionnaire
				28 Teacher educators	Responding to 5-point Likert scale questionnaire

In total, three (3) TEU campuses were selected for the study; 329 out of 625 randomly answered the 5-point Likert scale questionnaire for students, 28 teacher educators out of 37 answered the 5-point Likert scale questionnaire for teacher educators, nine (9) pre-service mathematics teachers were selected for a semi-structured interview, and three (3) teacher educators were also selected for a semi-structured interview.

3.9.1 Criteria for Selection of Universities

An effective purposive sample requires defined criteria and justification for inclusion (Obilor, 2023). The author further asserted that when done correctly,

purposive sampling allows researchers to filter out insignificant responses that are not appropriate to the study's context. The researcher, out of eight public teacher education universities, selected three (3) for the study based on the following criteria:

1. They have the oldest departments of MEPs and have trained most mathematics teachers in the Ghana education school system.

2. They have final-year pre-service teachers (level 400 students) at the time of the study.

3. They offer at least a mathematics teacher education programme at an MEPs department meant to produce mathematics teachers for the Ghana school system.

Table 3.2 is the profile of the eight (8) public TEUs in Ghana.

Table 3.2: Profile of Teacher Education Universities

Sr. No.	Public Teacher Education University	Date of Establishment	Date of Introduction of Education Programmes	Teacher Education in Mathematics Programme
1.	The University of Ghana, Legon (UG.)	August 1948	2019	B.Sc in Education (Mathematics)
2.	Kwame Nkrumah University of Science and Technology (KNUST)	January 1952	2019	BEd. Junior High School Education (Mathematics)
3.	University of Cape Coast (UCC.)	October 1962	Established as a teacher education Institution	BEd Mathematics
4.	The University of Education, Winneba (UEW.)	September 1992	Established as a teacher education Institution	BSc Mathematics Education
5.	The University of Development Studies, UDS	May 1992	2007	BEd. Mathematics
6.	The Akenten Appiah Menkah University of Skills Training and Entrepreneurial Development (AMMUSTED)	August 2020	Established as a teacher education Institution	BSc. Mathematics Education
7.	The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	May 2020	Established with a teacher education department	BEd. Mathematics
8.	The Simon Diedong Dombo University for Business and Integrated Development Studies (SDD-UBIDS),	May 2020	Established with a teacher education department	B.Ed Accounting and Mathematics

The University of Cape Coast and the University of Education are among the TEUs whose MEPs were selected for the study. The two are the oldest and most recognised TEUs in Ghana. These two universities have trained the most mathematics teachers, especially teachers. The third university selected for the study was the CK Tadem University for Technology and Applied Sciences (CK-UTAS). Although CK-UTAS was recently established and made autonomous out of the University of

Development Studies, it inherited the Mathematics education department of the UDS established in 2017. This makes the mathematics Education programme of the CK-UTAS the third oldest in Ghana.

3.9.2 Description of the Campuses Selected as Sample for the Study

The Universities and departments selected for the study are described in detail in this section, focusing on the academic programmes run by the departments and other related aspects.

a) The University of Cape Coast (UCC)

The UCC is the oldest TEU in Ghana. The UCC was established in October 1962 as a Teacher Education Institution (TEI). The capital of Ghana's Central region, Cape Coast, is the location of UCC. The university was placed in a special relationship with the University of Ghana from its establishment until it was made a fully-fledged university in 1971 by the University of Cape Coast Act, 1971 [Act 390] and subsequently the University of Cape Coast Law, 1992 [PNDC Law 278] (University of Cape Coast, 2024).

The Department of ICT and Mathematics Education prepares mathematics and ICT teachers for Ghanaian schools in accordance with the university's original mandate to produce graduate professionals for the country's second-cycle institutions and the Ministry of Education. The department was established in 2016, although it previously ran as a Computer Science Education Unit within the Department of Science and Mathematics Education. The department runs two undergraduate programmes: BEd Mathematics and BEd Computer Science. The postgraduate programmes run by the department include M.Ed Mathematics Education (Sandwich), M.Ed Information Technology (Regular), M.Phil Mathematics Education (Regular), M.Phil Mathematics Education (Sandwich), and PhD Mathematics Education (Regular).

b) University of Education, Winneba

University of Education, Winneba, was established 1992 as a university college and became a full university under the University of Education Act in 2004, Act 672 (UEW, 2019). The university's mandate is to train human resources for Ghana's school education and the education sector. The UEW previously had four

satellite campuses: the Winneba Campus, the Adwumako Campus, the Kumasi Campus and the Asante Mampong Campus. In 2020, the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development Act (2020), Act 1026, made the Kumasi and the Asante Mampong campuses together an autonomous university and ceased to be satellite UEW campuses (Republic of Ghana, 2020).

The Mathematics Education Department of the UEW trains mathematics educators at the undergraduate and graduate levels to provide Ghana's educational human resources. The department is among the oldest in the university and can boast a student population of over a thousand (1000). The department was one of the starting departments under the University College of Education, and it started with two programmes, namely, a 3-year diploma and a 2-year post-diploma programme. The department currently runs the following graduate and undergraduate programmes: 3-year (minimum) PhD in Mathematics Education (full time), 2-year (minimum) MPhil in Mathematics Education (full time), two sections (1-year) M.Ed. Mathematics (Sandwich), 4-year BSc in Mathematics Education (full time), 4-year BSc in Mathematics Education with Economics (full time), and 2-year Diploma in Mathematics Education.

c) The CK Tadem University for Technology and Applied Sciences (CK-UTAS)

The CK-UTAS was formerly among the UDS satellite campuses. In 2019, an Act of Parliament, ACT 1000(2019), was enacted, making CK-UTAS an autonomous University chined out of the UDS. Although a young institution by its establishment, the university inherited some old departments from the UDS.

The Department of Mathematics and ICT Education was one of the old departments inherited by CK-UTAS. The department has a student population of over a hundred (100). The department currently runs the B.Ed Mathematics and Diploma in ICT Education at the undergraduate level and the MPhil in Mathematics Education and M.Ed in Mathematics at the graduate level.

3.9.3 Description of the MEPs in the TEUs of Ghana

The Mathematics Education Programmes (MEPs) run by the TEUs of Ghana are programmes meant to train mathematics teachers at the school level of Ghana's education. Though the names of the programmes might differ from one institution to

the other, they are all meant to serve one purpose. The programmes are all integrated programmes. The programmes integrate content and pedagogical courses to equip pre-service teachers with enough knowledge to succeed as mathematics teachers.

The names of these programmes from different institutions include B.Ed Mathematics, BSc Mathematics Education, BSc Mathematics Education with Economics, B.Sc in Education (Mathematics), and BEd. Junior High School Education (Mathematics). Most programmes equip students with knowledge in two content areas: a major area, which is always Mathematics, and a minor area, which can be a relevant content area depending on the options available to students in an institution. For example, the BSc Mathematics Education with Economics of the UEW equips graduates with enough content knowledge to handle Mathematics and Economics at the school level.

PCK, CK, and PK are all involved in the training of pre-service teachers. The programmes combine theoretical and practical experience to train the best mathematics teachers. In courses related to ICT and other practical-oriented content areas, the curriculums combine theory with practicals for a better experience. In terms of pedagogy, in all the programmes, there exists a classroom practical experience where students join a school for on-the-job experience in a real classroom with guidance from field teachers as their mentors.

3.9.4 Description of the Sampled Pre-service Teachers

In Ghana, all undergraduate bachelor programmes are four-year programmes. The MEPs of the TEUs are mostly 4-year, eight-semester bachelor's degree programmes. All students have to complete the required courses within the eight semesters to be eligible to graduate.

The researcher sampled students in the final year of their study. The researcher made this decision because Off Campus Teaching Practice (OCTP), also called internship, is very important to MEPs. To get information about the OCTP, the final year students in their final semester were targeted for the study. The eighth semester, their final semester on campus, is when they have completed their OCTP and returned to campus for their final semester. This was necessary to get the information required for the study about the OCTP.

There were 658 final-year pre-service teachers in the three selected TEUs when the researcher collected data for the study. Of the 658 final-year pre-service teachers, 329 (50.0%) were randomly sampled by answering the five-point Likert scale questionnaire for pre-service teachers and twelve (12) were randomly selected for semi-structured interviews. Table 3.3 shows the distribution of the study sample.

Table 3.3: Distribution of the Sample and Sampling of Pre-service Teachers

University	**Number of Final Year MEP pre-service teachers**	**Sample**	**Sampling technique and purpose of sampling**
University of Cape Coast (UCC)	186	150	Random sampling for answering the Likert scale questionnaire
		4	Random sampling for semi-structured interviews.
University of Education, Winneba (UEW)	447	156	Random sampling for answering the Likert scale questionnaire
		5	Random sampling for semi-structured interview
The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	25	23	Random sampling for answering the Likert scale questionnaire
		3	Random sampling for semi-structured interview
Total	**658**	**329 (50.0%)**	For answering the Likert scale questionnaire
		12 (1.8%)	For semi-structured interview

From Table 3.3, out of the 625 final-year pre-service teachers who were the target population, 329 (50.0%) were sampled for answering the 5-point Likert scale questionnaire, and 12 were sampled for the semi-structured interviews.

3.9.5 Description of the Sampled Teacher Educators

The sample teacher educators' profiles are shown below. The teacher educators come in various ranks, from lecturers (assistant lecturers and lecturers) to associate

professors. Table 3.4 represents the total available teacher educators in the sampled universities' mathematics education departments, and Table 3.5 shows the sampled teacher educators for the study.

Table 3.4: The Total Available Teacher Educators in Sampled Campus Departments

Teacher Education University	**Teacher Educators**		**Total**
	Male	**Female**	
University of Cape Coast	5	0	5
University of Education, Winneba	19	4	23
The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	8	1	9
Total	**32**	**5**	**37**

Table 3.5: The Sampled Teacher Educators for the Study.

Teacher Education University	Total Teacher Educators		Sampled Teacher Educators		Total Sampled	Sampling Techniques and Reason for Sampling
	Male	Female	Male	Female		
University of Cape Coast (UCC)	5	0	4	0	4	Random sampling for answering 5 Likert Scale Questionnaire
					1	Purposive sampling for semi-structured interview
University of Education (Winneba)	19	4	14	4	18	Random sampling for answering 5 Likert Scale Questionnaire
					1	Purposive sampling for semi-structured interview
The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	8	1	5	1	6	Random sampling for answering 5 Likert Scale Questionnaire
					1	Purposive sampling for semi-structured interview
Total	**32 (86.49%)**	**5 (13.51%)**	**23 (62.16%)**	**5 (13.51%)**	**28 (75.68%)**	**For answering 5 points Likert scale questionnaire**
			3 (8.11%)	**0**	**3 (8.11%)**	**For semi-structured interview**

From Table 3.4, there was a total of 37 teacher educators in the Mathematics teacher education departments of the selected TEUs. Of the total, 32 (86.49%) were male and 5 (13.51%) were female. The sample for the study had 23 (62.16%) and 3(8.11%) male teacher educators answer a 5-point Likert scale questionnaire and

involved in a semi-structured interview, respectively, while 5 (13.51%) female teacher educators were sampled for the 5-point Likert scale questionnaire as shown in Table 3.5. None of the female teacher educators were involved in the semi-structured interview.

3.10 Sources of Data

The data sources for the study were quantitative and qualitative. Primary and secondary sources of data were used in the study. Data collecting as a primary stage in research can increase the quality of results by reducing the errors that may occur during a research effort (Taherdoost, 2021). The following lists demonstrate educational researchers' six prevalent techniques for collecting data: tests, questionnaires, interviews, focus groups, and observations, constructed, secondary, and existing data (Johnson and Christensen, 2019).

3.10.1 Sources of quantitative data

The researcher collected quantitative data. Numerical data that is mathematically produced and processed is classified as quantitative (Taherdoost, 2021). They were collected from the study's participants (pre-service teachers and teacher educators) and other sources, including observations. A questionnaire is a self-reported information data collection tool that everyone who participates in research completes as a part of a research study (Johnson and Christensen, 2019). Table 3.6 shows the quantitative data collected for the study.

Table 3.6: Sources of Quantitative Data

Techniques	Source of Data	Total
Survey (5-point Likert scale questionnaire)	Pre-service teachers	329
	Teacher educators	28
Observations	Classroom	15
	Environment (Learning Culture)	16
	Resources	3

From Table 3.6, 329 and 28 questionnaires were administered to the pre-service teachers and teacher educators, respectively. The researcher also observed 15, 16 and 3 times respectively of classroom interactions, environmental activities

(learning culture) and Resources of the campuses and departments selected for the study.

The total number of classroom observations conducted by the researcher at the sampled TEUs MEP departments is shown in Table 3.7.

Table 3.7: Classroom Observations Conducted by the Researcher

University	Course Observed	Level	Total Observations
University of Cape Coast	Vectors and Mechanics	300	1
	Problem-Solving in Mathematics	200	1
	Introductory statistics I	200	1
	Computer Applications in Mathematics	300	1
University of Education, Winneba	Courseware design and Development Using Multimedia Tools	300	2
	Algebra 1	100	1
	Partial Differential Equations	400	2
	Mathematics Curriculum Studies	100	1
	Computer Applications for Teaching and Learning Mathematics	200	1
	Post Internship Seminar	400	1
The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	Vectors and Matrix Algebra	100	1
	Psychology of Learning Mathematics	200	1
	Educational Measurement and Evaluation	300	1
Total			**15**

The total number of learning culture observations conducted by the researcher at the sampled TEUs MEP departments is shown in Table 3.8.

Table 3.8: Learning Culture Observations Conducted by the Researcher

University	Total Observations
University of Cape Coast	6
University of Education, Winneba	6
The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	4
Total	**16**

The number of Resource observations conducted by the researcher at the sampled TEUs MEP departments are shown in Table 3.9.

Table 3.9: Resource Observations Conducted by the Researcher

University	Total Observations
University of Cape Coast	1
University of Education, Winneba	1
The CK Tadem University for Technology and Applied Sciences (CK-UTAS)	1
Total	**3**

In total, 329 and 28 questionnaires were administered respectively to pre-service teachers and teacher educators; 15 classroom observations, 16 learning culture observations and three (3) resource observations were conducted towards the quantitative data for the study.

3.10.2 Sources of Qualitative Data

The researcher collected qualitative data. Qualitative data in words or sentences includes nominal and descriptive non-numerical data that cannot be shown numerically (Taherdoost, 2021). They were collected from the participants (pre-service teachers and teacher educators) and departmental administrators. Table 3.8 shows the quantitative data collected for the study.

Table 3.10: Sources of Qualitative Data

Techniques	Source of Data	Total
Survey (Open-ended questionnaire)	Pre-service teachers	Not applicable
	Teacher educators	
Document Analyses	Curriculum material from departments	2
	Semester course outlines	7
Semi-structured interviews	Pre-service teachers	12
	Teacher educators	3

From Table 3.10, the qualitative data collected by the researcher includes open-ended questionnaire responses, curriculum materials (2), semester course outlines (7) and semi-structured interviews (audio responses). The data collection process in all situations was conducted after obtaining permission from the heads of departments or deans of faculty of the departments selected for the study.

3.11 Research Tools and Techniques

A researcher can get the data required to address a study's research objectives using research tools. The tools to be used for the research are dependent on the research objectives and paradigm. An effective research tool requires validity, reliability, and validity status to generate a generalisable scientific statement (Baral, 2018). The tools and techniques used by the researcher for data collection are explained in detail in the section.

a) Documents: The researcher collected documents from the TEUs to explore the objectives, curriculum, assessments, course descriptions, and other aspects of the TEUs. Additionally, this data was utilised to develop several necessary themes, structures, and dimensions to narrow the study's focus through data collection. Course outlines and curriculum materials are among the key documents collected for the study.

b) Questionnaire: A survey method was used to collect data from pre-service teachers and teacher educators using questionnaires, one for pre-service teachers and the other for teacher educators. The researcher prepared the questionnaires, namely 'Questionnaire for Students (Pre-Service Mathematics Teachers)' and

'Questionnaire for Teacher Educators,' based on the literature review of subjects related to the study. Detailed Description of the questionnaire are as follows;

(i) Questionnaire for Students (Pre-Service Mathematics Teachers)

The questionnaire for pre-service teachers has six (6) sections (Sections A to F). Section A consisted of questions with options, Sections B to E consisted of a 5-point Likert scale questionnaire, and Section F contained open-ended questions. Below is a description of the sections of the questionnaire:

Section A

Section A contained the demographic characteristics of the participants (pre-service teachers). The participants were required to choose the appropriate options or provide an answer (open and close-ended questions) on subjects including Gender, Admission Qualification, Goal after Graduation, etc. The section had ten (10) questions on various subjects.

Section B

Section B contained 5-point Likert scale questions on Academic Standards in the TEUs MEPs. The questions were categorised into "Academic Enhancement Activities," "Learning Environment," "Learning Resources," "Teaching-Learning Process," and "Leadership and Governance." The section had 32 questions.

Section C

Section C contained 5-point Likert scale questions on "Curriculum Design, Development and Implementation" in the TEUs MEPs. The questions were categorised into "Curriculum Design," "Curriculum Development," and "Curriculum Implementation." The section had 26 questions.

Section D

Section D contained 5-point Likert scale questions on "Learning Culture" in the TEUs MEPs. The questions were categorised into "Learning Culture Before Class," "Learning Culture During Class," "Learning Culture After Class," and "Learning Culture During Examination". The section had 30 questions.

Section E

Section E contained 5-point Likert scale questions on "Challenges Encounted" in the TEUs MEPs. The questions were categorised into "Academic Challenges," "Resource Challenges," "Welfare Challenges," and "Economic Challenges". The section had 35 questions.

Section F

Section F contained open-ended questions. The participants were required to write suggestions for improving the TEUs MEPs training of pre-service teachers on Academic Standards, Curriculum Design, Development and Implementation, Evaluation Methods/Practices, Resources at the TEUs (Human and Material), Academic Leadership, Learning Culture and any other suggestions to improve the training of pre-service teachers.

(ii) Questionnaire for Teacher Educators

The questionnaire for teacher educators has six (6) sections (Sections A to F). Section A contained open-ended and closed-ended option questions, Sections B to E contained 5-point Likert scale questions, and Section F contained open-ended questions. Below is a description of the sections of the questionnaire:

Section A

Section A contained the demographic characteristics of the participants (teacher educators). The participants were required to choose the appropriate options or provide an answer (open and close-ended questions) on subjects including Gender, academic qualification, Designation, etc. The section had ten (10) questions on various subjects.

Section B

Section B contained 5-point Likert scale questions on Academic Standards in the TEUs MEPs. The questions were categorised into "Admission Process," "Staff Recruitment and Professional Development," and "Teaching Learning Activities." The section had 21 questions.

Section C

Section C contained 5-point Likert scale questions on "Curriculum Design, Development and Implementation" in the TEUs MEPs. The questions were categorised into "Curriculum Design," "Curriculum Development," and "Curriculum Implementation." The section had 24 questions.

Section D

Section D contained 5-point Likert scale questions on "Academic Leadership Practices" in the TEUs MEPs. The questions were categorised into "Knowledge," "Leadership Experience," "Relationships," and "Professionalism". The section had 24 questions.

Section E

Section E contained 5-point Likert scale questions on "Challenges Encounted" in the TEUs MEPs. The questions were categorised into "Academic Challenges," "Resource Challenges," "Welfare Challenges," and "Economic Challenges". The section had 20 questions.

Section F

Section F contained open-ended questions. The participants were required to write suggestions for improving the TEUs MEPs training of pre-service teachers on Academic Standards, Curriculum design, development and Implementation, Evaluation methods/practices, Resources at the TEUs (Human and Material), Academic leadership Practices, Learning culture and any other suggestions to improve the training of pre-service teachers.

c) **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 evaluation procedures for the MEPs. It involved internal assessment processes, external assessment processes, and off-campus teaching practice assessment.

The schedule for teacher educators was on Purpose, Present Status and Future Directions of the TEUs MEPs. Using interviews as a data collection strategy begins with assuming that the respondents' viewpoints are worthwhile, knowable,

and can be made clear and that their perspectives influence the project's success (Groenland & Dana, 2019).

d) Classroom Observation Schedule: The researcher developed an observation schedule to observe the classroom interaction of the selected TEUs MEPs. The classroom observation schedule was a 3-point Likert scale schedule with the options "Not Observed," "More Emphasis Recommended," and "Accomplished Very Well" in five (5) categories. The categories were "Introduction of Lesson", "Presentation of Lesson", "Interaction with Lessons", "Content Knowledge and Relevance," and "Lesson Assessment." In totality, there were 31 statements on the schedule.

6) Learning Culture Observation Schedule: The researcher developed an observation schedule to study the learning culture of the TEUs' MEPs. The learning Culture schedule was a 5-point Likert scale schedule with the options "Not Observed," "Rarely Observed," "Sometimes Observed," "Often Observed," and "Always Observed" in three (3) categories. The categories were "Before Class," "During Class," and "After Class." In totality, there were 21 statements on the schedule.

7) Resource Observation Schedule: The researcher developed a schedule to aid in observing the resources (Human and Material) in the TEUs' MEPs. The schedule was in two sections, A and B. Section A was for human resource observation, and section B was for material resource observation. Section A was designed to identify the availability of human resources, the number available, whether the number is adequate or not and remarks concerning the human resources. Section B also identified the availability of the material resource, the quantity available, and its adequacy for the MEPs' remarks concerning the material resource. Section A had ten (10) listed human resources, and section B had 33 items to be observed.

3.12 Validity and Reliability of Tools

Validity is the accuracy with which a concept is measured in quantitative research (Heale and Twycross, 2015). The research tools for primary data collection were all developed by the researcher. After the construction of the tools, the tools were sent to five (5) experts in Education and Mathematics Education to validate the content and language of the research tools. Of the five (5) experts who accepted and

validated the tools for the researcher, two (2) were experts from India, and three (3) were experts from Ghana, with one of them being a practising Ghanaian expert in South Africa. All the experts gave suggestions, which were accordingly discussed with the research guide and incorporated to better the tools for improved research outcomes.

Of the suggestions from the experts, twenty-nine (29) of them were from the content point of view, while thirty-nine (39) were on language (grammar and mechanical accuracy). The content suggestions involved adding content, removing content, and rearranging content to suit the study's objectives. The suggestions on language involved grammar and mechanical accuracy, including typographical errors. The researcher has considered and incorporated the relevant suggestions into the research tools.

The questionnaire for pre-service teachers and teacher educators initially sent to the experts for validation was well scrutinised by the experts for content and language (grammar and mechanical accuracy). As mentioned above, many suggestions were received for language improvement (39) and content improvement (29).

The final questionnaire had one hundred and twenty-two (124) 5-point Likert scale questions, five (5) multiple choices (demographic characteristics) questions, one (1) open-ended (demographic characteristics) question and one (1) open-ended question on recommendations for pre-service teachers.

The final questionnaire for teacher educators had ninety-two (92) 5-point Likert scale questions, seven (7) multiple choice (demographic characteristics) questions and one (1) open-ended question on recommendations, whilst the initial tools sent to the experts had one hundred and twenty-one (121) 5-point Likert scale questions, 12 multiple choices (demographic characteristics) questions, two (2) closed-ended (demographic characteristics) questions and one (1) open-ended question for pre-service teachers and one hundred and six (106) 5-point Likert scale questions, eleven (11) multiple choice (demographic characteristics) questions and one (1) open-ended question for pre-service teachers.

The final classroom observation schedule had thirty-one (31) observation statements on the introduction of lessons, presentation of lessons, interaction with

learners, content knowledge and relevance and lesson assessment. The resource observation checklist had ten (10) observable items on human resources and thirty-three (33) items on material resources. Also, the learning culture observation schedule had twenty-one (21) statements.

3.13 Data Collection

The researcher personally collected all the data for the study. Initially, the researcher sought permission from the MEP departments where the data was to be collected. The researcher submitted permission letters to the heads of departments or the dean of faculty for approval. On meeting the head or dean, the researcher discussed the study's objective, the data to be collected, and how the researcher intended to collect the needed data. After the satisfaction of the heads/deans, permission was granted, and a notification was sent to the department to alert all the teacher educators and administrative staff of the researchers' presence, purpose and permission to embark on the collection of quantitative and qualitative data.

The necessary documents for the study were initially collected from the right sources (departmental administrators) for critical examination. Among the resources were curriculum materials, departmental handbooks, and course outlines to study the design and structure of the curriculum, as well as how course outlines are presented to learners for the necessary information.

The researcher randomly gave the pre-service teachers the questionnaire during the quantitative data collection phase. This was done with the help of some of the students the researcher had spoken to, and permission was sought from the heads of the department for their assistance. In the same way, the researcher approached the teacher educators when available to distribute the questionnaire to them. The questionnaires were then collected from the participants after they had completed them.

The researcher blended in among the students during lectures to observe the lessons. It was easy to get access to the lecture halls since the teacher educators were already made aware of the data collection process. The researcher also made himself present on campus after lectures to monitor and observe the learning culture after class. Libraries were also regularly visited to monitor students' presence and activities.

For the resource observation, the researcher contacted the administrators of the departments, who then appointed personnel from the department to assist with the observation process. The appointed person led the researcher to various locations to observe the resources. When necessary, the administrators were contacted to clarify some of the confusing aspects of the observation process, especially on the human resource observation face.

The qualitative data was collected through interviews and open-ended questions. The researcher personally interviewed the participants. The participants were randomly approached after lectures to be part of the interview process. The researcher then scheduled an appointment with the students who agreed to be interviewed. On the part of the teacher educators, the administrators were contacted to help the researcher identify the teacher educators who could be interviewed based on the criteria for the purposive selection. The teacher educators who fell within the category were then contacted, and time was scheduled for the interviews. The interviews were recorded using a "Sony ICD-PX470" digital voice recorder. The researcher took field notes to complement the quantitative data from students, teacher educators, and observations.

The collected data were analysed employing descriptive statistics (Frequencies, percentages and means), inferential statistics (Mann Whitney U Test and Kruskal Wallis Test), Content Analyses and Thematic Analyses. The results are displayed in tables in the analyses section of the study. Based on the study's objectives, the qualitative data from document analysis, student interviews, teacher-educator interviews, and open-ended questions were analysed and presented per the emerging themes.

3.14 Conclusions

The chapter thoroughly explained the data collection methods, research tool development and validation, and research design. The chapter also described the selected campuses, programmes, pre-service teachers, and teacher educators. In all, 28 teacher educators and 329 pre-service teachers participated in the study. The results of the data analysis, which included information collected from multiple sources, are shown in the next chapter to provide answers to the suggested research questions. The next chapter gives a detailed description of the data analysis process from various sources.