CHAPTER 2

REVIEW OF RELATED LITERATURE

2.0. Introduction

"A Study of the Mathematics Education Programmes in the Teacher Education Universities of Ghana" is a descriptive study employing quantitative and qualitative data collection methods. This chapter is dedicated to reviewing studies regarding the variables in the objectives set to be achieved by the researcher. The review covers studies conducted in foreign dispensations and locally in Ghana. Studies were available regarding the main variables within the study's objectives, but studies conducted locally were limited. The review is organised according to the following sub-headings.

A. Review of Studies Conducted Abroad

1. Review of Related Journal Articles Conducted Abroad

   Studies Conducted on General Teacher Education

   Studies Conducted on Mathematics Teacher Education

   Studies Conducted on Teaching Mathematics at the School Level

2. Review of Related Thesis Conducted Abroad

   Studies Conducted on General Teacher Education

   Studies Conducted on Mathematics Teacher Education

   Studies Conducted on 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 in the area of Mathematics Teacher Education in Ghana*
3. *Studies conducted in the area of Mathematics teaching at the school level in Ghana*

Mathematics Teacher Education (MTE) in Ghana has various pathways; most Ghanaian Mathematics teachers who teach in second-circle institutions (Senior High Schools) go through the integrated MTE system. As the main source of the production of Mathematics teachers for the high school level of Ghana's education, the researcher feels the need to examine its effectiveness. The literature review has been done mainly to establish the study's theoretical background. It is also meant to determine

study models and methodologies used by various authors to conduct studies related to the study. The sources of reviewed studies were different libraries, such as the online repository of ERIC, Google Scholar, ResearchGate, ProQuest, Shodhganga, Smt. Hansa Mehta Library, Library Genesis, Sci-Hub, CiteSeerX, and the NIFT Website. The reviewed studies mainly consisted of journal articles and doctoral theses.

International and national studies are included in the review of related literature. The review determined the key areas studied under MTE and Mathematics Education (ME) internationally and locally. The review provided insights into the research methods and tools utilised for the study.

2.1 Review of Related Journal Articles Conducted Abroad

The researcher reviewed journal articles related to the study conducted abroad. The review sequence was General Teacher Education, Mathematics Teacher Education, and Teaching Mathematics at the School Level.

2.1.1 Journal Articles Reviewed on General Teacher Education Abroad

Salas-Pilco et al. (2022) conducted a review study titled “Artificial Intelligence and Learning Analytics in Teacher Education: A Systematic Review”. The authors aimed to investigate the impact of Artificial Intelligence (AI) and Learning Analytics (LA) on Teacher Education. The researchers used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedures to review articles. Utilising the PRISMA guidelines, the authors identified 30 studies for the review study. The study concentrated on how AI and LA are being used to achieve the goals of teacher education based on participants, data sources, and the tools used to improve teaching-learning processes. From the review, the authors revealed that: 1) researchers are concentrating on behaviours, perceptions, and digital competence of pre-service and in-service teachers regarding AI and LA, 2) researchers predominantly source behavioural data, discourse data, and statistical data for their studies, 3) most studies have machine learning algorithms as their focus, and 4) few studies mentioned ethical clearance.

Mäkipää et al. (2022) investigated student teachers' perceptions at the University of Helsinki about pedagogical courses in emergency remote teaching through a case

study. The study participants were 79 students' teachers. The researcher collected data using an online questionnaire and interviewed five (5) participants. The researchers used descriptive statistics, multiple linear regression, and content analysis to analyse the collected data. The researchers made the following conclusions from the analyses of collected data: 1) teachers averagely have mastery over the pedagogy of remote teaching, but older teachers face challenges than their younger counterparts.
2) classroom transactions were effective and on the high 3) teachers' pedagogical knowledge is the best indicator of effective remote teaching.

Neokleous et al. (2022) explored teachers' perceptions of using learners' Mother Tongues (MTs) during teaching and the contribution of teacher education towards the teachers' beliefs. The researchers conducted a study titled "The Impact of Teacher Education on English Teachers' Views about Using Mother Tongues: A Teachers' Perspective". The researchers conveniently recruited forty-four (44) participants to answer a questionnaire and four (4) for interview. Data was collected by administering a questionnaire and conducting interviews with four (4) participants. The results show that while most participants emphasised the importance of maximising the use of Target Language (TL), some also recognised the benefits of using MTs for particular objectives, such as supplying task instructions and grammar explanations, anchoring new learning, lowering teacher and student anxiety, sustaining motivation, and promoting learner identity. Also, most participants acknowledged that their teacher education programme impacted their practises and beliefs. However, they also cited their learning and teaching experiences as an essential influence.

Ning et al. (2022) wanted to investigate the effect of teacher education interventions on teachers' Technological Pedagogical Content Knowledge (TPACK). The researchers conducted a study titled "Teacher Education Interventions on Teacher TPACK: A Meta-Analysis Study" to achieve this objective. The researchers initially employed the literature retrieval and snowballing approach to search for literature. Journal papers, conference papers, and dissertations were retrieved from Chinese and English databases. The literature was retrieved from Scopus, Web of Science, Google Scholar, and ProQuest databases. Out of 2490 retrieved literature, the researchers screened the literature by specific criteria to reach a final literature of 59 papers. The

literature was then coded to enable moderator analysis and group comparison based on how the literature is organised. Meta-analysis software (Comprehensive Meta-Analysis, CMA) was employed for data analyses. Meta-analyses regression was used to investigate sources of heterogeneity in the pooled effect of the literature. The study's findings concluded that teacher education intervention has a positive promoting impact on teachers' TPACK.

Pauwels et al. (2022), out of the researcher's wish to investigate the goals of student teachers in academic teacher education for secondary school and how these goals change during their training while taking into consideration various student profiles, conducted a study titled "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". The study was a survey. The researchers adopted and adapted questionnaires from surveys of University of Antwerp students pursuing teacher education during the 2020 - 2021 school year. The first face of the administration of the questionnaire was for 232 registered beginning students from the 2020 - 2021 academic year. In June 2021 of the same academic year, the researchers again administered the questionnaire to 49 graduating students. The researchers wanted to compare the results of the second group to those of the first group to determine the changes that would be observed. The researchers resorted to an independent sample t-test employing IBM SPSS 28 to analyse the quantitative data. This was to sort the changes and differences in the first and second groups' responses. Thematic analyses were employed to analyse the qualitative data (open-ended questionnaire). The following conclusions were realised from the study: 1) It seems that newly graduated student teachers gave the goals of "subject orientation" and "educational orientation" greater weight than they had between the beginning and conclusion of the teacher education courses, 2) graduates are shifting to a more practical educational approach, 3) 'Work dynamic' factors were typically valued equally by men and women as a reason to work in education, but men placed a higher value on combination possibilities, 4) Graduated 'teacher in training' (TiT) students valued the motivator' idealism' more than non-TiT-students, specifically concerning those students.

Estellés et al. (2021) conducted a study titled "The Consensus on Citizenship Education Purposes in Teacher Education". The study's objective was to examine the views on Citizenship Education (CE) that pre-service teachers with various political philosophies and levels of civic engagement have. The study was an exploratory sequential mixed-method design. The researcher utilized simple random sampling to select participants for the quantitative face of the study. The total number of participants for the quantitative part was 324 student teachers. Purposive sampling was utilised for the qualitative phase. In total, 27 participants participated in the study's qualitative phase. An online questionnaire was employed to gather data for the quantitative part of the study. Visual interviews were conducted to collect data for the qualitative phase of the study. Photo-elicitation techniques (visual images) were used to get information about the participants' beliefs about citizenship education. The researcher used R software and R studio employing descriptive statistics, Shapiro-Wilk, Chi-square test, Fisher's exact test, t-test, Welch's correction regression, and logistic regression for quantitative data analyses. The researchers resorted to inductive and deductive analyses for qualitative data analyses by themes (thematic analyses) elicited after coding transcribed data. The results concluded that there is a need to re-politicise teacher education programmes since pre-service teachers' political ideologies and degrees of civic participation suggest a significant presence of moderate students with low engagement.

Zelalem et al. (2021) investigated the self-efficacy of teacher educators and their perceptions of differentiated instruction practises in Ethiopian primary teacher education programmes through a study titled "Teacher Educators' Self-efficacy and Perceived Practices of Differentiated Instruction in Ethiopian Primary Teacher Education Programs: Teacher Education Colleges in Amhara Regional State in Focus". The study was a sequential explanatory mixed-method study. By proportionate stratified random sampling, the researchers selected 400 teacher educators as participants for the study's first phase. For the second phase, the researchers purposively selected 15 teacher educators for interviews. A questionnaire was employed for data collection for the study's first phase. Interviews were conducted to collect data for the second phase of the study. Frequencies, percentages, and one sample t-test were employed in the quantitative data analyses, and thematic analyses were done on a case-by-case basis for the qualitative data. The results

showed that most teacher educators lack training in differentiated instruction and are less effective at implementing it. Additionally, it was discovered that there was a relatively low level of differentiated instruction implementation in the research area.

Tucunduva and Bortoleto (2019) conducted a study titled "Circus and Curricular Innovation in Physical Education Teachers' Education (Pete) in Brazil". The authors aimed to qualitatively analyse the experience of teacher educators (professors) regarding using circus in Brazilian Universities. Participants in the study were 22 teacher educators selected from higher education institutions. Out of the 22, five with the most experience were purposively further selected for an in-depth interview. The tools used for data collection were a semi-structured questionnaire and an interview schedule. The data collected were analysed thematically to determine the outcome of the study. The findings supported the idea that the circus is a long-lasting pedagogical innovation in Physical Education Teachers' Education (PETE) that increases sociocultural, historical, aesthetic, and technical diversity. However, professors' methods primarily emphasise fundamental abilities, paying little attention to their creative components. It was also discovered that circus pedagogy in physical education might provide a creative logic to play with the body and movement that combines artistic expression with improving physical ability and conditioning.

Tajik et al. (2019) conducted a study titled "Now as a Teacher": Novice Teachers Reflect on English Language Teacher Education in Iran". The researcher's objective was to examine teacher training in the nation's 420 language schools and three (3) private language institutes with headquarters in Tehran. The study was a qualitative grounded theory. The researchers employed purposive sampling to select twelve (12) female English teachers from three private language institutes and three (3) supervisors from each institute. The researchers collected data through teacher diaries, peer interviews, participant observation, semi-structured interviews and focus group interviews. The researchers employed an inductive analysis procedure using content analyses to analyse the data. Results showed that the theory-practice gap, supervised in-service workshops, reflective teaching techniques, use of technology, and teachers' experience learning might all need to be improved in the context of existing language teacher training courses.

Young (2018) conducted a study titled "CO-CREATE: Teachers' Voices to Inform Special Education Teacher Education" to explore teacher education programmes regarding issues affecting graduates who ply their trade in the Special Education arena. The researcher recruited 77 special education teachers and principals for the study. The study employed an online survey (questionnaire) for data collection, which involved qualitative and quantitative data collection methods. Data analyses were descriptive for the quantitative data and thematic analyses for the qualitative data. Results emphasise the significance of meaningful consultation and engagement with the families of kids with disabilities and adults with disabilities, such as through Q&A sessions, tutoring, presentations, and participation in local support organisations.

Symeonidis (2018) wanted to use the European Teacher Education Area (ETEA) to examine how and to what extent internal and external agents of Europeanization affect the development of teacher education practises and policies in Europe. To achieve the above objective, the researcher conducted a study titled "Revisiting the European Teacher Education Area: The Transformation of Teacher Education Policies and Practices in Europe". Adopting an empirical base research report, the researchers collected data from document review of official EU policy documents, websites, and online materials dedicated to European institutions connected to teachers and teacher education. In addition, the researcher reviewed secondary data, such as published scholarly works and analyses of policy in European teacher education. In addition to the data collected from these sources, a specific type of semi-structured interview was conducted with European policy officials. Thirteen experts were interviewed as participants in the study. The experts were from the following institutions: the European Commission, the European Trade Union Committee for Education (ETUCE), the Teacher Education Policy in Europe (TEPE) network and the European Network on Teacher Education Policies (ENTEP). The data collected were analysed utilizing qualitative content analysis techniques. MAXQDA software was used to assist with the coding and handling of data. The findings of the study elicited mechanisms, processes and key agents which the researcher clustered into the following functions: (1) cross-sectoral instruments; (2) policy coordination; (3) evidence-based management; (4) educational programmes; (5) the Bologna process; and (6) stakeholder pressure.

Deneen and Brown (2016) conducted a study titled "The Impact of Conceptions of Assessment on Assessment Literacy in a Teacher Education Program" to assess how student teachers' reported literacy and assessment concepts are affected by a master's level teacher training course on assessment in education. Data was collected using achievement tests of 30 pre-service and practising teachers. Pre and post-course interviews were conducted for six (6) participants out of 30 pre-service and practising teachers. Data were analysed utilising inferential statistics for quantitative data and a qualitative coding process of phenomenography for the qualitative data. ATLAS Ti software was used for the data analyses. The study's findings seem to confirm that, at the very least, the skill and knowledge components may and do develop through an assessment in education courses at the master's level. It was also concluded that instead of encouraging ruthlessly pragmatic but unsuitable practices among teachers, we should urge improved alignment between assessment policy and practice and more equal and advantageous results. While basic tensions may never be resolved entirely, doing so would at least make them tolerable for instructors as they conceptualise and use evaluation.

Kärkkäinen et al. (2014) conducted a study titled "Teacher Education as a Promoter of Health: Teacher Students' Perceptions about Medicine Education". The researchers explored the perceptions of Finnish primary school student teachers about medical education. The study was a case study and had 21 teacher educators as the participants. The researchers collected data from student teachers' written blogs, questionnaires and focus group interviews. Techniques for data analyses included inductive content analysis for the written blogs and qualitative data analyses (thematic analyses) for the questionnaire and group interview data. The perceptions of teacher students concerning the subject matter of medical education were relatively limited. Although students understood the significance of using medications properly, they highlighted the subject of misuse, contrary to the objectives and strategies of medical education. Given that they had little personal experience with medical education from their own time in school, teacher students only listed a limited number of strategies for teaching the proper use of medications.

Akhter and Butt (2012), in their study titled "A Qualitative Approach to Study the Role and Importance of Inquiry-Based Learning: Professional Learning Experience of

Teacher-Educators and Student -teachers in Initial Teacher Education Programs", wanted to investigate how university-level educators and pupils perceive the components and methodology of inquiry-based education. Using a qualitative approach, the researchers collected data through two student-teacher focus groups and interviewed twenty (20) teacher-educators. The teacher-educators were selected utilising the convenient sampling techniques. Thematic analyses were used to elicit the necessary results from the qualitative data collected. The researcher used semi-structured interview schedules for data collection. According to the study, teachers and students tended to favour inquiry-based teaching.

Carrasco-Embuena and Hernández-Amorós (2012) explored the level of conceptual understanding that the Secondary Education Master's students at the University of Alicante had throughout the academic year 2011–12 by conducting a study titled "Pre-Service Teacher Education and Comprehension of Didactic Concepts. An Experience within the Master of Secondary Education Teachers". The study was quantitative. The participants for the study were 227 students out of 385 who participated willingly. A Questionnaire was employed for data collection. The researchers used descriptive, inferential and correlational statistics for data analyses. The findings showed that the students do not fully understand the fundamentals of didactic concepts; there are variances in the levels of understanding and other learning-related and attitude-related learning variables.

Ronspies (2011) conducted "A Study Investigating the Reasons behind the Involvement of Non-Traditional Students in Physical Education Teacher Education Programmes". Through a qualitative study, the researcher wanted to explore the factors and beliefs of the participants about what it meant to be a physical educator. A solitary participant was used for the study. The researcher collected data through artefacts, observations and interviews. The study revealed that the participant, out of love for physical activities, sports, and working with youths, was attracted to physical education. It was also realised that the participants' socialisation into physical education was affected by contextual and social variables, such as favourable interactions with a teacher or coach, supportive relationships with family and friends, and his steadfast principles and views for physical education.

2.1.1.1 Summary of the Review of Journal Articles Conducted Abroad on General Teacher Education

Seventeen (16) journal articles were reviewed under journal articles conducted on general teacher education abroad. The researchers utilised different methodologies from the reviewed studies to achieve their objectives. The methodologies used include case studies (2), descriptive surveys (4), mixed method studies (2), qualitative studies (4), empirical research (1), and quantitative Studies (1), meta-analyses (2),

The studies were conducted by Ronspies (2011), Carrasco-Embuena and Hernández-Amorós (2012), Akhter and Butt (2012), Kärkkäinen et al. (2014), Deneen and Brown (2016), Symeonidis (2018), Young (2018), Salas-Pilco, Xiao and Hu (2022), Mäkipää, Hildén and Samulin (2022), Neokleous, Krulatz and Xu (2022), Ning, Zhou, Wijaya and Chen (2022), Pauwels et al. (2022), Estellés, Amo and Romero (2021), Zelalem, Melesse and Seifu (2021), Tucunduva and Bortoleto (2019), and Tajik, Mirhosseini, and Ramezani (2019).

The studies concentrated on artificial intelligence and learning analytics in teacher education, the perceptions of student teachers at the university about pedagogical courses in emergency remote teaching, influence of teacher preparation on the opinions of English teachers about the use of mother tongues, teacher education interventions on teacher TPACK, the objectives of student teachers in secondary academic teacher education school and how these goals change during their training, consensus on citizenship education purposes in teacher training, self-efficacy of teacher educators and perceived practices of differentiated instruction in primary teacher training programmes, experience of teacher educators regarding using circus in Brazilian Universities, teacher training in the nation's 420 language schools and three (3) private language institutes with headquarters in Tehran, transforming of teacher training policies and practices, how student teachers' reported literacy and assessment concepts are affected by educational assessment courses at the masters' level, perceptions of Finnish primary school student teachers about medical education, the role and importance of inquiry-based learning, level of conceptual understanding that the secondary education master's students at the University of Alicante had throughout the academic year 2011–12, and the reasons behind the involvement of non-traditional students in physical education teacher education programmes.

The researchers collected data through interview schedules, questionnaires, artefacts, observation schedules, written blogs, achievement tests, documents, website

analyses, examination tasks, and teacher diaries. Techniques employed for data analyses include descriptive statistics, multiple linear regression, content analysis, independent sample t-test, thematic analyses, Shapiro-Wilk, Chi-square test, Fishers' exact test, t-test, Welch's correction regression, logistic regression, frequencies, percentages, one sample t-test, theoretical-based qualitative analysis techniques, inductive content analysis, and correlational statistics.

2.1.2 Journal Articles Reviewed on Mathematics Teacher Education Abroad

Hine and Herbert (2022) investigated changes in Pre-Service Mathematics Teachers' (PSMTs') perspectives over time on strategies for teaching mathematics in secondary schools, both before and after they have taken courses in mathematics teaching methods (including practical teaching) with a study titled "Shifting Pre-Service Teachers' Views of Teaching Secondary Mathematics". Participants in the study included pre-service teachers from two Australian Universities. Data collection was through online surveys (questionnaires) and semi-structured interviews. Sixty-one participants participated in the before and thirty-four (34) in the after survey. Twelve of the participants agreed and were interviewed. Data analyses were done with descriptive statistics (means and standard deviations). The qualitative data was analysed using thematic analyses. From the findings of the study: 1) there was no significant change concerning PSMTs' views on how ready they are to teach mathematics, 2) According to an examination of qualitative data, PSMTs were not prepared to teach secondary mathematics, with a focus on their need for improvement in both their mathematical subject knowledge and mathematical pedagogical expertise. Over 50% of those surveyed felt competent to instruct maths in lower secondary classes (Years 7–10).

Moreno-Pino et al. (2022) wanted to examine how teachers view the subject of study more thoroughly, their working methods, etc. To attain the above objective, the researchers conducted a study titled "Training in Mathematics Education from a Sustainability Perspective: A Case Study of University Teachers' Views". The study was a multiple-case study. Three mathematics teacher educators who teach Didactics of Mathematics volunteered to be interviewed and recorded for the research and were used as study participants. The authors used a semi-structured personal interview, an initial exploratory questionnaire, and the topic syllabi for which the teachers were

responsible to gather data. The researchers employed document review and content analyses to analyse the data collected. The study's findings conclude that to include sustainability in mathematics instruction effectively, university teachers must adapt and collaborate from the same perspective: the one they want to advance.

Morkoyunlu and Altun (2022) conducted a study titled "The Effect of Error-Based Activities on the Reflective Thinking Skills of Pre-Service Elementary Education Mathematics Teachers" to explore what impact error-based exercises have on the reflective thought processes of aspiring elementary school mathematics teachers. The authors employed the qualitative methodology of research. The researchers used a criterion sampling technique (purposive) to select six (6) third-year student teachers of the Elementary Education Mathematics Teaching department at a state university in Turkey. The participants were selected from the 2017-2018 academic year spring batch. Data was collected through the respondents' written reflective diaries and face-to-face interviews (semi-structured). Themes were developed and used to analyse the data gathered from the respondents. The findings showed that the error-based exercises benefited the student teachers' thought processes. Additionally, the error-based exercise improved the student teachers' reflective thinking skills during the week.

Tinh et al. (2021) conducted a study titled "Preparing Pre-Service Teachers for Mathematics Teaching at Primary Schools in Vietnam" to investigate the professional competencies primary school teachers require for effective mathematics teaching and teacher education's role in ensuring that pre-service teachers are equipped with these competencies in Vietnam. Employing a mixed method design, the researcher purposively sampled five universities and 20 stakeholders (experts) for the first part of the study. The first part of data collection was a focus group meeting of 20 stakeholders (experts). The second part of the data collection process was the administration of a questionnaire to 493 pre-service teachers and interviewing twenty (20) teacher educators from the participating universities. Thematic analyses were employed to analyze collected data. The study showed that Vietnamese pre-service teachers received appropriate mathematical content training but were less prepared in teaching methodologies.

Rifandi et al. (2021) conducted a study titled "Pre-Service Mathematics Teachers' Perception on Realistic Mathematics Education", intending to explore pre-service mathematics teachers' perceptions concerning Realistic Mathematics Education (RME). The researchers employed the descriptive survey method. Thirty-six (36) students from Universitas Negeri Padang's mathematics education study programme who took the Mathematics Instruction Strategy Course during the 2019–2020 academic year are the participants in this study. Data collection was via an online questionnaire, and the researchers used descriptive statistics (percentages) to analyse the data. According to the findings, pre-service maths teachers favourably view RME in the classroom.

Gumiero and Pazucha (2020) wanted to investigate factors in a collaborative environment which support the formation of teaching processes in teacher education. The researchers conducted a "Collaborative Work in Mathematics Teacher Education" study to achieve this objective. The study was a review study. The researchers sourced works published in databases including Scielo, ERIC, PsycINFO, Web of Science, and MathEduc for the study. The researchers initially got 175 journal articles for the study (139 from ERIC, 26 from Web of Science, 25 from PsycINFO, 24 from MathEduc, and five (5) from Scielo). After applying all the selection criteria for articles for the study, the researchers settled on 12 articles. After reviewing the 12 selected articles, the researchers concluded that class planning, teaching practices, and knowledge production contribute to mathematics teacher education.

Johnson (2020) conducted a study titled "Mathematics Teacher Identity: The Case of a Black Male Pre-service Teacher". The study aimed to investigate the challenges black male pre-service teachers encounter while pursuing their dream of becoming Mathematics teachers. The exploratory qualitative study had five (5) black pre-service mathematics teachers as the participants. The concentration of the study was on one of the participants with a unique situation due to his in-depth accounts and remarks, as well as the fact that his case was typical in that the themes in his story were also present in those of the other research participants. The participant, who was in a unique situation, initially presented a self-narrative for analyses, which was the primary data source for the study. Interviews (semi-structured and open-ended) were the source of data for the study. The researchers employed narrative analyses with

themes in the data analysis process. The conversations with the participants focused on how the racialisation of mathematics education may push Black male pre-service teachers out of the pipeline into Mathematics teaching while illuminating their resiliency and persistence.

Widiati et al. (2020) conducted a "Pre-service Mathematics Teachers Creativity in Designing Mathematics Assessment Based on Education for Sustainable Development" study to analyse the originality of mathematical exam instruments created by pre-service maths instructors based on Education for Sustainable Development. The study was a qualitative, phenomenology design with four participants who were pre-service Mathematics teachers. For data collection, the researcher made the respondent construct mathematical exam items as a part of education for sustainable development as application problems that are particular to the social, economic, and environmental issues. Interviews were also conducted for further information on the construction of test items. The findings showed that pre-service mathematics teachers had difficulties creating applications for the topic of the environment due to students' lack of experience in creating application questions.

Alsina and Mula (2019) conducted a study titled "Advancing Towards a Transformational Professional Competence Model through Reflective Learning and Sustainability: The Case of Mathematics Teacher Education". The study's goal was to start by outlining the elements of teacher educators' professional practice that support the transformation of past knowledge, experiences, and worldviews into professional competence grounded in education for sustainability and reflective learning. The study was a qualitative case study. The researchers observed thirty (30) class sections of mathematics teacher educators of classes for the "Learning Mathematics" course. The class sections were recorded on video for analysis. For comprehensive data, the researchers also collected and analysed the teacher educators' evaluation forms completed by students enrolled on the "Learning Mathematics" subject. The video recording was analysed using "MediaNotes" video analysing software. The deductive application of categories was employed in analysing the data collected from the videos. Specifically, the researchers utilised the twelve self-regulation traits for the analyses. The study revealed that prior information, experiences, and beliefs are modified if pre-service teachers and teacher educators are synchronised.

Alex (2019) conducted a study titled "The Preparation of Secondary School Mathematics Teachers in South Africa: Prospective Teachers' Student Level Disciplinary Content Knowledge (SLDCK)". The researcher aimed to verify the level of knowledge of the content of mathematics of pre-service mathematics teachers at a rural South African institution concerning what they are expected to teach in the classroom. From a positivist paradigm and a quantitative approach, the researchers used 40 pre-service mathematics teachers who voluntarily accepted to be part of the study out of 140 for the particular batch. The researcher used "A standardised Mathematics question paper comprised of the National Senior Certificate (NSC) Matric Examinations of November 2014 was purposively selected" as a research tool and the results of the test conducted as the data for the study and also documents (course modules) of the prospectus of the pre-service teachers. The researcher analysed the data collected using Microsoft Excel. The author employed percentages and document analysis for the study. It was discovered that the pre-service teachers had only a limited SLDCK on the subjects they would teach in the classrooms. The limited SLDCK of the future teachers was caused by the university's curriculum restrictions, according to an extensive review of the course modules given at the university.

Kim et al. (2019) conducted a study titled "Creative Character Education in Mathematics for

Prospective Teachers". Through a university-based teacher training program, the study investigated how students' teachers perceived creativity and character education in mathematics. The mixed method design study had 56 pre-service mathematics teachers (grades 7-12) voluntarily participating. Data was collected using a questionnaire and teachers' artefacts (written reflections and transcribed data from student debates and presentations). Analyses were done employing statistical techniques, including paired sample t-tests and post hoc analyses. The results suggest that a mathematics teacher education programme incorporating mathematical creativity and character education could prepare future educators to embrace pedagogy that links process and content in classroom mathematics for the next generation of students.

Rahayu (2017), in the researchers' interest to explore the basic teaching skills of prospective teachers of the STKIP Garut at Field Experience Programme in the academic year 2014/2015 mathematics education department conducted a study titled "Analysis of Prospective Mathematics Teachers' Basic Teaching Skills (a Study of Mathematics Education Departement Students' Field Experience Program at STKIP Garut)". Through the descriptive analyses method of research, the researcher selected 4 participants from the Mathematic Education Department at STKIP Garut, which took PPL SMAN 16 Garut in 2015. The tool for data collection was an observation schedule of basic skills in teaching mathematics. The researcher employed three (3) data analysis methods: data reduction, presentation, and conclusion drafting. The findings of the study revealed the following observations: 1) Content mastery and explaining abilities fell into the average range, 2) Conducting assessments, conducting variations, and asking questions all fell into the "good" category, and 3) management of the classroom and motivating others fell into the low category.

Hine (2015) conducted a study titled "Self-Perceptions of Pre-Service Mathematics Teachers Completing a Graduate Diploma of Secondary Education". The study aimed to find out how pre-service secondary maths teachers who were going to finish their Graduate Diploma in Secondary Education felt about themselves. Employing a qualitative methodology, the researcher collected data by administering a qualitative survey (questionnaire) to the respondents online on two separate occasions. The participants responded to the same questionnaire before and after their off-campus teaching practice (teaching practicum experience). The participants were purposively sampled: fifteen (15) out of twenty (20) pre-service teachers. The researcher thematically analysed the collected data. The findings revealed the following: pre-service teachers should receive more training in content, especially in upper-level mathematics, and additional training in mathematical pedagogy, and from practicum experience, pre-service teachers exhibited readiness for fieldwork.

Nolan (2015) conducted a study titled "Beyond Tokenism in the Field? On the Learning of a Mathematics teacher educator and faculty supervisor". The study aimed to explore the field experience of mathematics education based on Bourdieu's social field theory concept tools to analyse self-reported data regarding the function of supervision "in the field." The study was a self-study of the authors' supervision

practices. The researcher employed personal interviews and focus group interviews as a means of data collection. The data analysis process is as follows: The "typical" normative relation was detailed first, then an attempt to disrupt the relationship and maybe forge new connections and exchanges, and then a look at the plot from the perspective of Bourdieu's social field theory notions. The study's findings encourage a reflexive approach to teacher education that reveals the cultural capital and habits that shape field behaviour and support teacher training as they challenge discursive relationship networks.

Gierdien (2012) investigated the views of four-year pre-service mathematics education students on the modules of their programme. The researcher conducted a study titled "Pre-Service Teachers' Views about their Mathematics Teacher Education Modules" to achieve this objective. The researcher collected data by voluntarily allowing pre-service mathematics teachers to complete a questionnaire on their experiences with their programme module at the time. Twenty-eight (28) of the pre-service teachers willingly answered the questionnaire. Data analyses were done from the perspective of bridging the university–school divide. The researcher analysed eight respondents' responses based on space considerations and the requirement to consider the complexity of a conceptualisation of bridging the gap between universities and schools. The respondents' views were coded using the following themes: disagreement, anxiety, apprehension, uncertainty, confidence or agreement. Findings show that the PSTs take varied positions concerning their training for teaching mathematics in schools.

2.1.2.1 Summary of the Review of Journal Articles Conducted Abroad on Mathematics Teacher Education

The researcher reviewed fifteen (15) journal articles concerning mathematics teacher education conducted abroad. The research methodologies employed by the researchers in the various studies include descriptive surveys, case studies, qualitative research designs, mixed method designs, review studies, quantitative studies, and self-study. The majority of the researchers employed various types of qualitative studies. Five (5) out of the fifteen reviewed studies were qualitative, four (4) were descriptive,

two (2) were mixed method studies, and one (1) each was a case study, a review, a quantitative and a self-study.

The studies were conducted by Hine and Herbert (2022), Moreno-Pino et al. (2022), Morkoyunlu and Altun (2022), Tinh et al. (2021), Rifandi et al. (2021), Gumiero and Pazucha (2020), Johnson (2020), Widiati, Turmudi and Juandi (2020), Alsina and Mula (2019), Alex (2019), Kim et al. (2019), Rahayu (2017), Hine (2015), Nolan (2015), and Gierdien (2012).

The emphasis of the reviewed studies were on Pre-Service Mathematics Teachers' (PSMTs') perspectives over time on strategies for teaching mathematics in secondary schools, how teachers view the subject of study more thoroughly, their working methods, impact error-based exercises have on the reflective thought processes of aspiring elementary school mathematics teachers, competencies of school teachers required for effective teacing of mathematics and teacher education's role in ensuring that pre-service teachers are equipped with these competencies, pre-service mathematics teachers' perceptions concerning Realistic Mathematics Education, factors in a collaborative environment which support the formation of teaching processes in teacher education, the challenges black male pre-service teachers encounter while pursuing their dream of becoming Mathematics teachers, the originality of mathematical exam instruments created by pre-service maths instructors that are based on Education for Sustainable Development, defining the elements of teacher educators' professional practice that support the transformation of past knowledge, experiences, and worldviews into proficiency in reflective learning and sustainable education., verifying the level of knowledge of the content of mathematics of pre-service mathematics teachers at a rural South African institution concerning what they are expected to teach in the classroom, the fundamental teaching abilities of aspiring teachers of the STKIP Garut at Field Experience Program, and pre-service teachers' opinions on creativity and character education in mathematics through a university-based teacher education program, Pre-service secondary maths teachers' opinions of themselves as they prepare to get a Graduate Diploma in Secondary Education, applying Bourdieu's social field theory conceptual tools to analyse self-reported data about the role of supervision "in the field" and four-year pre-service mathematics education students' opinions about their program's modules in order to investigate the field experience of mathematics education.

The researchers collected data through questionnaires, semi-structured interviews, syllabi of subjects, reflective diaries, exam items, observations, MediaNotes, test results, artefacts, and focus group interviews. The following techniques were employed for data analyses of collected data: thematic analyses, document review, content analyses, narrative analyses, deductive analyses, descriptive analyses, paired sample t-tests, post hoc analyses, data reduction, presentation, and conclusion drafting.

2.1.3 Journal Articles Reviewed on Teaching Mathematics at the School Level Abroad

Mohamed et al. (2023) conducted a study titled "Mathematics teachers' awareness of effective teaching practices: A comparative study". The study's objective was to investigate Saudi Arabia and the Arab Republic of Egypt's mathematics teacher's knowledge of effective teaching practices per the recommendations of the United States National Council of Teachers of Mathematics (NCTM, 2014a) via a comparative study. The researchers resorted to the quantitative approach. The study population was mathematics teachers from Saudi Arabia and Egypt in 2022. The researchers sampled 1271 mathematics teachers (651 Arabians and 620 Egyptians) randomly selected via an online questionnaire. The researchers used descriptive statistics (means and standard deviations) to analyze the data, and t-tests and ANOVA were used to compare other variables. According to the survey, mathematics teachers in Egypt and Saudi Arabia were well aware of good teaching techniques. Furthermore, there were no differences in Saudi teachers' knowledge of potential differentiating factors. However, variations may be attributed to the gender variable in the female group's favour.

Yuan et al. (2023) conducted a study titled "Facilitating Conditions as the Biggest Factor Influencing Elementary School Teachers' Usage Behavior of Dynamic Mathematics Software in China" to investigate factors influencing teachers' use of dynamic mathematics software in China. The study was a quantitative survey. The study was based on four variables (independent), namely, Social Influence (SI), Effort Expectancy (EE), Performance Expectancy (PE), And Facilitating Conditions (FC) emanating out of the United Theory of Acceptance and Use of Technology (UTAUT). The researchers constructed a questionnaire for data collection. The data was

administered online by using convenient sampling for a sample of 266 elementary mathematics teachers. The researchers used SPSS 26 and SmartPLS 4, employing descriptive statistics and the Shapiro–Wilk test for data analyses. According to the findings, effort expectancy and facilitating conditions impact how primary school teachers use dynamic mathematics software, with facilitating conditions being the primary influencing variable. Additionally, teachers' utilisation of dynamic mathematics software is not significantly impacted by major, gender, or training on any of the relationships in the conceptual model of dynamic mathematics software utilisation.

Wondem et al. (2023) conducted a study titled "Institutional Setting and Its Influence on the Teaching of Mathematics: Implications to Implementing Reform Vision in Mathematics Education in Ethiopian Schools". The study's objective was to examine how the school and district environments affect reform visions for mathematics education. The case study had 17 participants who were mathematics teachers (grades 5 -8) from four primary schools. Data collection was done utilising an interview schedule. Participants were interviewed in a semi-structured interview as part of the initial data collection phase. The researchers used snowballing methodology and the bottom-up strategy for data collection. In the second stage, two district-level experts, a cluster principal, and the principal and vice principal from each school were interviewed. Documents were also collected for analysis. Thematic analyses were utilised to analyse the collected qualitative data. The results show that the educational environment does not effectively support reform visions but upholds the practice meant to be changed.

Yao and Zhao (2022) conducted a study titled "Chinese Mathematics Teachers' Use of Digital Technologies for Instruction: A Survey Study" to investigate the mathematics teachers' technology integration practices to be able to offer assistance to them. The study was a survey, and the researchers used a questionnaire to collect data. The participants of the study were Chinese mathematics teachers from the Tianjin province. The participants were randomly selected via online administration using the study data collection tool. In total, 1465 mathematics teachers' responded to the questionnaire. After sampling the responses based on the duration used to answer the questions and incomplete responses, 1,083 (73.9%) were finalised for data analyses. The researchers resorted to descriptive statistics (frequencies and percentages) and

logistic regression analyses to analyse the collected data. The findings revealed that most participants often used search engines, self-accumulated digital resources, courseware, and smartboards to teach mathematics. The participants also utilised technologies to access resources, make courseware and look out for mathematical problems when preparing for lessons. According to the study, the teachers also use technology as a motivational tool.

Záhorec et al. (2022) conducted a study titled "Concept Mapping in Teaching Mathematics in Slovakia: Pedagogical Experiment Results". The study aimed to explore mathematics teachers' concept mapping application at the primary level and verify its quantitative impact on education. From an experimental perspective, the researchers used the control and experimental group research methods. The research process involved the following processes: construction of tools, construction of research tools (questionnaire), selection of control group (ten (10) boys and ten (10) girls) and experimental groups (10 boys and 11 girls), administration of questionnaire, intervention and administration of the questionnaire. The Levene non-parametric test, the chi-squared test of independence, the Mann-Whitney U test, and their graphical representation are among the statistical methods employed for analysis. The study's findings indicated that teaching supported by concept mapping does not reduce students' negative attitudes towards mathematics at the primary level.

Wardat, Belbase and Tairab (2022) conducted a study to investigate mathematics teachers' perceptions and self-report practices when teaching for Trends in International Mathematics and Science Study (TIMSS) in Abu Dhabi. To achieve their objective, the researchers conducted a study titled "Mathematics Teachers' Perceptions of Trends in International Mathematics and Science Study (TIMSS)-Related Practices in Abu Dhabi Emirate Schools". The study was a quantitative survey. The study's population was all full-time Abu Dhabi mathematics teachers of grade 8 in the 2020-2021 academic year. The sample consisted of 522 mathematics teachers who voluntarily approved to participate in the study from 449 schools in Abu Dhabi. A questionnaire of teachers' perceptions was developed and used for data collection. The researcher employed one-way ANOVA, one-sample t-test, independent sample test, and descriptive statistics for data analysis. According to the results, male and female teachers' TIMSS-focused mathematics teaching practices and their assessments of students' preparedness for TIMSS did not differ statistically

significantly; however, their perceptions of the school and the classroom setting did differ significantly. Furthermore, there was a statistically significant difference in how students were perceived to be prepared for the test and in the school and classroom environments, but no statistically significant difference in how maths teachers used the TIMSS between public and private schools.

Moh'd et al. (2021) conducted a study titled "Assessing the Level of Secondary Mathematics Teachers' Pedagogical Content Knowledge (PCK)" to examine the pedagogical content knowledge (PCK) of mathematics teachers in several Zanzibar secondary schools. In the mixed-method explanatory sequential study, 69 in-service teachers (34 male and 35 female) were randomly selected from regions of the Unguja Island of Zanzibar, Tanzania. The researchers utilised a questionnaire and observation guide for data collection. Data analyses employed descriptive statistics (means and standard deviations) and inferential statistics (independent t-test). Analyses of the data from the questionnaire revealed that the teacher's PCK level was moderate; however, teachers' level of PCK is low according to classroom observations. While teachers' specialisations did not significantly affect their PCK levels, there were significant differences in PCK levels from their education and teaching experience. Based on observation, the results show little PCK in classroom procedures. This demonstrates how difficult it is for teachers to include PCK in their lesson plans. Therefore, more in-service training on improving teachers' PCK levels is required, as this would ultimately result in better teaching and learning of mathematics. The study found that the PCK of maths teachers was moderate based on the questionnaire.

Cerezci (2020), to explore if there is a relationship between the quality of early mathematics instruction and learning outcomes in 73 Pre-K to 3rd-grade classrooms, conducted a study titled "The Impact of The Quality of Early Mathematics Instruction on Mathematics Achievement Outcomes". The author recruited 73 early childhood teachers and 546 students (Pre-K to 3rd grade) as participants in the study. The author used a test ((HIS-EM (The Early Math Collaborative, 2011), WJ-AP subtest (Woodcock et al., 2011)), observation, and questionnaire (online survey) for data collection. Descriptive and regression analyses were utilised for data analyses (three-level hierarchical linear modelling (HLM) analyses). The findings indicated that while mathematics education in the observed classrooms varied in quality, it was generally

mediocre. Additionally, a strong positive correlation between learning outcomes and the quality of early mathematical education was discovered.

Mazana et al. (2020) conducted a study to examine the mathematics performance of students through analyses of data and also the perceptions of teachers towards the poor performance of students in Tanzania. The study employed both qualitative and quantitative methods of research. Data for the study was obtained from the National Examination Council of Tanzania and the College of Business Education. The data included the performance of primary, secondary and tertiary students from 2008 to 2016. The authors also conducted 28 semi-structured interviews for selected teachers and lecturers purposively selected for the study. The authors utilised descriptive statistics to analyse quantitative data and content analyses for the qualitative data. The findings of the analyses revealed a high failure rate in primary and secondary schools, particularly at the lower secondary level. It was also realised that most teachers and lecturers had mixed emotions towards students' mathematical abilities and the teaching-learning environment.

Nugroho Yanuarto et al. (2021) conducted a study titled "ICT Literacy Level of Indonesian Senior High School Mathematics Teachers". The study's objective was to explore the ICT literacy level of high school Indonesian mathematics teachers. The study was a quantitative cross-sectional survey. The study sample includes 235 high school mathematics teachers. The researchers employed descriptive (frequencies and percentages) statistics for data analyses. Analyses of the data gathered showed that the level of comprehension of ICT use and operation, ICT-rich pedagogy, teaching and professional participation of ICT, social ecology, and teaching are all classified at the level of access to ICT.

Al-Abdullatif and Alsaeed (2019) investigated the degree to which maths teachers' practises at their institutions and in their classrooms equipped with technology reflect Visible Learning (VL) through a study titled "Evaluating visible learning: Mathematics teachers' practices in technology-enhanced classrooms". The researchers utilised a Visible Learning Scale (VLS) for data collection. Participation in the study was restricted to 119 in-service mathematics teachers who were randomly chosen. The participants voluntarily accepted to be part of the study. For analyses of the data collected, the researchers utilised descriptive statistics (means, standard deviations,

frequencies and percentages), ANOVA, comparison of means and MANOVA. The study's findings indicated that Saudi mathematics teachers used evidence-based VL practises to improve and develop students' achievements and growth to a modest to a large extent. The findings additionally showed that instructors' practises are improved to significantly impact students' learning progress when they have a higher degree of information and communication technology (ICT) integration competency.

Mahmud et al. (2019) conducted a study titled "Impact of School Location and Professional Qualification on Level of Giving Feedback Among Primary School Mathematics Teachers in Oral Questioning Process ". The researcher aimed to determine how primary school maths instructors' comments on oral questioning in the classroom were influenced by the school's location and professional background. Employing a quantitative survey as a research method, the researchers used simple random sampling to select 158 primary school mathematics teachers (classes 1 to 6) for the study. Data was gathered via a questionnaire. Using SPSS, the researchers employed descriptive (frequencies and percentages) and inferential (Levene's test and two-way ANOVA) statistics for data analyses. The study's findings revealed that location and professional qualification do not influence feedback during oral questioning in the classroom. It also showed that primary mathematics teachers engaged very well in giving feedback to student responses in oral questioning activities.

Ogbonnaya (2019) wanted to explore how reliable secondary school students' evaluation of mathematics teaching was. The researcher conducted a study titled "The Reliability of Students' Evaluation of Teaching at Secondary School Level" to achieve this objective. The study used a quantitative descriptive research method and a survey research design. The researcher conveniently selected North West Province and schools in South Africa for the study due to the proximity of the province and schools to the researcher. Eight Grade 11 mathematics were used for the study. The mathematics teachers involved consented to their classes being used for the study. The study's participants were eight (8) teachers and 194 students. A questionnaire was employed to collect data. In SPSS, the Average Deviation Index (ADI) and Intraclass Correlation Coefficient (ICC) of the student's teacher evaluations for each item were computed to analyse the data. A one-way random effects, absolute agreement, multiple measurements model with a 95% confidence interval was used to calculate

the ICC. The study's findings revealed that Student's Evaluation of Teaching might provide a reliable measure of secondary school mathematics teachers' practices.

Gürbüz and Yıldırım (2016) conducted a study titled "An Investigation of Mathematics Anxiety of Primary School Teachers". The researchers aimed to explore the primary school mathematics teachers in Turkey anxiety levels and the variables that affect anxiety levels. The research was a survey model. The study participants were 559 randomly selected primary school mathematics teachers in Turkey. Criterion sampling was also used to select participants. A questionnaire (Mathematics Anxiety Scale) was employed to collect data. The researchers employed descriptive statistics (frequencies and percentages), t-test, ANOVA and Tukey test. It was revealed that: 1) the anxiety scores of the teachers were at the level "I am a little anxious a little", 2) Teachers' anxiety levels and the gender variable differed significantly, 3) female teachers' anxiety levels were high compared to their male counterparts 4) the anxiety of the teachers decreased with increase in age and tenure 5) Primary school teaching programme graduates had lower levels of anxiety than those who had graduated from other programmes, 6) Teachers of mathematics who enjoy their jobs report less anxiety than those who do not.

Amoo and Disu (2012) conducted a study titled "School Environmental Factors and Mathematics Teaching Effectiveness: Implication for E-Learning". The researchers aimed to explore what pre-professional mathematics teachers believe are the factors that can influence the effective teaching of mathematics in secondary schools. The study was an ex-post facto research type. The study's participants were 115 Postgraduate Diploma in Education students. The participants were teachers with different demographic backgrounds. The researchers constructed two questionnaires as tools for data collection. Data analyses were done using descriptive statistics, t-tests, and ANOVA. The findings of this study suggest that while discussing the effectiveness of mathematics education, experiences, qualifications, and gender are significant and should be considered.

2.1.3.1 Summary of the Review of Journal Articles Conducted Abroad on Mathematics Teaching at School Level

The researcher reviewed fifteen (15) journal articles on mathematics teaching at the school level. The research methodologies used by the researchers of the

reviewed studies include quantitative methods, descriptive surveys, quantitative surveys, case studies, experimental studies, mixed methods studies, and comparative studies. Most of the studies reviewed employed the quantitative survey methodology. Seven (7) of the fifteen journal articles were quantitative surveys, three (3) were descriptive surveys, and there is one (1) study each of comparative study, case study, experimental, mixed method study and ex-post facto study.

The studies reviewed were conducted by Mohamed, Khalil and Awaji (2023), Yuan et al. (2023), Wondem, Tesfamicael and Getahun (2023), Yao and Zhao (2022), Záhorec, Hašková and Hrmo (2022), Wardat, Belbase and Tairab (2022), Moh'd et al. (2021), Cerezci (2020), Mazana, Montero and Casmir (2020), Nugroho Yanuarto, Maat and Husnin (2021), Al-Abdullatif and Alsaeed (2019), Mahmud et al. (2019), Ogbonnaya (2019), Gürbüz and Yıldırım (2016), and Amo and Disu (2012).

The studies concentrated on Mathematics teachers' awareness of effective teaching practices, factors influencing teachers' use of dynamic mathematics software in China, the Impact of the Institutional Environment on Mathematics Education, the mathematics teachers' technology integration practices to be able to offer assistance to them, mathematics teachers' concept mapping application at the primary level and verify its quantitative impact on education, Perceptions and self-reporting behaviours of maths teachers while teaching for trends, Assessing the Level of Secondary Mathematics Teachers' Pedagogical Content Knowledge, association between learning results and the calibre of early mathematics instruction, explore what pre-professional mathematics teachers believe are the factors that can influence the effective teaching of secondary school mathematics, the primary school mathematics teachers in Turkey anxiety level and the variables that affect the anxiety of mathematics teachers, and the Reliability of Students' Evaluation of Teaching at Secondary School Level.

Data collection was through questionnaires, interviews, observations, test scores, and the Visible Learning Scale. The researchers utilized descriptive statistics, t-tests, regression analyses, content analyses, ANOVA, MANOVA, Levene's test, Tukey test, Shapiro–Wilk test, thematic analyses, logistic regression analyses, Mann-Whitney U test, the chi-squared test of independence, one-sample t-test, and independent sample test for data analyses.

2.2 Review of Related Doctoral Thesis Conducted Abroad

The researcher reviewed doctoral theses related to the study conducted abroad. The review sequence was General Teacher Education, Mathematics Teacher Education, and Teaching Mathematics at the School Level.

2.2.1 Doctoral Studies Conducted on General Teacher Education Abroad

Valdez (2022) study on "Teacher Educator and Preservice Teachers' Efforts to Enact Justice-Centered Science Pedagogy during Covid-19". The researcher's goal was to examine the perceptions and implementations of justice-centred scientific teaching by a science teacher educator and a group of preservice secondary science teachers. The study was a multiple-stage case design. The researcher purposively sampled nine (9) secondary science preservice teachers and collected data through semi-structured interviews and observations. The researcher also analysed the content of the institutions' course websites. Thematic analyses were utilised for data analyses. While preservice teachers reported focussing on academics, eliciting student ideas, framing students as knowledge and culture producers, and prioritising building positive relationships with students, few reported incorporating social justice science issues into their science lessons. These findings show that the pandemic hindered the implementation of justice-centred science pedagogy.

Orr (2022) conducted a study titled "Examining Teachers' Preparation for Effective Coteaching". The study aimed to understand the preparation teachers received for coteaching. The study employed a qualitative case study design to create an in-depth understanding of and investigate a contemporary issue. Participants in the study were four school principals, four teachers, and four special education directors. The researcher collected data for the study by interviewing four school principals, four teachers, and four special education directors. The researcher utilised Hatch's topological analysis to identify themes relevant to the research objectives for the analysis face of the study. According to the study's findings, few college courses on co-teaching were offered throughout teacher education training, participants had little experience co-teaching before being given a co-teaching position, and few professors served as co-teaching role models. In addition, they recognised a need for ongoing training with regular follow-up and evaluation, as well as training for administrators on how to evaluate co-teachers. Better educating teachers for co-teaching classrooms

and increasing student learning through the creation of cooperative communities of practice among co-teachers, district administration, and higher education faculty are two implications for positive social change.

Grana (2022) conducted a study titled "An Examination of Culturally Responsive Teaching Practices and the Preparation of the Preservice Teacher". The study evaluated teachers' education programmes and explored how they prepare preservice teachers with culturally responsive teaching practices. The study was a Mixed Method Study. The study's participants included preservice teachers, administrators, and curriculum leaders. A questionnaire and interview schedule were utilised for data collection. Documents were also reviewed for more insight into the study. Data analyses were descriptive statistics, ANOVA for quantitative data, and thematic analyses for qualitative data. The study revealed more similarities than differences between the teacher preparation programmes. According to the study, most administrators, curriculum specialists, and preservice teachers advised early exposure to varied field experiences, texts, and materials to facilitate a deeper grasp of culturally responsive teaching strategies.

Bradley (2022) study titled "Black Male Teachers: Their Decision to Enter Teacher a Preparation Program" examined how Black male teachers describe their experiences and values that influenced their decision to enter a teacher preparation programme in Southeast Louisiana public school systems. The study was a qualitative descriptive study. Twenty-seven (27) black male teachers who had finished a teacher training program in public school districts in Southeast Louisiana were chosen by the researcher using purposive sampling. An interview schedule was used for data collection. For data analyses, Braun and Clark's six steps for thematic analyses were used. According to the results of a study, Black male teachers identify their desire to give back to the community, strong familial support, a conviction in the importance of education, and mentoring experiences as important reasons for enrolling in a teacher preparation program.

Akagi-Bustin (2022) conducted a study titled "Does Preservice Teacher Evaluation Vary by Location?". The study aimed to understand better the factors influencing the success of student teaching for teacher education candidates. The study was a quasi-experimental design. The researcher employed a purposeful sample to select roughly

400 participants. The participants were preservice teachers in their student teaching in the 2018/2019 and 2019/2020 academic years. Data was gathered from archival sources, test scores, GPA of students, and performance results during clinical and field experience. The researcher used Microsoft Office Excel, SPSS and R software to analyse data. Race/ethnicity and gender are factors that influence the Missouri Educator Evaluation System (MEES) evaluation ratings depending on the student teaching school's geographic area, according to the statistical analysis results that address the researcher's questions. This displayed that preservice teachers of non-White race and those who identify as female earned lower evaluation scores from their CT and US.

Glass (2021) conducted a study titled "The Relationship between Preservice Teachers' Social-Emotional Competence and Teacher Burnout, Secondary Traumatic Stress, and Compassion Satisfaction". The author aimed to investigate the relationship between Social and Emotional Competence (SEC) and professional quality of life factors in preservice teachers. The study was a non-experimental correlational design. The author utilised power analyses to select 43 preservice teachers as participants for the study. The researcher used a questionnaire (Test of Regulation in and Understanding of Social Situations in Teaching (TRUST), Professional Quality of Life Scale Version 5 (ProQOL 5), and demographic questionnaire) for data collection. Multiple regression using SPSS was employed for data analyses. There were no statistically significant associations between emotion regulation and relationship management and the degrees of burnout, STS, and compassion fulfilment among preservice teachers.

Additionally, no significant correlations between emotion regulation and burnout, STS, or compassion fulfilment were found when the participant's school setting and level were changed. When participants' greatest degree level and topic area were taken into account, the results showed a significant correlation between relationship management and burnout. A presentation and discussion of the investigation's findings are provided.

Durieux (2021) conducted a study titled "Is Teacher Efficacy Influenced by the Teacher Internship Mode? A Collective Case Study Exploring the Self-Efficacy of Preservice Teachers". The researcher aimed to explore how preservice teachers perceive their teacher efficacy based on a specific internship model. The study was a

qualitative case study. The researcher purposively sampled four preservice teachers for the study. A questionnaire and interview schedule were used for data collection. The researcher used MAXQDSA (VERBI software, 2019) to manage the data and descriptive statistics for the analyses and employed narrative vignette descriptions, a meta-matrix and cross-case analysis to present the study findings. The study's findings revealed that none of the internship models was shown to be more effective than the others. It was observed that preservice teachers believed their efficacy rose due to real-world experience working with students, college lesson plan expectations, and the use of evaluation with students.

McKown (2021) studied "Instructional Strategies in Teacher Preparation: Are We Building Efficacy in Beginning Teachers?". In addition to determining whether andragogical and constructivist techniques were employed in their educator preparation program, the researcher aimed to investigate how first-year teachers perceived their own self-efficacy at the start and finish of their first year in the classroom. The researcher employed purposive sampling for the sampling stage of the study. Using Likert-type scale statements and open-ended questions, a modified Delphi method was employed to collect more thorough information. Descriptive statistics were used for data analyses. The study's findings reveal that teachers' confidence in their capabilities and capacity to organise engaging classes, integrate curriculum, and administer assessments remained unchanged during the school year. However, confidence declined in handling classroom management, arranging active participation, monitoring time allotted for responsibilities, and conducting assessments.

Lancaster (2021) investigated the Teacher Education Programme and the Hiring of Newly Certified Teachers in At-Risk and Non-At-Risk Schools. The study looked at the first occupations students in the university teacher preparation program decide to pursue after earning an education degree. The study was a mixed-method study. All preservice teachers enrolled in the programme during the spring semester of 2019 were involved in the study. Six (6) white women and one (1) white guy, aged 18 to 24, two between 25 and 34, and one between 35 and 44, made up the seven participants in the qualitative phase. The researcher employed an open-ended questionnaire and secondary data from the State Department of Elementary and Secondary Education. The secondary data were analysed using two-population z-tests

and regression analyses, whilst the qualitative data were analysed thematically. The qualitative findings are inconsistent with the quantitative data, indicating that recent graduates are equally likely to enter a non-at-risk, at-risk, or failing school. The qualitative data indicated that many elements influenced job decisions, and there was no evidence that one thought or factor was more significant than another.

Koenig (2021) studied "How Well Prepared Are They, Description of How Teacher Education The goal of Oregon's programs is to prepare aspiring teachers for inclusion, diversity, and equity. The study was intended to find out how Oregon's directors of teacher education intend to train teacher candidates for equity, diversity, and inclusion. The study was qualitative. The researcher used purposive sampling to select five programme leaders who comprised 46% of the population during the study. An interview schedule was used for data collection, and thematic analyses were utilised to analyse the participants' transcribed interviews. The study's findings revealed substantial correlations between state and national standards and what is taught in each preparatory programme. Still, interpretation and focus on individual requirements vary from programme to programme.

Horne (2021) conducted a study titled "Learning by Doing: A Case Study Exploring Mentor Teachers' Experience in A Teacher Preparation Program through the Lens of Communities of Practice and Transformative Learning" to examine how a change in teacher education programs impacts the mentor teachers' experience. The study was a case study. The researcher employed the purposive sampling technique to select four mentors for the study. An interview schedule and a questionnaire were utilised for data collection. Thematic analysis using codes to identify themes in the data was employed for data analyses. The analysis of the collected data revealed how mentoring is a disorienting experience and how communities of practice and transformative learning generate a transforming experience for mentor teachers.

Herman (2021) conducted a study titled "Student Perceptions of Online Peer Learning in Preservice Music Teacher Education: Motivation, Social-Emotional Learning, and Classroom Climate". Through the self-reported lenses of classroom atmosphere, social-emotional learning, and student motivation, the study investigated how preservice music teacher education students perceived an online Peer-assisted Learning (PAL) experience. In a quantitative survey design, the researcher utilised a

maximum variation sampling approach to select four participants for the interview. A questionnaire and interview schedule were employed for data collection. The quantitative questionnaire received a response rate of 79.4% from 27 out of 34 students, generating a response rate of 79.4%. Data were analysed using descriptive statistics with R statistical programming software. According to the findings, student opinions were likely influenced by their unique motivation orientation, aptitude for social-emotional learning, and impression of the online classroom setting. The participants' unique experiences with group interactions, peer feedback, student connectivity, and course structure offered further context for these findings.

Carter (2021) conducted a study titled "The National Teacher Shortage Crisis: Understanding Teacher Attrition and Turnover". The researcher aimed to understand teacher shortages and attrition. The study was an exploratory design. To answer the research questions, the researcher purposively sampled eight K-12 teachers with three to twenty years of experience. An interview schedule was employed to collect data, and thematic analyses were utilized for data analyses. Key findings revealed that discontent with one's employment influences teacher turnover. Lack of administrative support, classroom management concerns, low morale, job expectations, low compensation, and inadequate preservice training significantly impact teacher turnover.

Henning (2021) conducted a Multiple Case Study to Investigate the Preparation of Teachers for A Stem Endorsement. The study aimed to answer that call and examine how higher education teacher preparation programmes prepare teachers to teach integrated STEM in the classroom. The researcher purposively sampled nine participants for the study. The tools used for data collection were a demographic questionnaire, semi-structured interviews, and digital documents. For data analyses, the researcher employed NVivo. The study's findings revealed that the combination of the three studies revealed a transition from a broad overview of the STEM endorsement programmes to techniques courses for STEM endorsement in the programme and finally to a particular outcome of that programme through the perspectives of teacher-graduates.

Barker-Fludd (2021) conducted a study titled "A Quantitative Study Examining the Relationship between Special Education Teacher Preparation and Standardised

Achievement Scores". The researcher sought to determine whether and to what degree standardised achievement scores in special education are correlated with teacher preparation in instructional skills and pedagogical strategies. The study was quantitative correlational research. The participants in the study were special education teachers in New York State public schools (NYS). A survey of 82 special education teachers was used for the study. The researcher constructed a new instrument using an eight-step developmental model Churchill (1979) created for data collection. Data analyses were by exploratory factor analysis. The practical implications of the findings advised necessary adjustments for curriculum writers, policymakers, educators, and state credentialing lawmakers.

Hernandez (2020) conducted a study titled "Examining Preservice Teacher's Self-Efficacy Development Throughout Teacher Education" to understand preservice teacher self-efficacy development and perceptions of teacher education programme effectiveness for better programme improvement. The study was a casual comparative mixed-method design. The population of the study was 48 preservice teachers. The researcher purposively selected three to ten preservice teachers who were willing to be used for the study's qualitative aspect. The researcher used Tschannen-Moran and Hoy's (2001) Teachers' Sense of Efficacy Scale (TSES) Short Form, questionnaire and interview schedule for data collection. Descriptive statistics, ANOVA, and thematic analyses were utilised to analyse the data. Vicarious experiences were the most powerful source of self-efficacy for preservice teachers. Emotional and physiological states had much less of an impact on efficacy beliefs than verbal persuasion and mastery experiences. The two most advantageous aspects of teacher education were the influence of the professional support network and the coursework's real-world relevance. Two difficult aspects of teacher education were a gap in the professional support system and a lack of relevance or real-world application of the coursework.

Rennie (2020) conducted a study titled "Mind the Gap: A Crosswalk Analysis of California Teacher Preparation Standards and Public K-12 Local Teacher Evaluations". The researcher's goal was to identify the local public school districts that do not evaluate preservice preparation coursework criteria and the evaluation items that do not correspond with those standards. The study employed the instrumental case study design methodology. The author used nine school districts for

the study. Data was obtained from the selected schools' documents about “teacher evaluation” or “teacher observation” forms. The researcher used content analysis and critical discourse analysis to analyze the data. Based on preliminary research, it appears that many districts use the California Standards for the Teaching Profession, which were developed by the same California regulatory body that developed and approved the California Teacher Performance Expectations. The preliminary findings also included assessments from school districts that were not connected to the California Standards for the Teaching Profession. These evaluations were “crosswalked” with the Teacher Performance Expectations to determine alignment and non-coverage areas.

Peteman (2012) conducted a study titled “Implications of Constructivist Pedagogy in Teacher Education: A Comparison of Problem-Based Learning vs Non-Problem-Based Learning in Teacher Education Programs”. The researcher sought to determine how preservice teachers who engaged in Problem-Based Learning (PBL) in their content courses differed from those who did not in terms of their performance on the state licensure exam (Praxis II Principles of Learning and Teaching, PLT). The study was a mixed-method study. The researcher adopted convenient sampling to select 263 preservice teachers enrolled in seven off-campus cohort groups for the study. Data for the qualitative part of the study was gathered from nine professors who taught content courses through interviews. The study’s dependent variable was scored from the Principle of Learning and Teaching Exam. ANCOVA was used to detect potential differences between the groups. The qualitative data were explored using inductive analysis. According to the PLT state licensure exam, the PBL approach did not enhance the applicants' pedagogy or topic understanding for the preservice teachers who took part in the PBL implementation. The qualitative data analysis suggested that professors and preservice teachers perceived portions of the PBL process as beneficial in promoting critical thinking and student autonomy.

DePeza (2010) investigation titled “No Teacher Left Behind: Transition Management in Teacher Education: A Case Study”. The qualitative case study (both exploratory and descriptive) studied the management and implementation of the transition from in-service to preservice teacher education in Trinidad and Tobago in 2006, as well as the perspectives of 21 participants regarding the transition process. The researcher drew the sample from the academic staff and administrators of the two teacher

colleges and the committees of stakeholders and administrators of Trinidad and Tobago's restructuring teacher education process. Criteria of sufficiency and saturation (purposive sampling) determined the selection of a sample of 21 participants for the study. Documents, interview schedules and observation schedules were utilised for data collection. Inductive analysis through themes, document analyses, and time series analyses were the techniques for data analyses. The findings demonstrated that the target audience anticipated and appreciated the change, but the manner and technique of the change were unexpected and undesirable. The changeover was managed autocratically, and the reorganisation process was undertaken without educational leadership. Indeed, as the system evolved, the teacher fell behind.

Ianniello (2009) conducted a study titled "Concerns, Uses and Reflections of Teachers in Hybrid Teacher Education Program" to examine the concerns, levels of use, and reflections of interns in a hybrid teacher education programme, including components of traditional and alternative programmes. The study utilised qualitative and quantitative methods of research. The study participants were 43 intern teachers in a hybrid education system. A questionnaire and interview schedule were used for data collection. The researcher also requested the use of andragogy from Elsevier Publishing Company. From low to high stage scores, the questionnaire was analysed and interpreted following the stages of worry. The interviews were transcribed and analysed. The researcher also employed descriptive statistics in the analysis process. The findings revealed that participants' perceptions of instruction changed during the three phases of concern (self, task, impact). Additionally, they raised their use of teaching in all areas and their surface and deep knowledge.

2.2.1.1 Summary of the Review of Doctoral Studies Conducted Abroad on General Teacher Education

From doctoral studies reviewed concerning general teacher education, the researcher reviewed twenty (20) Studies. The research methodologies utilized by the authors of the reviewed studies include multiple-stage case design, qualitative case study design, mixed method design, qualitative descriptive study, quasi-experimental design, non-experimental correlational design, qualitative design, quantitative survey design, exploratory design, quantitative correlational design, casual comparative mixed-method design, and an instrumental case study design. Eight (8) of the twenty-

one studies reviewed were case studies, five (5) were mixed method designs, three (3) were qualitative studies, two were correlational studies, and one (1) each were quantitative and exploratory studies. The studies were conducted by Valdez (2020), Orr (2022), Grana (2022), Bradley (2022), Akagi-Bustin (2022), Glass (2021), Durieux (2021), Mckown (2021), Lancaster (2021), Koenig (2021), Horne (2021), Herman (2021), Carter (2021), Hennings (2021), Barker-Fludd (2021), Hernandez (2020), Rennie (2020), Peteman (2012), DePeza (2010), and Ianniello (2009).

The studies concentrated on examining science teacher educators and understandings and implementations of justice-centered scientific instruction by aspiring secondary science teachers, understanding the preparation teachers received for coteaching, evaluating teacher education programs and exploring how they prepare preservice teachers with culturally responsive teaching practices, investigating how black male teachers describe their experience and how that influence their decisions, better understanding the elements that affect teacher education candidates' effectiveness in student teaching, investigating the connection between preservice teachers' professional quality of life aspects and social and emotional competence (SEC), explore how preservice teachers perceive their teacher efficacy based on a specific internship model, investigating the self-efficacy perceptions of first-year teachers at the start and finish of their first year in the classroom, as well as the first occupations that students choose to pursue while pursuing an education degree, how teacher education intend to train teacher candidates for equity, diversity, and inclusion, student opinions of an online Peer-assisted Learning (PAL) course in a preservice music teacher education course through the self-reported lenses of classroom climate, social-emotional learning, and student motivation, and how a change in teacher education programs affects the experience of mentor teachers, understanding teacher shortages and attrition, how higher education teacher preparation programs prepare teachers to teach integrated STEM in the classroom, what extent a relationship exists between teacher preparation in pedagogical methods and teacher preparation in instructional skills and standardised achievement scores in special education, preservice teacher self-efficacy development and perceptions of teacher education program effectiveness for program improvement, the training of white preservice teachers' preparedness to be racially literate, district evaluation items and preservice preparation coursework standards, the

variations between preservice teachers who took part in Problem-Based Learning (PBL) and those who did not in their topic courses in terms of their performance on the state licensure exam (Praxis II Principles of Learning and Teaching, PLT).

The studies were conducted utilizing data collection tools, including interview schedules, observation schedules, questionnaires, documents, archival sources, test scores, GPA of students and practical results, digital documents, and memo Scripts. The researchers used content analyses, thematic analyses, Hatch's topological analysis, descriptive statistics, ANOVA, multiple regression, narrative vignette descriptions, a meta-matrix, cross-case analysis, two-population z-test, regression analyses, exploratory factor analyses, inductive analyses, Critical Discourse Analysis, ANCOVA, time series analyses, and the protocols outlined by Hall et al. (2006) for data analyses.

2.2.2 Doctoral Studies Conducted on Mathematics Teacher Education Abroad

Pelaez (2022) conducted a study titled "Teaching Data Science for Social Justice to Pre-Service Mathematics Teachers" to investigate the possibilities of teaching data science to pre-service math teachers socially consciously to emphasise how statistics and data science link with racism and race. The author employed design-based research (quantitative and qualitative data collection methods) for the study. The study participants were 1470 students from 36 statistics courses across 33 institutions. Data collected for the study included pre- and post-test assessment, pre and post-task-based interviews and classroom data. The author utilised paired sample t-test, paired Wilcoxon signed-rank test and thematic analyses for data analyses. From the findings, after learning the usual statistics and data science topics, students were more involved in dialogues regarding race and racism. Also, after discussing selecting, randomisation, training, and 307 testing datasets, students could determine how the machine learning procedure was racially biased.

Nazelli (2021) intended to understand the types of learning afforded or impeded by a modified lesson study activity within an early pre-service Mathematics content course for elementary school teachers. The author conducted a mixed-methods interpretive case study titled "Understanding Pre-Service Elementary Mathematics Teacher Learning in an Early Lesson Study Experience". Participants in the study were eleven Pre-Service Teachers (PSTs) who were enrolled in a mathematics subject course for

aspiring primary school teachers at a research institution in a major Midwestern city. The author utilised the Learning Mathematics for Teaching-Teacher Knowledge Assessment System (LMT-TKAS) (Hill et al., 2007) Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs et al., 2000). Data were also collected through a discussion of transcripts and reflections. The author utilised grounded theory, constant comparative method, thematic analyses and descriptive statistics for data analyses. This study demonstrates that a modified lesson study activity could assist pre-service teachers in learning a lot during the first phases of their training. The lack of improvement in mathematical knowledge for teaching during the lesson study activities was also identified as a worry that needs additional investigation.

Kalinec-Craig (2012) conducted a study on "A Case Study of Four Latina/O Pre-service Teachers in Learning to Teach Mathematics for Understanding and Integrate a Child's Out-of-School Mathematical Knowledge and Experiences" intended to comprehend Latina/o PSTs' perspectives while they study effective techniques for teaching children from linguistically and culturally diverse backgrounds in mathematics. The researcher utilised the phenomenological methodology of research for the study. The participants of the study were four pre-service teachers (PST). The researcher used a questionnaire, interview schedule, observation schedule, assignment artefacts and audio recordings of methods course discussions for data collection. Grounded theory, inductive analyses, thematic analyses, and descriptive statistics were employed for data collection. All PSTs agreed that instructors should recognise and use children's mathematical knowledge, experiences, and languages gained outside of school in their Mathematical lessons. In addition, the PSTs valued children's knowledge, experiences, and language since doing so assisted them in learning mathematics; nevertheless, it was not yet obvious how children would utilise their experiences to acquire mathematics. Further, PSTs lacked experience in helping students apply their outside-of-school skills and experiences to mathematics study.

Ferner (2013) conducted a study on "Elementary Teacher Candidates' Images of Mathematics, Diverse Students, and Teaching: An Exploratory Study with Implications for Culturally Responsive Mathematics Education". The study investigated how prospective elementary teachers view educating mathematicians in a multicultural setting. The study was a critical constructivism qualitative instrumental multiple case study. The study used opportunistic sampling to focus on four

participants. The researcher used a questionnaire and interview schedule for data collection. Holistic coding and inductive analyses were used for data analyses. The study revealed that the participants' conceptions of mathematics, students, and mathematics education were interconnected.

Elrod (2017) conducted a study titled "Exploring Mathematics Teacher Education Fieldwork Experiences through Storytelling". During a year-long final fieldwork experience at the end of middle school, the researcher set out to examine three novices, their mentors from school and their mentors from the university. The study was a multiple-case study. The researcher selected three residents and their cooperating teachers as study participants. Tools for data collection were interview schedule, observation schedule, fieldwork artefacts and practitioner-researcher journal. Thematic analyses were used for data analyses. The study supports the idea that story-sharing fosters empathy, which can lead to more fruitful and successful learning experiences for beginners. Specifically, open communication offered the collaborators a forum for admitting educational differences, negotiating fieldwork expectations, and establishing and achieving novices' professional goals.

Mccoy (2011) conducted a study titled "Specialised Mathematical Content Knowledge of Pre-service Elementary Teachers: The Effect of Mathematics Teacher Efficacy". The researcher looked at the connection between pre-service primary teachers' increasing specialised mathematical content knowledge and mathematics teacher efficacy. The quantitative study had 101 participants, including elementary education majors enrolled in two courses on mathematics content and methods. The tools used in the study were a questionnaire (Mathematics Teaching Efficacy Beliefs Instrument (Enochs et al., 2000)) and a Common Content Knowledge Instrument used by another university for data collection during a similar study. For data analyses, the researcher utilised multiple regression analyses and t-tests. During the mathematics methods/content course, the level of specialised mathematics subject knowledge of pre-service teachers grew significantly, according to the findings of this study. Personal mathematics teacher efficacy, expected mathematics teaching outcomes, and common mathematical topic understanding all increased significantly. In addition, the study found that the initial level of specialised topic knowledge strongly predicted the development of female students' mathematics teacher efficacy.

2.2.2.1 Summary of the Review of Doctoral Studies Conducted Abroad on Mathematics Teacher Education

The researcher reviewed six (6) doctoral theses conducted abroad involving Mathematics Teacher Education. Out of the seven (6) reviewed studies, two (2) were case studies, and one each (1) was design-based research, phenomenological, exploratory and quantitative studies. The reviewed studies were conducted by Pelaez (2022), Nazelli (2021), Kalinec-Craig (2012), Ferner (2013), Elrod (2017), and Mccoy (2011).

The studies focused on how a modified lesson study activity within an early pre-service mathematics content course for elementary school teachers can either facilitate or hinder learning, and how a social-oriented approach to teaching data science to pre-service math teachers can highlight the intersectionality of race and racism with statistics and data science, the experiences of Latina/o PSTs as they learn about effective strategies for teaching Mathematics for linguistically and culturally diverse students, perceptions of secondary mathematics teacher training concerning standards, subject knowledge, and content pedagogical expertise, prospective elementary teachers view educating mathematicians in a multicultural setting, examining the relationship between pre-service elementary teachers' development of specialised mathematical content knowledge and the effectiveness of mathematics teachers, as well as novices, their school-based mentors, and their university-based mentors who worked together during a year-long final fieldwork experience at the end of a middle school.

The researchers utilized tests, interview schedules, transcripts and reflections, questionnaires, observation schedules, assignment artefacts, audio recordings, artefacts, and practitioner-researcher journals for data collection. Data were analysed employing paired sample t-test, paired Wilcoxon signed-rank test, thematic analyses, grounded theory, constant comparative method, descriptive statistics, grounded theory, inductive analyses, thematic analyses, descriptive statistics, multiple regression analyses and t-tests.

2.2.3 Doctoral Studies Conducted on Mathematics Teaching at the School Level Abroad

Zingerman (2021) conducted a study titled "A Qualitative Descriptive Study of Teachers Implemented Instructional Strategies and Perceived Effectiveness for Foundational Mathematics Literacy". The study sought to address early primary children's deficiencies in early mathematical literacy skills, particularly those about fluency with multiplication facts. The study was based on the cognitive learning theory. The study's target population was 15 mathematics teachers for elementary grades 3-6. The researcher conducted focus groups and semi-structured interviews using interview guides to gather data. MAXQDA was utilised for data collection. According to the study, teachers consider fluency with multiplication facts a fundamental mathematical ability. It was also discovered that teachers add methods they believe work best to their educational strategies when given time.

Moran (2021) conducted a study on "An Investigation of Bilingual Additive Mathematics Instructional Practices and Achievement on State and Local Mathematics Assessment for Fourth-Grade Latinx English Learner Students". The researcher used the quantitative, causal-comparative ex-post-facto design to examine differences in mathematics achievement between fourth-grade Latinx English Learners (EL) trained in English and Spanish in one-way dual/developmental additive basic bilingual language programmes but assessed in English. The researcher collected data from 276 Latinx EL pupils from six schools in three Illinois suburban districts. The researcher also used Math scores from the 2017-2018 and 2018-2019 spring Illinois Assessment of Readiness (IAR) and Measures of Academic Progress (MAP) assessments. The researcher resorted to ANOVA and ANCOVA for data analyses. When tested in English, the adjusted mean spring MAP and IAR scores for Latinx EL students receiving instruction in Spanish were statistically significantly higher than those receiving instruction in English. On the other hand, children who were taught in Spanish and assessed in English did not differ statistically significantly in their adjusted mean spring MAP or IAR maths scores. For the spring MAP and IAR, no differences in the methods of instruction or testing were found between socioeconomic status groups or genders.

Kulpa (2021) conducted a study on "An Investigation of Success Factors in a High School Algebra I Program" to investigate a high school Algebra I programme by examining possible relationships between teachers' views about teaching and learning mathematics, teachers' instructional techniques, students' academic self-concept in mathematics, and students' mathematics proficiency in an Algebra I course. The researcher used a quantitative method, a questionnaire, and an observation schedule to collect data from students and teachers during the 2016-2017 academic year. The student's final examination score for the academic year was also analysed for the study. The researcher employed the Pearson Product Moment Correlation Coefficient (PPMCC) to determine the relationship between the various variables. According to final semester statistics, there was only a statistically significant correlation between students' academic self-concept in mathematics and their general understanding of algebraic subjects.

Pearson (2021) conducted a study titled "Disrupting the Status Quo in Elementary Mathematics: Teacher Beliefs, Mindsets, Self-Efficacy, and Instructional Practices". The researcher wanted to investigate the relationship between detracking, teacher beliefs, mindsets for teaching, self-efficacy, and reported instructional practices. The study was a cross-sectional exploratory sequential mixed-methods design. The study participants were full-time mathematics teachers in Grades 1 through 5. The researcher used a questionnaire and perception scale for data collection. The researcher used descriptive and multiple regression for data analyses. The findings showed that teachers had a high self-efficacy for engaging learners in mathematics. Additionally, no significant difference was seen between teachers who encounter detracking and those who do not.

Prigodich (2021) conducted a study titled "Early Implementation of a Standards-Based Mathematics Curriculum: Understanding Teacher Perspectives and Concerns". In the first year of introducing Bridges in Mathematics, a standards-based primary school curriculum, the researcher set out to investigate teachers' concerns in US school districts. The study was a Collective Case study. To select participants from a cohort of K-classroom teachers who were using the Bridges in Mathematics, 2nd edition curriculum for the first time, the researcher employed purposive sampling. The researcher used a questionnaire and interview schedule for data collection. The study's findings showed that teachers' perspectives differ from different stages.

Walker (2021) conducted a study titled "Effective Instruction for Teaching Mathematics Strategy Transfer in an Elementary Setting: A Multiple-Case Study" to explore the phenomenon of strategy transfer in elementary Mathematics classrooms. The researcher utilised the qualitative, multiple case study. The researcher purposively selected three Mathematics instructional coaches based on their influence and expertise in Mathematics instruction. The participants were elementary coaches. The researchers used a questionnaire, interview schedule and lesson plans for data collection. According to the research, mathematics instructional coaches viewed a balanced mathematics block and modelling as successful instructional strategies. Furthermore, the results indicated that students need peer collaboration, practice, and modelling to succeed at strategy transfer and that curriculum pace and retention are barriers to strategy transfer.

Pomerenke (2022), in the authors' study "First through Third Year Secondary Mathematics Teachers' Mentoring Experiences: A Phenomenological Study", aimed to explore the lived experiences of first-to-third-year secondary mathematics teachers who were mentored and persisted in the profession. The study participants were seven Mathematics teachers with at most three years of teaching experience. The researcher used personal and focus group interviews for data collection. The interview transcriptions were thematically analysed, and inferences were made from the themes. From the study's findings, teachers' support includes personal, instructional, collegial, and classroom management. The participants also indicated that they were sourcing support from colleagues due to their proximity to them. Observations and criticism were valuable components of the mentoring experience, and participants accepted the valuable feedback to advance their careers. Lastly, participants' mentoring experiences were marked by imprecise expectations.

Abdeljaber (2015) conducted a study titled "High School Mathematics Teachers' Perceptions of Mathematics Education in Northwest Florida" to explore why high school students in the United States underperform in mathematics based on teacher perceptions of the existing curriculum and instructional methods utilised in high school mathematics classrooms. The researcher employed an open-ended questionnaire and interview schedule to investigate the opinions of twelve high school maths teachers in northwest Florida as part of a qualitative exploratory case study. Criterion sampling (purposive) was used to select the sample for the study. The survey

and focus group results were triangulated with lesson plans and other teacher artefacts. The study's findings stipulate that teachers are allowed enough time to teach, plan and collaborate. It was also discovered that teachers require more support from educational leaders in order to provide professional development that will help them abandon the traditional teaching approach that most teachers favour and adopt real-world, collaborative learning.

S. Kelly (2022) investigated 30 contextual parameters to identify major determinants of girls' worldwide mathematics achievement through a study titled "Judith Shakespeare's Problem: Using TIMSS to Examine Contextual Indicators in Girls' Mathematics Achievement". The researcher employed the three nested levels in the hierarchical linear model (individual, classroom, and nation). The study utilised cross-national scores and a contextual questionnaire for data collection. The researchers' model highlighted the efficacy of various policy measures by examining key characteristics of individual girls' education (home), classroom, and national levels and determining the greatest variability. The study discovered that the third (national) level explains a surprisingly large proportion of the variance in the mathematical achievement of girls.

Franzak (2019) conducted a study titled "Mathematics as a Racialized Space: An Analysis of Secondary Teachers' Beliefs of Teaching Mathematics to Latinx Students". The study's objective was to explore Mathematics teachers' beliefs about teaching the majority community of Latinx students using the qualitative collective case study approach. Two self-identified female Hispanic teachers and two self-identified white teachers—one male and one female—were among the study participants. The participants were either teaching in middle or high school in New Mexico. Interviews were employed for data collection. The themes from the analyses of the data collected include "(1) varied beliefs of Mathematics, the meritocracy of learning mathematics, teaching mathematics is a colourblind endeavour and the enduring power of deficit thinking". According to this study, the secondary mathematics classroom is a highly racially charged setting, and the way that math teachers' perspectives on mathematics intersect with their racial attitudes has a significant impact on Latinx pupils' capacity to learn the subject.

Rogers (2014) had the objective to "examine the differences between mathematics preparation and teachers' perception of self-efficacy for teaching mathematics at low and high-performing schools" through a study titled "Mathematics Teaching Self-Efficacy: A Descriptive Comparative Study of Teacher Preparation and Self-Efficacy at Low and High-Achieving Schools". The author employed the descriptive comparative method for the study. Sixty-nine (69) maths teachers participated in the study, 33 of whom were from underperforming schools and 36 from high-performing ones. Questionnaires conducted annually by the US Department of Commerce and MTEBI developed by Enochs et al. (2000) were adopted and adapted for the study. It was discovered that the teachers' mathematical preparation and self-efficacy levels were uniform. The level of preparation, Personal Mathematics Teaching Efficacy (PMTE), and Mathematics teaching outcome expectancy of elementary mathematics instructors from high-performing schools were marginally greater, but differences were not statistically significant.

Jackson (2021) studied "Middle School Mathematics Teachers Using Culturally Relevant Pedagogy to Improve Learning for Historically Marginalised Students" to identify mathematics teachers' experiences and instructional practises as they move towards culturally relevant pedagogical methods in the classroom. The study employed the narrative enquiry methodology to achieve its purpose. The study participants were five middle school mathematics teachers. Data was collected through an interview schedule, documents, and member checking. The researcher used thematic analyses to analyze the data collected. Also, vivo coding and axel coding were utilised in the analysis process. The study revealed that: 1) "set high expectations for their students to promote academic growth and development, and 2) desire meaningful and ongoing professional development".

Pelemo (2022) conducted a study titled "Parental Involvement - Investigating the Roles, Barriers, and Strategies of Effective Parent-Teacher Relationships in Middle School Math". The author conducted the study to examine the roles, challenges, and techniques for successful parent-teacher partnerships in middle school mathematics. Using a single data collection instrument, the author employed the qualitative case study research method to achieve the study's aims. Data collected was analysed thematically by transcribing and sorting for themes that arise from the data. The study participants were three (3) parents and three (3) Mathematics teachers. The researcher

conducted a semi-structured interview using an interview schedule for the study. The findings offered recommendations for parents, teachers, and school administrators for establishing an engaged parent-teacher collaboration in middle school mathematics.

Hicks (2021) conducted a study titled "Stealth Assessment: Teacher's Perceptions of How Digital-Based Educational Games Influence Teaching and Learning in the Middle School Mathematics Classroom". The study aimed to investigate how teachers view the effects of stealth assessment games on their teaching and learning in middle school maths classes. The study was a qualitative multiple-case study. The author purposively selected three participants for the study. It was ensured that the participants: "1) possess at least one year of mathematics teaching experience in a middle school classroom, 2) require both experience teaching with and without using stealth assessment games, and 3) have a middle school Mathematics teacher at the time of the study". Data collection utilised an interview schedule, physical artefacts, and participants' reflection notes. The author thematically analysed the data by coding and sampling the patterns within the qualitative data. Computer-Assisted Qualitative Data Analysis Software (CAQDAS) and vivo coding was employed in the analysis process. This research identified several patterns of why and how stealth assessment games can effectively guide instruction and promote the growth of middle school students' mathematics knowledge. The study indicates that students experience flow when playing stealth assessment games.

Willis (2022) aimed to investigate the factors that influence the mathematical instruction of upper elementary teachers in school districts within Southern California through a study titled "Teacher Experiences and Perceptions in Implementing Instructional Strategies for Fostering Student Engagement in Upper Elementary Mathematics". The author resorted to the qualitative phenomenological research method for the study. The author purposively recruited nine elementary Mathematics teachers as participants in the study. Semi-structured interviews with the participants through a virtual Zoom environment were employed for data collection. The data gathered was thematically analysed. Four major findings emanated from the analyses of data: "1) the first conclusion is indicative of teachers engaging students in small group instruction with academic rigour when teaching higher grade primary mathematics to push pupils to study, 2) teachers should ensure that the mathematics curriculum is student-centred and cognitively challenging so that students are actively

engaged and motivated to study, 3) teachers employing instructional strategies to engage and motivate pupils to study mathematics constitutes the third conclusion, and 4) the fourth conclusion is educators using technology from the 21st century into mathematics instruction to engage and motivate students to study".

Nichols (2022) investigated strategies focused on transforming advanced Mathematics spaces to benefit Black learners' self-efficacy and cultural identity through a study titled "Towards Black Students' Self-Efficacy in Advanced Middle School Mathematics: A Mixed Methods Participatory-Social Justice Research Study". The study employed mixed research methods, specifically the explanatory sequential core design, quan → qual. The researcher used an online survey (questionnaire) and interview schedule for data collection. The researcher selected four grade 6-8 students for the qualitative face of the study. A student was selected from the selected schools for the study. To make decisions from collected data, the author resorted to IBM SPSS (descriptive and inferential statistics) for the quantitative data and thematic analyses (by coding) for the qualitative data. The study used homogenous, purposeful, stratified, and operational construct sampling for the qualitative phase and cluster, criteria, and convenience sampling in the quantitative phase. Three conclusions were drawn from the study: "{1) Students who had a favourable attitude towards mathematics either had strong verbal and social persuasion scores or high mathematics self-efficacy scores, 2) Students with strong verbal and social persuasion scores and/or high mathematics self-efficacy scores had excellent teachers and/or supports for learning outside the classroom, and 3) Students with strong verbal and social persuasion scores or mathematics self-efficacy scores regularly exhibited a variety of relationships that aided their mathematical learning".

Edgington (2021) conducted a study titled "Understanding the Potential of Anticipation, Teaching, and Response to Struggle in the Learning of Mathematics." The study's objective was to investigate teachers' beliefs regarding the prospect of learning with productive struggle according to teachers' beliefs, anticipation, planning, teaching, and response to Mathematics struggles. The qualitative study utilized a semi-structured interview of four participants for data collection. The participants were three fifth-grade and one sixth-grade teacher whom the researcher purposively selected. The results prove that a teacher's opinions regarding the

function of struggle in mathematical learning directly influence the phenomena of productive struggle in that subject.

Cannon (2021) conducted a study titled "Young Adolescents' Opportunity to Develop Concept Images of Polygons in Middle School Mathematics Textbooks". The study's goal was to find out how young adolescents might be able to develop concept images of polygons in middle school math textbooks by being exposed to a range of polygon representations, polygon orientations, non-prototypical images, contexts, and image roles, as well as by being given developmentally appropriate tasks. The researcher resorted to content analysis methodology for the study. One popular textbook each from the publishers Pearson, Houghton Mifflin Harcourt, and McGraw Hill Education of 6th, 7th, and 8th-grade level were selected for analyses due to the dominance of these publishers regarding middle school Mathematics textbooks used in the USA. Online materials from the textbooks were not included in the study. Content analyses were employed to analyse the content of the selected textbooks. The study revealed that learners lack opportunities in three middle school mathematics textbook series to form solid mental representations of polygons.

2.2.3.1 Summary of the Review of Foreign Doctoral Studies on Mathematics Teaching at School Level

The researcher reviewed eighteen (18) foreign doctoral theses on Mathematics teaching at the school level. Of the eighteen (18) Studies reviewed, seven (6) were case studies, two (2) were mixed method studies, two (2) were phenomenological studies and one (1) each of the studies was a quantitative study, cognitive learning theory based, casual-comparative ex-post-facto, hierarchical linear model, descriptive comparative study, narrative enquiry and content analyses. The studies were conducted by Zingerman (2021), Moran (2021), Kulpa (2021), Pearson (2021), Prigodich (2021), Walker (2021), Pomerenke (2022), Abdeljaber (2015), S. Kelly (2022), Franzak (2019), Rogers (2014), Jackson (2021), Pelemo (2022), Hicks (2021), Willis (2022), Nichols (2022), Edgington (2021), and Cannon (2021).

The reviewed studies focused on how young adolescents could develop concept images of polygons in middle school math textbooks by being exposed to various polygon representations, polygon orientations, non-prototypical images, contexts, and image roles with developmentally appropriate tasks. teachers believes

regarding the prospect of learning with productive struggle and response to struggle in learning Mathematics, methods for changing advanced mathematics classrooms to enhance the cultural identity and self-efficacy of Black students, elementary in-service teachers' knowledge and opinions regarding the usage of representations explain their instructional use, Teachers' opinions about how students with specific learning disabilities (SLD) perform in inclusive high school maths classes, roles relationship, curriculum, or pedagogy teachers consider to have the greatest impact on instruction, elements that affect upper elementary teachers' mathematical education in school districts, as well as how instructors view the effects of covert assessment games on middle school math instruction, relationship between elementary teachers' Mathematical Knowledge for Teaching (MKT) and their implementation and adaptation of mathematical assignments to assist students' development of multiplicative reasoning, roles, challenges, and techniques for successful parent-teacher partnerships in middle school mathematics, the experiences and teaching strategies of maths teachers as they transition to culturally appropriate teaching techniques in the classroom, the disparities between teachers' perceptions of their own abilities and their preparation for teaching mathematics in low- and high-performing schools, the beliefs of Mathematics teachers about teaching majority community of Latinx students using the qualitative collective case study approach, contextual indicators in girls' mathematics achievement, low mathematical performance as determined by teachers' opinions of the current curriculum and teaching strategies used in high school math classes, the real-life experiences of first- to third-year secondary math teachers who received mentoring and continued in their careers, the transfer of strategies in elementary math classrooms, and the worries of US school districts in their first year of implementing Bridges in Mathematics relationship between detracking, teacher beliefs, mindsets for teaching, self-efficacy, and reported instructional practices, students' experiences and perspectives in mathematics, schools and communities, relationships between teachers' views about teaching and learning mathematics, teachers' instructional techniques, students' academic self-concept in mathematics, and students' mathematics proficiency in Algebra, disparities in fourth-grade kids' mathematical proficiency and early primary pupils' lack of early mathematics literacy skills, particularly those pertaining to multiplication fact fluency.

The researchers employed content analyses, descriptive statistics, inferential statistics, thematic analyses, item analyses, confirmatory factor analyses, multiple regression, case and cross-case analyses, ANOVA and ANCOVA, Pearson product-moment correlation coefficient, descriptive statistics, and multiple regression.

2.3 Review of Related Studies conducted in Ghana

The researcher reviewed studies conducted in Ghana that are related to the study. The review sequence was General Teacher Education, Mathematics Teacher Education, and Teaching Mathematics at the School Level.

2.3.1 Studies Conducted on General Teacher Education in Ghana

Mensah (2023) conducted a study titled "Pedagogical Competencies in Minor Subjects of
Ghanaian Pre-Service Geography Teachers and their Implications for Teacher Education". Ghanaian pre-service geography teachers' pedagogical competence in their minor subject areas, political science, economics, social studies, and history, was assessed in this study. 182 out of 369 final-year pre-service geography teachers, or 49.32% of the total, took part in an online survey using a cross-sectional design. An online questionnaire was constructed and used for data collection. The researcher employed descriptive statistics (means and standard deviation) and MONOVA for data analyses. The findings showed that pre-service geography teachers knew more about their minor topic than they did about their pedagogical substance or technology pedagogy. Classifications of minor subjects substantially impacted pedagogical knowledge, with the Economics minor group reporting higher scores.

Abonyi et al. (2021) conducted a study titled "Motivations of Pre-service Teachers in the Colleges of Education in Ghana for Choosing Teaching as a Career". The study examined why pre-service teachers at one Ghanaian College of Education pursued teaching as a career. The study was a descriptive survey. The study's target population was all first- and second-year pre-service teachers at the Ada College of Education in the Greater Accra region of Ghana. The researchers utilised random sampling to select 300 pre-service teachers for the study. Out of the 300 participants, 248 of them completed and returned the questionnaire administered by the questionnaire. A FIT-choice instrument was used for the study. Data analyses used descriptive (means and

standard deviations) and inferential (t-test) statistics. According to the study's findings, pre-service teachers chose to become teachers because they felt they were qualified teachers, wanted to increase social fairness, had previous teaching and learning experiences, and wanted to make a difference in the lives of children and adolescents. Additionally, compared to male pre-service teachers, female pre-service teachers rated working with children and adolescents, career security, family time, and influencing the future of children and adolescents significantly higher. Additionally, compared to pre-service teachers in urban areas, those in rural regions gave much higher ratings to perceived teaching competence and intrinsic career value.

Blankson (2022) conducted a study titled "Program Evaluation of Music Teacher Education in Ghana: Implications for Practice, Policy, and Research". The study aimed to assess Ghana's programmes' efficiency in training music teachers. The researcher employed a concurrent mixed methods approach for the study. All colleges of education in Ghana that offer music as a programme were involved in the study. Of the Colleges of Education, 28 were accepted to assist the researcher with data collection. Out of 120 respondents, 89 were used for the study because of incomplete or missing data sets. The researcher collected data using a questionnaire and documents (curricula and instructional materials) for training music teachers in Ghana. Techniques for analyses used by the researcher include descriptive statistics (frequencies, median, and percentages), inferential statistics (Chi-Square, Spearman's Correlation Coefficient), content analyses and thematic analyses. The study showed that while programmes emphasised theoretical and historical ideas, music teachers favoured practical and performance-related activities. The support and dedication of the faculty, the availability of experiential learning opportunities, and the focus on African music were all practices that helped the programmes succeed. The programmes' main issues were a lack of musical instruments, incorrect curriculum alignment, and insufficient training time.

Adu-Gyamfi and Otami (2020) conducted a study titled "In Search of an Effective Teacher: Ghana's Move towards Achieving in Search of an Effective Teacher: Ghana's Move towards Achieving Sustainable Education through Teacher Education Reforms". The researchers wanted to examine Ghana's efforts to identify what makes a good teacher through revisions to teacher education in connection to sustainable education. The study was qualitative. The researcher collected data utilising

documents, observation schedules and interview schedules. The researchers conducted facility observations in ten (10) CoEs and interviewed ten (10) teacher educators. The researchers analysed the data collected utilising content and thematic analysis. The results showed that the quality of teacher education was impacted by factors such as entry requirements for students, curricular changes, and the involvement of development partners in educational reforms. However, achieving a sustainable basic level of education requires consideration of cultural context, support structures, and educator professional growth.

Agyemang (2020) conducted a study on: "Embedding Sustainable Development in Teacher Education in the Central Region of Ghana." The researcher sought to understand how teacher educators incorporate sustainability values, knowledge, and principles, how they use pedagogical approaches to teach sustainability concepts, what motivates them to teach sustainability, and what challenges they face when implementing sustainability models. The study was qualitative. From three (3) CoEs of education in Ghana's central, the researcher selected thirty (30) teacher educators. The survey also included staff from the regional education directorate and college principals. For data collection, semi-structured interviews were conducted for the teacher educators and focus group interviews were conducted for the teacher-educators, principals and personnel from the regional education directorate. Data was analysed thematically by the researcher. The Findings showed that the teacher educators made a minimum effort to embed sustainability concerns in their work.

Adu-Yeboah and Kwaah (2018) conducted a study titled "Preparing Teacher Trainees for Field Experience: Lessons from the On-Campus Practical Experience in Colleges of Education in Ghana". The researchers' aim was to comprehend how teacher candidates are prepared for their practicum in elementary schools by giving them on-campus practical experience, as well as how the candidates perceive these experiences. The study was exploratory and employed the sequential mixed method design. The researcher purposively sampled three (3) CoEs from the Central region of Ghana for the study. For the data collection, the researchers administered a questionnaire to two hundred thirty-two pre-service teachers who were randomly sampled, 12 focus group interviews were organised with the participants, and 24 college tutors were interviewed using a standardised interview guide. There were also

randomly selected 20 different micro/peer teaching groups observed from the selected Colleges of Education. Data from the questionnaire were analysed with descriptive statistics. Data collected from the interviews, focus group discussions, observation, and documents were transcribed and sequentially analysed. Data from the observations were thematically analysed. The results demonstrated that the on-campus experience allowed trainees to advance their knowledge and practise general pedagogical skills like creating lesson plans, formulating suitable lesson objectives, delivering lessons, scheduling activities, and utilising teaching and learning resources. Additionally, trainees did not have much time to interact with their supervisors or critically analyse and consider their practices.

Akyeampong (2017) studied "Teacher Educators' Practice and Vision of Good Teaching in Teacher Education Reform Context in Ghana". Using qualitative methodologies and data from the Ghana component of the Teacher Preparation in Africa (TPA) research project, the author investigated the practices and visions of eight teacher educators about effective primary mathematics teaching. Some of the conclusions from the study were:

(i) Pre-service teachers' practice of good teaching was influenced by teacher educators' practice and vision of good teaching.
(ii) Given that teacher educators felt that teacher-centred creative methods could be applied in any situation, primary mathematics education has not been critically examined in a way that could transform it.
(iii) Teacher education was moving in a good direction, and there was a shift to bring college-based training closer to school-based training practised in advanced countries such as the United States of America.
(iv) One of the main obstacles to an effective practicum was the hierarchical connection between teacher educators and school teachers, which limited the chance to change how teacher educators view and approach teaching primary mathematics.

Anane (2014) worked on a study titled 'Pre-Service Teachers' Motivational Orientations and the Impact of Self-Regulated Learning on Their Academic Achievement: A Mixed-Method Study. The study aimed to look into the motivation

and self-regulation of pre-service teachers and how these factors affected their academic performance while they were undergoing professional training at educational institutions. The author utilised the convergent parallel mixed-methods design. The researcher used the multi-stage sampling technique to select 500 pre-service teachers for the study. The researcher utilised a questionnaire and an interview checklist and analysed archival documents to gather data. Descriptive statistics, independent sample t-test, zero-order correlation, Pearson's product-moment correlation coefficients, a test of associations, mediation and moderation analyses were used to analyse the data collected. According to the study's results, the association between academic achievement (GPA) and past performances (entry aggregates) was mediated by the incentive component of pre-service teachers' self-regulation learning conceptions. According to the research findings, pre-service teachers' academic success in college was not predicted by desired traits, including critical thinking, the use of metacognitive strategies, and students' value for the job in the teacher training program courses.

Akyeampong (2003) conducted a study titled "Teacher Training in Ghana-Does it Counts". The researcher examined the issue of teacher quality in Ghana by enquiring into pre-service initial teacher training for variations that might be required to progress the quality and supply of teachers for basic schools. The researcher employed the three-stage research framework to get enough information on the stages of teacher education: the input, process and output. The researcher utilised a mixed research methodology. The study sample was from teacher training institutions in southern Ghana. A random sample of 100 beginning student teachers was selected from four schools (400 participants) for the input stage, and 300 final-year students were selected for the process stage. The researcher used questionnaire administration, interviews, observation and analyses of autobiography by beginning students for data collection. The author concluded that Ghana needs to reconsider its teacher training policies significantly if basic education quality objectives are to be met. The writer expressly indicated that the old-fashioned practices are grossly inadequate to meet the required demands of the quantity and quality of teachers. The author suggested that attention should be given to factors such as methods of teacher recruitment, enticements to make teaching eye-catching, particularly at the primary level, and greater prominence on continuing professional improvement programs provided

through organised, institutionalised in-service training and a compulsory internship program for beginning teachers.

2.2.3.1 Summary of the Review of Studies Conducted in Ghana on General Teacher Education

The researcher reviewed nine (9) studies regarding general teacher education in Ghana. Of the nine (9) studies conducted, four (4) were mixed method studies, three (3) were qualitative studies, and one (1) each were Cross-sectional and descriptive studies. The authors the researcher reviewed the studies were Mensah (2023), Abonyi et al. (2021), Blankson (2022), Adu-Gyamfi and Otami (2020), Agyemang (2020), Adu-Yeboah and Kwaah (2018), Akyeampong (2017), Anane (2014), and Akyeampong (2003).

The studies concentrated on teacher quality in Ghana, prior to service the impact of teachers' self-regulation and motivation on their academic performance during their professional development in educational institutions, as well as the practice and philosophy of effective primary mathematics teaching, teacher candidates are prepared for their practicum in elementary schools, how teacher educators integrate the principles, knowledge and values of sustainability, the pedagogical approaches used for sustainability concepts, the forces behind sustainability education and the challenges facing the strategies teacher educators use to put sustainability concepts into practice, Ghana's efforts to identify what makes a good teacher, Ghana's programmes' efficiency in training music teachers, why pre-service teachers at one Ghanaian College of Education pursued teaching as a career, the pedagogical proficiency of Ghanaian pre-service geography teachers in their minor subject areas, which includes political science, economics, social studies, and history.

The data analyses used by the authors of the studies reviewed were descriptive statistics, MONOVA, t-test, Chi-Square, Spearman's Correlation Coefficient, content analyses, thematic analyses, sequential analyses, zero-order correlation, Pearson's product-moment correlation coefficients, a test of associations, mediation, and moderation analyses.

2.3.2 Studies conducted on Mathematics Teacher Education in Ghana

Enu (2022) investigated mathematics teacher educators' concept of feedback and the influence of their concept of feedback on their practice when assessing students in mathematics modules. The researcher conducted a study titled "Connecting Knowledge and Practice: Mathematics Teacher Educators' Knowledge and use of formative feedback in Ghana" to achieve this objective. Employing a qualitative approach, the researcher purposively selected three Colleges of Education and two mathematics teachers' educators, each from the three colleges for the study. The participants were selected based on their longevity of service, experience in teaching at a particular level, and transition to a BEd programme. The participants were interviewed, and their responses served as data for the study. The researcher employed inductive and deductive methods for data analyses. The results showed that the knowledge and feedback practise of teacher educators are focused on giving pupils the necessary support to overcome their weaknesses, implying mathematics teacher educators give feedback primarily on how well students can complete the job at hand, paying little attention to how to support students in managing their learning.

Agyei et al. (2022) conducted a study titled "In-Service Mathematics Teachers' Preparedness, Knowledge, Skills, and Self-Efficacy Beliefs of Using Technology in Lesson Delivery." The study explored mathematics teachers' ability to employ technology in teaching mathematics. The study was an explanatory sequential mixed-methods design. Two hundred and two (202) maths teachers were chosen to take part in the study using stratified sampling. Data collection was done using a questionnaire, observation guide and interview schedule. The researcher used descriptive and multiple regression for quantitative data analyses and thematic analyses for the qualitative data. The results showed that although mathematics teachers had high technology knowledge and self-efficacy, they were less prepared and less skilled in using technology in their lessons, and teacher preparedness and ICT skills were found to be the best predictors of technology use in mathematics lesson delivery.

Enu (2021) conducted a study titled "An Exploration of Mathematics Teacher Educators (MTEs) Understanding and Practices of Formative Assessment: A Case of Three Colleges in Ghana". This study's goals were to ascertain how MTEs apply Formative Assessment (FA) in mathematics modules, investigate their comprehension

and practices of FA, and, lastly, investigate why they use FA approaches in the classroom. This researcher used a qualitative approach underpinned by an interpretive research paradigm. Three CoEs in the central region of Ghana were used for the study. Semi-structured interviews, instructional observations, and textual material review were the methods used by the researcher to collect data. Six MTEs, two each from each College of Education, were selected purposively based on their experience for the study. The generated data was analysed using interpretative techniques and thematic coding. The study results showed that MTEs view FA as a continuous activity that occurs before, during, and after teaching and learning and is essential to teachers' pedagogical approaches. The study's results also demonstrated that teacher educators' adoption of FA techniques is ultimately motivated by the desire to improve and modify students' performance in mathematics and prevent further decline. Implementing FA in mathematics appears to be hampered by a lack of material resources and college evaluation policies, even when teacher educators use FA strategies in their instruction.

Yarkwah (2020) studied **"**Female Students' Participation in Mathematics Education at the University Level in Ghana" to investigate female students' involvement in university-level mathematics education. The researcher employed the descriptive survey (mixed method) design. The researcher purposely sampled the University of Education, Winneba and the University of Cape Coast for the study. The quota-sampling technique selected 70% of the participants, representing 99 out of 141 students. A questionnaire was used for data collection. The researcher utilised descriptive statistics for data analysis. The survey found that female student enrollment in mathematics programs is declining, among other factors. Additionally, the study demonstrated that female students' motivations for participating in mathematics education were their interest in the subject, their want to learn it, their job potential in the field, and the fun they gained from studying it.

Armah and Kissi (2019) conducted a study titled "Use of the van Hiele Theory in Investigating Teaching Strategies Used by College of Education Geometry Tutors". The study aimed to explore mathematics teacher educators' extent of facilitation concerning geometry learning at Van Hiele's levels 1,2,3 and 4. The study was a case

study with an interpretive orientation. Using a purposive sampling technique, the researcher selected 11 mathematics teacher educators for the study. The researchers adopted the classroom observation schedule of Muyeghu (2008) based on Van Heile's theory for data collection. In order to analyse the data collected through observation of classroom activities, the researchers framed an operational characterization of Van Hieles' theory in plane shapes teaching. The researchers described and interpreted all the outcomes that emerged from the observations. The patterns observed from the observations were then noted and described in connection with Van Heile's theory to make meaning from the data. The study's findings indicate that mathematics teacher educators have a conceptual understanding of the facilitation of teaching and learning geometry. Additionally, it was discovered that the methods employed by the maths teacher educators did not promote the growth of thinking, as demonstrated by Van Hiele's Levels 3 and 4.

Eduafo (2011) studied the "Effects of Problem-Solving Approach on Mathematics Achievement of Diploma in Basic Education (DBE) Distance Learners at the University of Cape Coast (UCC), Ghana". The researcher's goal was to determine how a problem-solving method intervention affected the maths proficiency of DBE UCC distance learners (DLs) in Ghana. The study used a mixed research methodology using a sample of 506 DBE UCC first-year DLs and eight facilitators. Questionnaires, interview schedules, and test questions from before and after the intervention were among the study tools. Results for the study were analysed using mean, standard deviation, t-test statistics, and ANOVA. The study's conclusions include the following: most pre-service prospective elementary mathematics teachers' instrumentalist-driven views of mathematics teaching and learning were significantly altered to problem-solving-driven views or perceptions by the problem-solving approach; the problem-solving approach positively impacted DLs' mathematical achievement; and facilitators were unable to fully implement their developed problem-solving-driven view of mathematics teaching and learning due to many mitigating factors, such as the lack of non-routine problem-solving activity textbooks and a lack of instructional time.

Akayuure et al. (2013) conducted a study titled “Ghanaian Prospective Mathematics Teachers’ Perceived Self-Efficacy Towards Web Pedagogical Content Knowledge”. The study's objective was to investigate Ghanaian preservice mathematics teachers’ perceived self-efficacy concerning Web Pedagogical Content Knowledge (WPCK) for the integration of ICT. The study was a survey design. Employing a Learning Technology by Design approach, the researcher administered a Web Pedagogical Content Knowledge Survey (WPCKS) (questionnaire) as a source of data collection. The participants of the study were 172 preservice mathematics teachers. The participants were an intact class on a 12-week course called “Web Technologies for Mathematics Teachers”. The researchers purposively selected the class for the study. The data collection process was done in three phases: the semester's beginning, middle and end. The researcher analysed the collected data by first grouping the responses into three groups, web content, web pedagogical content, and web attitudes, for all three faces of the data collection process. The researchers then, using SPSS, calculated the composite means. The means were exported to Excel for further analyses by creating category area charts. Low self-efficacy (scores ranging from 0 to 2.4), moderate self-efficacy (scores ranging from 2.5 to 3.4), and high self-efficacy (scores ranging from 3.5 to 5.0) were assigned to the participants concerning their understanding of web material, their attitudes towards web instructions, and their knowledge of web pedagogy. The study found that whereas the mean scores for Web Attitude (WA) increased steadily from the start of the semester to its finish, the mean scores for WPCK increased in the middle of the semester but decreased at the end. The Web Content Knowledge (WCK) fell during the semester but rose at the semester's end.

Agyei (2012) conducted a study on: ‘Preparation of Pre-Service Teachers in Ghana to Integrate Information and Communication Technology in Teaching Mathematics.’ The study's primary goal was to look into the opportunities, learning requirements, and obstacles to getting maths teachers ready to use ICT in their lessons. The study was design-based research. The study involved 180 educators in total, 60 of whom were in-service teachers and 120 of whom were pre-service teachers. The researcher selected the in-service teachers from 16 senior high schools, and the pre-service teachers were selected from the Mathematics education department of the University of Cape Coast (UCC). To gather data, the researcher used an interview schedule and a

questionnaire. Descriptive statistics were used to analyse the quantitative data. For the qualitative data, the researcher transcribed and used a data reduction procedure for the analyses. The study's significant findings were that obstacles such as lack of ICT resources and knowledge of ICT hampered its integration in the classroom. It was also realised that the most predominant method of teaching used by teachers is the board and chalk by in-service teachers and the lecture method by Lecturers (University teachers).

Nyala (2012) worked on a study titled "Effect of E-Mentoring on Mathematics Interns in Teacher Education in Ghana". The study aimed to look into alternative mentoring models and e-mentoring for Ghanaian math interns enrolled in teacher education programs. The researcher employed the quasi-experimental design using the pre-test-post-test control group design. The researcher chose two hundred eighty (280) pre-service mathematics interns and students (210 interns and 70 practicum students) using random sampling from 40 public schools spread across five of Ghana's ten regions. For data collection, the researcher used an intern competence evaluation questionnaire, an intern-participant interaction questionnaire, a students' perception of interns' performance questionnaire, an intern access to resources questionnaire, a teacher competence measuring instrument, and an interview schedule. The researcher tested the hypotheses at the 0.05 significance level using ANOVA, ANCOVA, and MANOVA. The Bonferroni method was also used for post-HOC pairwise comparison. The most significant of the study's findings were:

1. A different mentorship approach may not be as successful or beneficial in the same school as the first, even if the first one was used to improve teacher professional competence. Therefore, the mentoring approach may determine the success and efficacy of establishing teacher competency.
2. Mathematics interns' exposure to the experimental e-mentoring modes greatly impacted their students' academic achievement.
3. Using different mentoring modes positively affects pre-service teachers' effectiveness and involvement in the mentoring process.

The researcher recommended that mathematics educators adopt e-mentoring, blended mentoring, and face-to-face mentoring modes in Ghana to enhance professional teacher skills.

2.3.2.1 Summary of the Review of Studies Conducted in Ghana on Mathematics Teacher Education

The researcher reviewed nine (9) studies regarding Mathematics teacher education in Ghana. Out of the nine (9) studies reviewed, two (2) were mixed method, two (2) were case studies, two (2) were descriptive surveys, and one each was conducted through a design-based approach, quasi-experimental design, and qualitative approach.

The studies were conducted by Enu (2022), Agyei, Darko Agyei and Benning (2022), Enu (2021), Yarkwah (2020), Armah and Kissi (2019), Eduafo (2011), Akayuure, Nabie and Sofo (2013), Agyei (2012), and Nyala (2012). The studies concentrated on teacher educators concept of feedback and the influence their concept of feedback has on their practice when assessing students in mathematics modules, mathematics teachers' ability to employ technology in teaching mathematics, MTEs' understanding and practices of FA in mathematics, The involvement of female students in university-level mathematics instruction, mathematics teacher educators extent of facilitation concerning the learning of geometry at the Van hiele's levels 1,2,3, and 4, effects of a problem-solving approach intervention on the mathematics achievement, The perceived self-efficacy of Ghanaian preservice maths teachers with regard to Web Pedagogical Content Knowledge (WPCK) for ICT integration, the obstacles, learning requirements, and opportunities for training maths teachers to incorporate ICT into their lessons, and e-mentoring and alternative mentoring modes for mathematics interns in teacher education in Ghana.

The tools used for data collection in the studies reviewed were interview schedules, observation schedules, documents, questionnaires, and tests. Data analysis techniques include inductive and deductive analyses, descriptive statistics, multiple regression, thematic analyses, interpretive strategies, t-test, ANOVA, ANCOVA, MANOVA, and Post-hoc pairwise comparison.

2.3.3 Studies Conducted on Mathematics Teaching at the School Level in Ghana

Ansah et al. (2022) conducted a study titled "Investigating the Effect of Using Geogebra as an Instructional Tool on Van Hiele's Geometric Thinking Levels of Senior High Technical School Students". The study's objective was to examine the impact of GeoGebra on van Hiele's level of geometric thinking in Senior High School

students. The study used a mixed-methods strategy with a single group pretest-posttest pre-experiment. The study's target population was all form-two Senior High Technical School (SHTS) students of the Central region of Ghana, and the accessible population was form-two SHTS students of the Abura Asebu Kwamankese district of the Central region of Ghana. The researcher chose a sample size of 80 second-year senior high technical school students (50 males and 30 females) using simple random sampling. Data on the impact of utilising GeoGebra on students' VHGTL scores were gathered using the Van Hieles' Geometry Tests (VHGT). The techniques used for data analyses were descriptive statistics (frequencies and percentages), one-way ANOVA and paired sample t-test. According to the results, there was a statistically significant difference between the students' pre-VHGTL and post-VHGTL scores and their Van Hiele's geometric thinking levels (VHGTL) after receiving instruction in GeoGebra.

Ansah et al. (2020) conducted a study titled "Mathematics Achievement in Crisis: Modelling the Influence of Teacher Knowledge and Experience in Senior High Schools in Ghana". The researcher's objective was to examine the interplay between the joint influence of experience, PCK, and Subject Matter Knowledge (SMK) to explain the variances in students' mathematics achievement. The study was carried out using a descriptive survey. The researcher employed cluster sampling to select 14 single-sex male schools, 14 single-sex female schools and 14 mixed schools (42 schools). From the clusters, random sampling was used to sample 5 teachers each from the schools for the study (42*5). Forty (40) students were randomly selected for each teacher (40*210) to participate in the study. The participants were 210 teachers and 8400 students. An instrument was adapted from the Knowledge of Algebra for Teaching (KAT) project (McCrory et al., 2012) at Michigan State University. The researcher used standardised and psychometrically sound items to assess teachers' SMK and PCK in algebra. Ten assignments were given under each construct (SMK and PCK), and teachers answered them. The researchers assess students' algebraic proficiency using the same ten (10) tasks. For data analyses, a Structural Equation Modeling (SEM) approach was utilised using SPSS, Analysis of Moment Structures (AMOS version 21), and the bootstrapping method (specifically, 5,000 bootstrap samples were used as the parameter estimations) were used. The study found that experiences did not significantly moderate the relationship between teachers' SMK and students' mathematical achievement, that teacher knowledge and teaching

experience significantly impacted students' mathematical achievement, and that PCK significantly indirectly affected students' mathematical achievement through teachers' SMK.

Arthur et al. (2017) conducted a study titled "Teacher-Student Variables as Predictor of Students' Interest in Mathematics: The Use of Stepwise Multiple Linear Regression Analysis". The study's objective was to investigate and clarify the impact of student and instructor variables on mathematics students' interests. The study utilised a quantitative approach. The study's target population was all senior high school students from the Ashanti region of Ghana. A cluster sampling technique was used to select ten (10) schools from all the Senior High Schools constituting the target population. Using the random selection technique, the researchers selected 1,263 individuals (1,263) from the ten (10) schools. The researchers administered one thousand five hundred questionnaires (1500) questionnaire to the sampled participants. Ultimately, the survey had 1,263 participants, and valid questionnaires were used for the study. Multiple linear regression analysis was used to analyze the collected data. The difference in student interest was caused by the teacher's capacity to relate mathematics to real-world issues and the school's leadership, by roughly 37.8% and 2%. The study's further findings showed that the following factors were statistically significant in predicting students' interest in mathematics: student perception, background, mathematical facility, instructor quality, and availability.

Asemani et al. (2017) conducted a study titled "The Geometric Thinking Levels of Senior High School Students in Ghana." The study's objective was to examine final-year SHS students Van Hiele's levels of geometric thinking they attain before completing school. The researchers employed a quantitative approach to the study. Three (3) municipalities from the Central Region were chosen using the stratified sampling technique, and one (1) public SHS was selected from each of the municipalities using the simple random sample technique. The sample included 200 senior high school students, 88 (44%) of whom were male and 112 (56%) of whom were female. Van Hiele Geometry Test (VHGT) and a curriculum analysis guide were the instruments used for data collection. The SHS Mathematics curriculum and some test books were analysed using Van Hiele's model of Geometric Thinking Level. The findings revealed that 42.5% of the students were unable to reach any VHG level at all, 33% of them attained Van Hiele's level 1, 22.5% did so at level 2, 1.5% did so at

level 3, and only 0.5% did so at level 4. The results showed that most SHS form 3 students in Ghana did not achieve any Van Hiele's Geometry Test (VHGT) level.

Kabutey (2016) studied "Resources Available for Teaching Mathematics in Senior High Schools in the Western Region of Ghana". The study aimed to investigate the teaching and learning materials available for mathematics instruction at the SHS level in Ghana's Western region. The study specifically sought to determine the available resources, whether they vary by school category, their condition, instructors' access to them, and how differently different sexes, academic backgrounds, and school categories use them. The researcher used the Mixed-Methods Explanatory Sequential design to implement the pragmatist paradigm approach. Random sampling was used to sample the study's eighty-four (84) mathematics teachers and 16 storekeepers. A questionnaire, interview, and observation schedule were used for data collection. Descriptive statistics, Shapiro-Wilk's test, Skewness and Kurtosis measures, standard errors, and non-parametric Levene's test were used for data analysis. The study found that the resources available for teaching mathematics in SHS were mathematics syllabi, textbooks, library books, Mathematical instruments for students, calculators, marker board drawing instruments, classrooms, furniture, and marker boards. The extent to which the resources were available in the schools was low, and there was no significant difference in their availability among the school categories.

Akayuure and Apawu (2015) conducted a study titled "Examining Mathematical Task and Pedagogical Usability of Web Contents Authored by Prospective Mathematics Teachers". The objective was to assess the perceived pedagogical applicability and mathematical challenge of the modules for Ghanaian mathematics instruction. The study employed descriptive research methods. The participants were 172 (157 men and 15 women) 4-year mathematics education programme at the University of Education, Winneba (UEW) who were enrolled on a one-semester Web Technologies Methods Course titled "Web Technologies for Mathematics Teacher" at the UEW. The researchers employed a Mathematical Task Usability Scale and Pedagogical Usability Rubrics for data collection. The researchers used cumulative mathematical task scores to analyse and answer the research objectives. According to the study's findings, most of the modules created by aspiring teachers have significant educational value.

Arthur et al. (2015) conducted a study titled "Student Mathematics Interest in Ghana: the Role of Parent Interest, Gender, Basic School Attended and Fear of Basic School Mathematics Teacher." The researchers aimed to investigate how parents' interest influences a student's interest in mathematics, the type of basic school they attended, and teachers' instilling fear in them. The study participants were undergraduate students from the University of Education, Kumasi campus. The researchers utilised convenient sampling to select the participants of the study. Three hundred (300) questionnaires were distributed, out of which 260 questionnaires were pronounced valid for the study. The researchers utilised quantitative techniques in an exploratory research design, collecting data through questionnaires. Descriptive (frequencies and percentages) and Inferential (Chi-square) statistics were used for data analyses. According to the study, parents' appreciation of and interest in mathematics greatly impacted their children's enthusiasm for and interest in solving mathematical issues.

Additionally, it was discovered that students' engagement was considerably impacted by the fear that basic school mathematics teachers instilled in them. The study also found that pupils' interest in mathematics is unaffected by their gender or the sort of basic school they attended. The study concluded that parental involvement and the fear of the elementary school mathematics teacher influence a student's interest in mathematics. It also shows that gender and the type of elementary school attended do not affect a student's interest in mathematics.

Appiahene et al. (2014) conducted a study titled "Assessing the Challenges of Learning and Teaching of Mathematics in Second Cycle Institutions in Ghana" to explore teachers' challenges in teaching and learning mathematics in Ghana. The study was delimited to the Kumasi metropolis of Ghana. The tools employed for data collection included questionnaires and interview guides. The data collection involved administering the questionnaire, interviews and focus group discussions. A sample of 360 participants comprising 100 teachers and 260 students were involved in the data collection process. The sample was selected via stratified and purposive sampling techniques. The researchers used descriptive statistics employing general statistical package (GENSTAT) software for data analyses. The research found that there are not enough qualified teachers, some teachers do not have access to quality teaching and learning resources, and most students have a negative attitude towards learning

mathematics and are afraid of it because of its abstract nature. Poor supervision and bad teaching practices also contributed to the challenges of teaching and learning mathematics.

Ampadu (2012) conducted a study titled "Investigation into the Teaching and Learning of Mathematics in Junior Secondary Schools: The Case of Ghana" to investigate mathematics teachers' teaching practices and students' learning experiences in junior high schools (12-14 years). The researcher employed a descriptive survey (mixed methods) design. Using random sampling techniques, the researcher sampled 24 mathematics teachers and 358 students from 12 schools. Tools for data collection include a questionnaire, interview schedule and observation schedule. The researcher utilised descriptive statistics and the Mann-Whitney U-test, employing SPSS, STATSDIRECT, and ORIGIN software for quantitative data analysis. The qualitative data was analysed using the thematic analysis approach. According to the findings, both educators and learners expressed the opinion that their methods aligned with the tenets and directives of the recently implemented mathematics curriculum. Additionally, teachers' perceptions of their teaching methods were complicated since they combined constructivist and behaviourist ideas with didactic methods.

Cole (2011) studied "Mathematical Knowledge for Teaching: Exploring its Transferability and Measurement in Ghana". The study aimed to determine how applicable Mathematical Knowledge for Teaching (MKT), a theory of teacher knowledge created in the United States, is in Ghana. The study aimed to address the issue of Ghanaian pupils' low math achievement, which is partially attributable to the calibre of instruction. The study was a descriptive survey in which 60 practising teachers were conveniently sampled to participate. The researcher first adapted U.S-developed measures of MKT to make them usable in Ghana without altering their substantive content and prepared an interview schedule and observation schedule for data collection. The researcher employed video lesson analysis, disciplinary mathematics viewpoints, and Item Response Theory (IRT) for data analysis. The data analysis's findings demonstrated that while the MKT architecture is theoretically sound in Ghana, there is compelling evidence that the tools used to evaluate MKT and

the calibre of mathematical education must be further modified to fit the country's needs.

Fletcher (1997) worked on a study titled “The Appraisal of Mathematics Teachers in Ghana” with the objectives of investigating mathematics Teacher Appraisal in Ghana (TAG) regarding the nature and potential of TAG to help mathematics teachers improve their teaching, mathematics teachers’ views of appraisal in Ghana, and implications of any changes in Ghana’s educational policies regarding appraisal. Triangulation was utilised to study the relationship between the two methods. Teachers of mathematics in mid-southern Ghana were the study's target group. However, due to certain practical issues, the study was restricted to full-time secondary mathematics teachers at public schools—referred to as "government (secondary) schools" in this chapter. Four hundred forty-one (441) secondary mathematics teachers (193 of whom teach the subject at the junior secondary level and 248 at the senior secondary level), 44 Ghana Education Service (GES) officials, and six secondary school heads who evaluate maths teachers were selected for the study using stratified cluster sampling. Data on instructors' and appraisers' opinions on the appraisal system was gathered using a questionnaire, observation schedule, Ministry of Education (MoE) papers, and interview schedules.

Additionally, some appraisers were observed while at work. SPSS, descriptive statistics, Chi-Square Analysis, multiple regression analyses, and exploratory and bivariate analyses were utilised to analyse the collected data. Interviews were transcribed and analysed by themes. According to the study, many Ghanaian education officials who evaluate maths teachers and are tasked with "helping" them better their work have little to no experience teaching or evaluating maths in secondary schools. The study results support the conclusion that Ghana's current teacher evaluation system cannot give maths instructors opportunities for professional growth.to gather information about how appraisers and teachers view the appraisal system.

2.3.3.1 Summary of the Review of Studies Conducted in Ghana on Mathematics Teaching at School Level

The researcher reviewed eleven (11) studies in mathematics teaching at the school level in Ghana. The studies reviewed were conducted by Ansah, Asiedu-Addo

and Kabutey (2022), Ansah, Quansah and Nugba (2020), Arthur, Asiedu-Addo and Assuah (2017), Asemani, Asiedu-Addo and Oppong (2017), Kabutey (2016), Akayuure and Apawu (2015), Arthur, Addo and Annan (2015), Appiahene et al. (2014), Ampadu (2012), Cole (2011), and Fletcher (1997). The research methodologies utilized by the researchers include five (5) descriptive surveys, two (2) mixed-methods studies, two (2) quantitative studies, an exploratory research design and a between-methods triangulation study.

The reviewed studies were concentrated on the impact of GeoGebra on van Hiele's level of geometric thinking, interaction between the combined effects of subject matter knowledge (SMK), pedagogical content knowledge (PCK), and experience impact of student and instructor variables on mathematics students' interests, final-year SHS students Van Hiele's levels of geometric thinking before completing school, resources for teaching and learning mathematics are accessible at the SHS., the perceived pedagogical applicability and mathematical challenge of the modules for Ghanaian mathematics instruction, how a student's interest in mathematics is influenced by their parents' enthusiasm and the kind of elementary school they attended, and teachers' instilling fear in them, challenges teachers encounter in the teaching and learning of mathematics in Ghana, mathematics teachers' teaching practices and students' learning, Ghanaian students' poor student achievement in Mathematics, and Mathematics teacher appraisal in Ghana.

The tools used by the reviewed studies authors were tests, questionnaires, documents, test books, interview schedules, and observation schedules. For analyses of data collected, the researchers utilized descriptive statistics, ANOVA, paired sample t-test, Structural Equation Modeling (SEM), Analysis of Moment Structures, bootstrapping, Multiple linear regression analysis, content analyses, Shapiro-Wilk's test, Skewness and Kurtosis measures, standard errors, Levene's test, Chi-square, Mann-Whitney U-test**,** thematic analyses, Item Response Theory (IRT), video lesson analysis for data analysis, multiple regression, exploratory and bivariate analyses.

2.2 IMPLICATIONS OF THE REVIEWED STUDIES

In total, the researcher reviewed 119 studies conducted abroad and in Ghana. The review was on journal articles and doctoral thesis. The topics were general teacher education, mathematics teacher education, and mathematics teaching at the school level. From the review, various methodologies, including qualitative and

quantitative methodologies, were utilized by the authors. The majority of the researchers utilized descriptive surveys. Among the various methodologies utilized by the authors were descriptive survey (28), mixed method study (22), quantitative study (8), qualitative study (15), exploratory design study (3), between methods triangulation study (1), case study (22), design-based study (2), experimental study (2), phenomenological study (3), review study (2), cognitive learning theory (1), comparative study (1), self-study (1), ex-post facto (2), correlational studies (2), hierarchical linear model study (1), narrative enquiry study (1), content analyses (1), meta-analyses (1) and empirical base research (1).

Also, a wide range of tools have been utilized, both quantitative and qualitative data collection tools and techniques has been utilized by the authors. Among the data collection tools used by the researchers are interview schedules, questionnaires, artefacts, observation schedules, written blogs, achievement tests, documents, website analyses, examination tasks, teacher diaries, transcripts and reflections, assignment artefacts, audio recordings, practitioner-researcher journals, interview schedule, syllabi of subjects, reflective diaries, exam items, Media Notes, focus group interviews, the Visible Learning Scale, archival sources, GPA of students, practical results, digital documents, memo scripts, and test books.

Data analysis techniques employed in the studies include both qualitative and quantitative methods. Quantitative techniques encompass descriptive statistics, inferential statistics (e.g., t-tests, paired sample t-tests, one-sample t-tests, independent sample t-tests, two-population z-tests), analysis of variance (ANOVA, ANCOVA, MANOVA), post-hoc analyses (e.g., Tukey test, Welch’s correction), regression analyses (e.g., multiple regression, logistic regression, zero-order correlation, Pearson’s product-moment correlation, Spearman’s correlation), exploratory and confirmatory factor analyses, tests of associations (e.g., Chi-square test, Fisher's exact test, Levene's test), time series analyses, and frequencies and percentages.

Qualitative techniques include thematic analyses, content analyses, narrative analyses (e.g., narrative vignette descriptions), grounded theory (e.g., constant comparative method), Critical Discourse Analysis (CDA), Hatch’s topological analysis, sequential and cross-case analyses, meta-matrix techniques, document review, inductive and deductive analyses, and data reduction, presentation, and

conclusion drafting. This diverse range of methods highlights the comprehensive and varied approaches used in data analysis.

The review of the various studies guided the researchers in various aspects. It contributed to the researcher's choice of methodology, research tools for the study, and analysis techniques. It also guided the researcher in identifying the research gap in the research context in Ghana. It was realized after the review that there is limited research in the area of mathematics teacher education programmes at the TEU level. Of the studies reviewed in the Ghanaian context, the researcher has yet to come across a study, particularly on MTE programmes in the TEUs of Ghana. Although some studies have been conducted on MTE, they do not assess the MTE programmes at the TEU level of Ghana's teacher education.

Although teacher education in Ghana is at both the University and College of education levels, researchers concentrate mostly on CoEs, neglecting the TEUs in the process. With the vital part TEUs play in training teachers and the realization of the neglect of research on TEUs, especially on the quality of the training process, the researcher saw the need to embark on this study.