International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 4, Jul-Aug-2026, ISSN (Online): 2395-566X

Teacher Knowledge and Teacher Efficacy as Predictors of Students' Learning Outcomes in Secondary School Mathematics: Evidence from Selected Secondary Schools in Bududa District, Uganda

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Abstract- Teacher knowledge and teacher efficacy have long been recognised as important determinants of effective teaching and learning. This study examined the influence of teacher knowledge and teacher efficacy on students' learning outcomes in Mathematics in selected secondary schools in Bududa District, Uganda. A cross-sectional survey design incorporating quantitative and qualitative approaches was used. Data were collected using questionnaires, interviews, classroom observations and Mathematics achievement measures. Quantitative data were analysed using descriptive statistics and Spearman's rank correlation, while qualitative evidence was organised thematically and used to enrich interpretation. The findings indicated positive relationships among teacher knowledge, teacher efficacy and students' learning outcomes. Teachers who demonstrated stronger subject-matter understanding, pedagogical competence and confidence in instructional practice were better positioned to explain mathematical concepts, manage learning activities, motivate learners and respond to learning difficulties. The study further indicated that teacher knowledge and efficacy were mutually reinforcing: professional competence strengthened instructional confidence, while successful teaching experiences reinforced teachers' beliefs in their capabilities. The study concludes that improving Mathematics achievement requires simultaneous attention to teachers' content knowledge, pedagogical competence and professional efficacy. Continuous professional development, supportive instructional supervision, adequate teaching resources and strengthened teacher preparation are recommended.

Keywords- Teacher knowledge; teacher efficacy; Mathematics education; learning outcomes; secondary schools; Bududa District; Uganda.

I. INTRODUCTION

Education is widely regarded as an important instrument for social, economic and technological development. Within education systems, teachers remain a central school-based influence on the quality of learning because curriculum intentions are ultimately translated into classroom experiences through their professional knowledge, instructional decisions and interactions with learners. This role is particularly important in Mathematics, a subject that develops logical reasoning, quantitative literacy, problem-solving capacity and foundations for scientific and technological study.

Mathematics has nevertheless remained challenging for many secondary school learners. Difficulties in achievement cannot be explained only by learner characteristics or curriculum content. Teacher-related factors, particularly what teachers know and what they believe they can accomplish through instruction, have received sustained attention in educational research. Shulman (1986) distinguished subject-matter knowledge from pedagogical content knowledge and argued that effective teaching requires teachers to transform disciplinary knowledge into forms that learners can understand. Bandura's (1977, 1986, 1997) work on self-efficacy similarly demonstrated that beliefs about capability influence effort, persistence and performance.

Teacher efficacy applies these ideas to instructional practice. Teachers with stronger efficacy beliefs tend to persist when learners encounter difficulties, adopt a wider range of teaching strategies and maintain stronger expectations for learning (Gibson & Dembo, 1984; Ashton & Webb, 1986; Tschannen-Moran, Hoy, & Hoy, 1998). In Mathematics classrooms, the interaction between professional knowledge and efficacy is especially significant because teachers must both understand abstract concepts and possess confidence to explain, illustrate, question, diagnose misconceptions and guide problem solving.

The present study examined teacher knowledge and teacher efficacy in relation to students' learning outcomes in selected secondary schools in Bududa District, Uganda. It sought to establish whether these teacher characteristics were associated with Mathematics learning and to consider their implications for teacher preparation, school support and instructional improvement.

II. BACKGROUND TO THE STUDY

Historical Perspective

Mathematical knowledge has developed across civilizations in response to practical and intellectual needs including measurement, trade, construction, astronomy and scientific inquiry. Over time Mathematics became an important component of formal schooling because of its contribution to reasoning and scientific development (Boyer, 1991). During the twentieth century, attention in Mathematics education increasingly moved beyond mastery of procedures toward conceptual understanding, problem solving and the quality of classroom instruction.

The development of teacher education followed a related movement. Earlier approaches often treated subject knowledge and general teaching method as largely separate domains. Later scholarship increasingly emphasised specialised knowledge for teaching. Shulman (1986) gave particular prominence to pedagogical content knowledge, describing the professional capacity to represent subject matter in ways that make it comprehensible to learners. Grossman (1990) extended this perspective by showing that effective teaching involves subject matter, pedagogy, curriculum and knowledge of learners and context.

Research on efficacy developed from social cognitive theory. Bandura (1977) proposed self-efficacy as a major influence on behaviour, and later work elaborated the role of mastery experiences, observation, social persuasion and emotional states in developing beliefs about capability (Bandura, 1986, 1997). Educational researchers applied these principles to teachers, demonstrating that efficacy beliefs influence persistence, classroom behaviour and willingness to work with learners experiencing difficulty (Gibson & Dembo, 1984; Ashton & Webb, 1986).

Conceptual Perspective

Teacher knowledge in this study refers to the professional understanding required to teach Mathematics effectively. It encompasses knowledge of mathematical content, knowledge of appropriate teaching approaches, awareness of curriculum expectations and the ability to interpret learners' responses. Strong content knowledge enables accurate explanation, while pedagogical content knowledge supports the transformation of mathematical ideas into examples, representations and activities suited to learners' levels of understanding (Shulman, 1986).

Teacher efficacy refers to teachers' beliefs in their ability to organise and execute instructional actions required to promote learning. It is reflected in confidence, persistence, willingness to employ alternative strategies, classroom management and commitment to assisting learners who experience difficulty. Tschannen-Moran and Hoy (2001) conceptualised efficacy around instructional strategies, classroom management and student engagement.

Students' learning outcomes refer to observable or measurable evidence of learning in Mathematics, including achievement in tests, ability to solve mathematical problems and demonstrated understanding of concepts. The study assumed that learning outcomes arise from interaction among learner characteristics, classroom conditions and teacher-related factors, while concentrating specifically on teacher knowledge and efficacy.

Contextual Perspective

Uganda has historically treated Mathematics as an important component of secondary education because of its relevance to science, technology and further study. Expansion of access to secondary education increased the importance of ensuring that growth in enrolment was accompanied by effective teaching. Rural districts faced particular constraints, including variation in teacher availability, professional support and instructional resources.

Bududa District, situated on the slopes of Mount Elgon in eastern Uganda, contains predominantly rural communities and geographically dispersed schools. These conditions made teacher competence and professional confidence particularly important because teachers frequently had to respond to diverse learner needs within resource-constrained settings. The study was therefore situated within a context in which improving Mathematics learning required attention not only to access but also to the quality of classroom instruction.

Mathematics education in the period preceding this study was increasingly influenced by the view that learners should construct meaning rather than merely reproduce procedures. The National Council of Teachers of Mathematics (2000) placed problem solving, reasoning, communication, connections and representation at the centre of effective Mathematics learning. This orientation increased the demands placed on teachers. A teacher had to understand the content sufficiently well to connect procedures to underlying concepts, anticipate alternative solution strategies and create opportunities for learners to explain their reasoning. In this sense, teacher knowledge became inseparable from the quality of curriculum implementation.

Research on effective teaching also suggested that the classroom consequences of professional knowledge depend on how teachers use it. Brophy (1986) observed that effective teachers structure learning purposefully, maintain academic engagement and provide clear explanations and feedback. These practices require both competence and confidence. In a Mathematics lesson, for example, a teacher may know a formula but still need pedagogical judgement to decide whether to introduce it through a worked example, a practical illustration, guided discovery or a sequence of questions. The ability to make such decisions is especially important when learners differ substantially in prior attainment.

The Ugandan context gave these questions additional importance. Expansion of secondary education increased the diversity of learners entering classrooms and placed pressure on schools to maintain quality while widening access. In rural settings, shortages of specialised teachers, textbooks and professional development opportunities could magnify the effects of individual teacher competence. A knowledgeable and efficacious teacher could use limited resources creatively, whereas weaknesses in professional knowledge or confidence could become more visible when external instructional support was limited.

Consequently, the study treated teacher knowledge and teacher efficacy as connected professional resources rather than isolated personal attributes. Knowledge represented the intellectual and pedagogical resources available to the teacher, while efficacy represented the teacher's belief that those resources could be mobilised successfully to bring about learning. This distinction provided a useful basis for examining why teachers with apparently similar qualifications might nevertheless produce different classroom experiences and learner outcomes.

III. STATEMENT OF THE PROBLEM

Mathematics is fundamental to scientific, technological and socio-economic development and occupies an important position in Uganda’s secondary school curriculum. Ideally, learners should acquire mathematical understanding, problem-solving competence and satisfactory achievement through instruction provided by professionally prepared teachers. However, Mathematics performance remained a concern in a number of secondary schools, suggesting that increased access to schooling and formal teacher qualifications did not automatically guarantee effective learning.

Teacher knowledge and teacher efficacy were plausible contributors to this problem. A teacher may possess formal qualifications yet differ considerably in depth of mathematical understanding, pedagogical competence or confidence in handling classroom challenges. Conversely, a teacher may be highly motivated but lack sufficient knowledge to explain difficult concepts effectively. Although international literature had linked teacher knowledge and efficacy to learner achievement, evidence from the local context of Bududa District was limited. The study therefore examined the relationships among teacher knowledge, teacher efficacy and students’ learning outcomes in Mathematics.

IV. PURPOSE

The purpose of the study was to examine the influence of teacher knowledge and teacher efficacy on students’ learning outcomes in Mathematics in selected secondary schools in Bududa District.

Objectives.

The objectives of the study were to:

1. determine the influence of teacher knowledge on students' learning outcomes in Mathematics.
2. examine the influence of teacher efficacy on students' learning outcomes.
3. establish the relationship between teacher knowledge and teacher efficacy; and consider their combined contribution to Mathematics learning.

Hypotheses

The study tested null hypotheses below:

1. statistically significant relationship between teacher knowledge and students' learning outcomes;
2. There is no statistically significant relationship between teacher efficacy and students' learning outcomes.
3. There is no statistically significant relationship between teacher knowledge and teacher efficacy.

V. LITERATURE REVIEW

Teacher Knowledge and Mathematics Learning

Shulman (1986) argued that subject knowledge alone is insufficient for effective teaching. Teachers require pedagogical content knowledge that enables them to select representations, examples and explanations appropriate to learners. Grossman (1990) similarly described teacher knowledge as an integrated professional resource rather than a collection of isolated facts.

Research in Mathematics education reinforced this position. Ball and Bass (2000) argued that teaching Mathematics demands specialised forms of mathematical reasoning because teachers must interpret learners' unconventional solutions, select examples and explain why procedures work. Hill, Rowan and Ball (2005) subsequently reported that teachers' mathematical knowledge for teaching was positively associated with gains in student achievement. These findings provided empirical support for the proposition that the quality of teacher knowledge has consequences for learning.

Darling-Hammond (2000) reviewed evidence on teacher quality and concluded that teacher preparation and qualifications were important correlates of student achievement. Although teacher quality is multidimensional, professional knowledge remains central because classroom decisions depend on teachers' understanding of both subject matter and pedagogy.

Teacher knowledge also affects assessment. A knowledgeable Mathematics teacher can distinguish between a computational error and a conceptual misconception, identify the source of difficulty and select appropriate remediation. This diagnostic function is particularly important because mathematical concepts are cumulative; misunderstanding at one stage may obstruct later learning.

Teacher Efficacy and Mathematics Learning

Teacher efficacy has been associated with instructional persistence and classroom behaviour. Gibson and Dembo (1984) found that teachers with stronger efficacy beliefs differed in their use of instructional time and persistence with learners experiencing difficulty. Ashton and Webb (1986) likewise associated teachers' sense of efficacy with classroom processes and student achievement.

Bandura (1997) explained that efficacy beliefs influence the goals individuals set, the effort they expend and their persistence when difficulties arise. Applied to teaching, this means that two teachers with comparable knowledge may use that knowledge differently if they differ substantially in confidence. A highly efficacious teacher may persist in finding alternative explanations, whereas a teacher with weaker efficacy may interpret learner difficulty as evidence that little more can be achieved.

Hoy and Woolfolk (1993) linked teachers' sense of efficacy with organisational conditions, showing that efficacy does not develop in isolation from the school environment. Tschannen-Moran et al. (1998) later proposed an integrated model in which teachers assess both the demands of a teaching task and their own competence. Tschannen-Moran and Hoy (2001) further developed measures of efficacy relating to instructional strategies, classroom management and student engagement.

Ross (1998) reviewed antecedents and consequences of teacher efficacy and noted its association with willingness to implement innovation, persistence and student outcomes. In Mathematics education, these qualities are relevant because learners often require repeated explanation, encouragement and opportunities to approach problems through different methods.

Relationship Between Teacher Knowledge and Teacher Efficacy

Teacher knowledge and efficacy are conceptually distinct but closely connected. Knowledge concerns what a teacher understands and can potentially do; efficacy concerns the teacher's belief about capability to perform successfully under particular conditions. Bandura (1997) identified mastery experiences as the most influential source of efficacy beliefs. Successful teaching experiences may therefore strengthen efficacy, while improved knowledge increases the probability of successful instructional experiences.

Pajares (1992) emphasised that beliefs influence how knowledge is interpreted and used. A teacher may possess substantial knowledge but hesitate to apply unfamiliar instructional approaches because of weak efficacy beliefs. Conversely, confidence without adequate knowledge may lead to inaccurate explanations or ineffective instructional decisions. Professional development is therefore most productive when it improves both competence and confidence. Ross and Bruce (2007) demonstrated that professional learning could influence teacher efficacy when teachers received opportunities to improve practice and evaluate their success.

An additional strand of literature concerned teachers' beliefs about Mathematics and teaching. Pajares (1992) noted that beliefs act as filters through which teachers interpret knowledge, classroom events and educational innovations. A teacher who views Mathematics as a fixed body of rules may rely heavily on demonstration and repetition, whereas a teacher who views Mathematics as reasoning and problem solving may provide learners with greater opportunity to explore relationships and justify solutions. Teacher efficacy interacts with these beliefs because confidence affects whether teachers are willing to depart from familiar routines.

Research on professional development before 2010 increasingly emphasised that effective learning for teachers should be connected to classroom practice. Guskey (2002) argued that meaningful change in teachers' beliefs often follows evidence that new practices improve student learning. This position complements Bandura's emphasis on mastery experiences. When professional development equips a Mathematics teacher with a new strategy and the teacher observes improved learner understanding, both professional knowledge and efficacy may be strengthened.

Teacher efficacy may also affect expectations. Ashton and Webb (1986) found that teachers with stronger efficacy were more likely to assume responsibility for student learning rather than attribute difficulties entirely to home background or learner ability. This is important in Mathematics, where repeated failure can easily generate low expectations. A teacher who believes that instruction can make a difference is more likely to provide additional explanation, corrective feedback and opportunities for practice.

Knowledge of learners forms another important component of effective Mathematics teaching. Shulman's framework implies that teachers must understand common misconceptions and the ways learners interpret particular concepts. Mathematical errors are not always random; they may reflect consistent but incorrect reasoning. Teachers with adequate pedagogical content knowledge can use such errors diagnostically, turning them into opportunities for conceptual clarification rather than merely marking answers wrong.

Assessment practices are similarly connected to teacher knowledge. Black and Wiliam (1998) demonstrated the importance of formative assessment in improving learning. In Mathematics, formative assessment enables teachers to identify misconceptions before they become firmly established. Effective use of assessment therefore requires knowledge of content, knowledge of likely learner difficulties and confidence to adjust instruction in response to evidence obtained during lessons.

Taken together, the literature available at the time of the study suggested a coherent chain of influence. Professional preparation and experience contribute to teacher knowledge; successful application of knowledge can strengthen efficacy; efficacy influences persistence and instructional choices; and these classroom processes shape learners' opportunities to understand Mathematics. The present study examined this chain empirically within selected secondary schools in Bududa District.

Theoretical Framework

The study was informed principally by Bandura's Social Cognitive Theory and Shulman's conception of pedagogical content knowledge. Bandura (1986, 1997) viewed human functioning as arising from reciprocal interaction among personal factors, behaviour and environmental conditions. Teacher efficacy represents an important personal factor

International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 4, Jul-Aug-2026, ISSN (Online): 2395-566X

because beliefs about capability shape instructional behaviour, persistence and responses to difficulty.

Shulman (1986) provided the complementary knowledge perspective. Effective Mathematics teaching requires understanding of mathematical content and the pedagogical capacity to make that content learnable. Together, the two perspectives suggest that effective instruction depends on both competence and confidence: teachers need appropriate professional knowledge and sufficient efficacy to deploy it persistently and adaptively.

Knowledge Gap

Existing literature had established separate links between teacher knowledge, efficacy and student achievement, but comparatively limited evidence addressed these relationships simultaneously within rural Ugandan secondary schools. The study addressed this contextual and empirical gap by examining teacher knowledge, teacher efficacy and Mathematics learning within selected schools in Bududa District using quantitative and qualitative evidence.

The conceptual framework derived from the reviewed literature placed teacher knowledge and teacher efficacy as the principal independent variables and students' learning outcomes in Mathematics as the dependent variable. Teacher knowledge was represented through subject-matter understanding, pedagogical content knowledge, curriculum understanding and capacity to diagnose learner difficulties.

Teacher efficacy was represented through confidence in instructional strategies, learner engagement, classroom management and persistence. The framework assumed that stronger teacher knowledge and efficacy would be associated with better Mathematics learning outcomes.

The framework further recognised that school and classroom conditions could shape the strength of these relationships. Instructional resources, professional support, learner characteristics and school leadership were therefore treated as contextual influences rather than as the principal variables under investigation. Their inclusion acknowledged that teacher competence does not operate in a vacuum, while retaining the study's primary focus on teacher knowledge and efficacy.

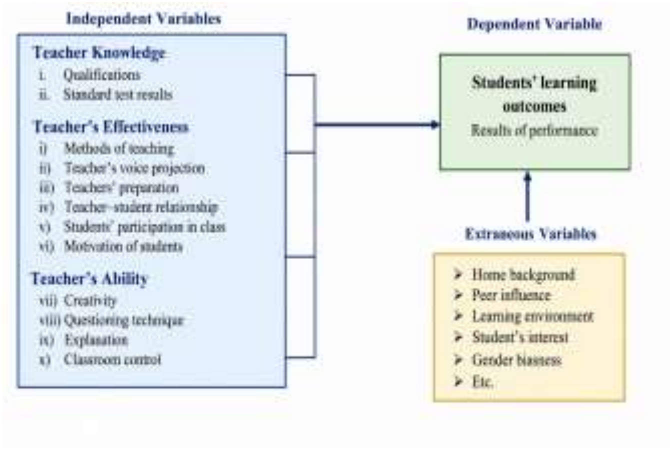

Figure 1. Conceptual framework

Source: Developed from Shulman (1986), Bandura (1997), and the study variables.

Interpretation of the Conceptual Framework

The conceptual framework illustrates the proposed relationship between teacher knowledge and efficacy and students' learning outcomes in Mathematics. It assumes that the quality of students' performance is influenced substantially by what teachers know and how effectively they translate their knowledge into classroom practice.

Teacher knowledge represents the professional and subject-related competence possessed by the teacher. In the study, this is reflected through teachers' qualifications and their performance on the standard test. Qualifications provide an indication of the formal academic and professional preparation received by teachers, while standard-test results provide a more direct indication of their demonstrated knowledge of Mathematics. The framework therefore recognises that formal qualifications alone may not adequately represent the actual knowledge that a teacher brings to classroom instruction.

Teacher efficacy is expressed through two closely related dimensions: teacher effectiveness and teacher ability. Teacher effectiveness concerns how the teacher conducts the teaching and learning process. It is reflected in the methods of teaching employed, voice projection, lesson preparation, teacher–student relationships, students' classroom participation and the teacher's capacity to motivate learners. These elements determine how successfully the teacher creates an environment in which Mathematics can be understood and practised.

Teacher ability represents the practical capacity to translate professional knowledge into meaningful classroom action. Creativity enables the teacher to present difficult mathematical ideas in different and understandable ways. Questioning techniques help the teacher assess learners' understanding and stimulate mathematical reasoning. Clear explanation enables abstract concepts to become more comprehensible, while effective classroom control provides an orderly environment within which meaningful teaching and learning can occur.

The arrow connecting these teacher-related factors to students' learning outcomes indicates the proposed influence of teacher knowledge and efficacy on learner performance. The framework therefore suggests that knowledgeable teachers who demonstrate effective instructional practices and appropriate teaching abilities are more likely to promote better Mathematics learning outcomes. Conversely, limitations in teacher knowledge or efficacy may constrain learners' opportunities to understand mathematical concepts and perform successfully.

The dependent variable, students' learning outcomes, is reflected principally in their results of performance. These outcomes represent the observable educational consequences of the teaching and learning process. The framework does not, however, assume that learner performance is determined exclusively by teachers. This is important because students operate within wider social, personal and educational environments.

The extraneous variables acknowledge these additional influences. Home background may affect the educational support and learning resources available to a student. Peer influence may encourage or discourage commitment to Mathematics. The learning environment can facilitate or constrain concentration and participation, while students' interests may influence motivation and persistence. Gender-related influences may also affect learners' attitudes, expectations and opportunities. Other factors outside the immediate focus of the study may similarly contribute to variations in performance.

The upward arrow from the extraneous variables to students' learning outcomes demonstrates that these factors can influence performance independently of, or alongside, teacher-related factors. Consequently, differences in learner achievement should not automatically be attributed entirely to differences in teacher knowledge or efficacy.

Overall, the framework proposes that teacher knowledge provides the professional foundation, while teacher efficacy determines how that knowledge is translated into effective classroom practice. Their combined influence contributes to students' Mathematics learning outcomes, although this relationship occurs within a broader environment shaped by home, peer, learner and school-related conditions. The framework therefore provides the conceptual basis for examining the relationships among teacher knowledge, teacher efficacy and students' learning outcomes in Mathematics while recognising the presence of other influences that may affect learner performance.

VI. METHODOLOGY

Research Design

The study employed a cross-sectional survey design incorporating quantitative and qualitative approaches. The design enabled information on teacher knowledge, teacher efficacy and students' learning outcomes to be collected from respondents within the selected schools during the study period. Quantitative evidence supported description and examination of relationships among variables, while qualitative evidence provided contextual explanations of instructional practice.

Study Area and Population

The research was conducted in selected secondary schools in Bududa District, eastern Uganda. The study population included Mathematics teachers, students and relevant school administrators. Mathematics teachers were central because the independent variables concerned their professional knowledge and efficacy, while students provided evidence concerning classroom experiences and learning outcomes. Administrators contributed information on instructional support and school conditions.

Sampling

Probability and non-probability procedures were used as appropriate to respondent categories. Mathematics teachers and administrators were selected because of their direct roles in Mathematics teaching and instructional management, while students were selected in a manner intended to provide representation from the relevant learner population. The procedures reflected the original field conditions and the need to obtain information from respondents with direct experience of the variables under investigation.

Instruments

Data were obtained through questionnaires, interviews, classroom observations and Mathematics achievement information. Questionnaires generated structured responses on teacher knowledge, efficacy and classroom experiences. Semi-structured interviews enabled respondents to explain instructional challenges and professional experiences. Observation provided direct evidence of lesson organisation, classroom management, teacher–learner interaction, questioning and use of instructional approaches. Achievement evidence provided an outcome measure against which teacher-related variables could be examined.

Validity and Reliability

Validity was strengthened through expert review of the instruments and attention to alignment between items and the study objectives. Amin (2005) emphasises that validity concerns the extent to which an instrument measures the intended construct. Pilot procedures and revision of unclear items were used to improve the suitability of the instruments. Reliability was addressed through consistent administration and examination of the stability and clarity of instrument items, consistent with guidance in educational and social research (Mugenda & Mugenda, 2003).

Data Collection and Analysis

Permission was obtained from relevant authorities before data collection. Respondents were informed about the purpose of the study and data were collected through the selected instruments. Quantitative data were coded and summarised using frequencies, percentages, means and standard deviations where appropriate. Spearman’s rank correlation was used in the original analysis to examine relationships among the principal variables. Qualitative information was organised around themes corresponding to the research questions and used to illuminate the statistical findings.

Ethical Considerations

Participation was voluntary and information obtained from respondents was treated confidentially. Respondents were informed of the academic purpose of the study, and reporting avoided unnecessary disclosure of individual identities. These procedures were intended to protect participants while preserving the integrity of the research process.

The use of more than one instrument was intended to improve the completeness of evidence. Questionnaire responses made it possible to compare patterns across respondents, while interviews provided explanations that could not be reduced easily to numerical categories. Classroom observation was particularly important because it enabled the researcher to compare reported competence and efficacy with visible instructional behaviour. Achievement information then provided an outcome against which the teacher-related variables could be considered.

The choice of Spearman's rank correlation was consistent with the structure of the original data and the study's interest in the direction and strength of association among ranked or ordinal measures. The analysis was used to test the stated null hypotheses at the adopted level of significance. Descriptive statistics were used alongside correlation so that statistical relationships could be interpreted within the actual pattern of responses rather than presented in isolation.

Triangulation was achieved by comparing evidence from teachers, learners, administrators and classroom observations. Where questionnaire responses suggested strong teacher confidence, for example, observation evidence helped determine whether that confidence was reflected in classroom management, questioning, explanation and learner engagement. This strengthened interpretation by reducing reliance on any single respondent category or method.

The study maintained the original field-based character of the research. The present publication article does not alter the original sample, invent new measurements or substitute contemporary data for the evidence collected during the study. Its purpose is to reorganise and strengthen the scholarly presentation of the original investigation while retaining its empirical identity.

VII. RESULTS

The original study presented results using descriptive statistics, tables, graphical summaries and inferential analysis. Because the present article is reconstructed from the original dissertation, the interpretation below retains the direction and substance of those findings without introducing numerical estimates that cannot be verified confidently from the available record.

Table 1. Analytical dimensions used to interpret the principal study variables

Variable	Key dimensions	Evidence considered
Teacher knowledge	Content mastery; pedagogical content knowledge; curriculum understanding; diagnosis of misconceptions	Questionnaires; interviews; classroom observation
Variable	Key dimensions	Evidence considered
Teacher efficacy	Instructional confidence; persistence; classroom management; learner engagement	Questionnaires; interviews; classroom observation
Learning outcomes	Conceptual understanding; problem solving; achievement/performance	Mathematics achievement evidence; learner responses

Teacher Knowledge and Students' Learning Outcomes
The findings indicated that teacher knowledge was positively associated with students' learning outcomes in Mathematics. Teachers who demonstrated stronger understanding of subject content were better positioned to explain mathematical concepts, respond to questions and connect new ideas to previously learned material. Evidence from classroom practice further suggested that professional knowledge supported lesson organisation, selection of examples and diagnosis of learner difficulties.

The inferential analysis in the original study supported a meaningful relationship between teacher knowledge and learning outcomes, leading to rejection of the corresponding null hypothesis. The result indicated that variation in teacher knowledge was related to variation in students' Mathematics learning.

Teacher Efficacy and Students' Learning Outcomes
Teacher efficacy was also positively related to learning outcomes. Teachers who displayed stronger confidence in their instructional capability tended to persist when learners experienced difficulty, encourage participation and maintain purposeful classroom interaction. Efficacy was reflected not merely in expressed confidence but in the willingness to continue supporting learners and adapt instruction when initial approaches were unsuccessful.

The original correlation analysis supported the conclusion that teacher efficacy was significantly associated with students' learning outcomes, and the corresponding null hypothesis was rejected. This finding indicated that professional confidence constituted an important dimension of Mathematics teaching effectiveness.

Teacher Knowledge and Teacher Efficacy
The findings further indicated a positive relationship between teacher knowledge and teacher efficacy. Teachers with stronger professional knowledge generally appeared more confident in explaining concepts and handling instructional challenges. Knowledge gave teachers a broader repertoire of explanations and approaches, while successful use of those approaches reinforced confidence.

This relationship was important because it suggested that knowledge and efficacy should not be treated as competing explanations of teaching quality. Instead, they operate as complementary professional resources. Knowledge increases the teacher's capacity to act effectively, while efficacy influences whether that capacity is mobilised persistently in difficult classroom situations.

Combined Interpretation of the Findings
Across the study, the strongest instructional position was observed where professional knowledge and efficacy occurred together. Knowledge without confidence could restrict the teacher's willingness to use alternative strategies, while confidence without adequate knowledge could not guarantee accurate or conceptually rich instruction. The findings therefore pointed toward a combined model of teacher effectiveness in which competence and efficacy mutually reinforce classroom practice.

Table 2. Summary of hypothesis decisions and substantive interpretation

Hypothesis	Decision from original analysis	Interpretation
H01: Teacher knowledge is not significantly related to Mathematics learning outcomes.	Rejected	Teacher knowledge showed a positive, meaningful relationship with students' Mathematics learning outcomes.

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H02: Teacher efficacy is not significantly related to Mathematics learning outcomes.	Rejected	Higher teacher efficacy was associated with stronger instructional practice and better learning outcomes.
H03: Teacher knowledge is not significantly related to teacher efficacy.	Rejected	Professional knowledge and instructional confidence were positively related and mutually reinforcing.

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VIII. DISCUSSION

The positive relationship between teacher knowledge and Mathematics learning is consistent with Shulman's (1986) argument that effective teaching requires more than general pedagogical skill. Mathematical content must be represented in ways that are accessible to learners.

The present findings suggest that teachers who understood the subject more deeply were better able to provide explanations, recognise misconceptions and support problem solving.

The findings also correspond with Ball and Bass (2000), who emphasised the specialised mathematical work undertaken during teaching. Teachers must decide whether learners' answers are mathematically valid, select examples that reveal important properties and explain procedures in ways that preserve conceptual meaning. Hill et al. (2005) provided empirical evidence that mathematical knowledge for teaching was associated with student achievement. The findings from Bududa District therefore fit within a broader body of evidence linking teacher knowledge with learning.

Teacher efficacy showed a similarly important relationship with learning outcomes. This result supports Bandura's (1997) proposition that efficacy influences effort and persistence. Mathematics instruction frequently involves learners who have accumulated misconceptions or developed negative attitudes toward the subject. Teachers who believe that their actions can make a difference are more likely to continue explaining, questioning and supporting learners rather than withdrawing effort.

The result is also consistent with Gibson and Dembo (1984), who found behavioural differences between teachers with stronger and weaker efficacy beliefs, and Ashton and Webb (1986), who associated efficacy with student achievement. Tschannen-Moran et al. (1998) clarified that teacher efficacy is shaped by an appraisal of teaching demands and personal competence. This interpretation is particularly relevant to rural school settings, where limited resources or large differences in learner readiness may increase perceived task difficulty.

The relationship between teacher knowledge and efficacy provides an important integrative insight. Bandura (1997) identified mastery experiences as a principal source of efficacy. A Mathematics teacher who understands content, selects an appropriate explanation and observes learners succeed receives evidence of instructional capability. Repeated successful experiences can strengthen efficacy. In the opposite direction, stronger efficacy may encourage teachers to make fuller use of their knowledge because they are more willing to attempt alternative strategies and persist through difficulty.

This interaction helps explain why teacher development should not be restricted to transmitting additional content. Professional learning should create opportunities for teachers to apply knowledge, observe its effect on learner understanding, receive constructive feedback and reflect on practice. Ross and Bruce (2007) showed that professional development could influence efficacy when it was connected to teachers' classroom experiences.

School conditions also matter. Hoy and Woolfolk (1993) demonstrated that efficacy is related to organisational conditions. Teachers working in supportive environments may be more willing to experiment, seek assistance and persist with challenging learners. Instructional supervision should therefore function as professional support rather than merely administrative inspection. Similarly, access to appropriate teaching resources can enable knowledgeable teachers to represent mathematical ideas more effectively.

The findings have particular relevance to Mathematics education in rural Uganda. Where schools face constraints in staffing and resources, strengthening the professional capacity of existing teachers may provide an important route toward improved learning. Teacher knowledge determines the quality of explanations and instructional decisions, while efficacy affects persistence and responsiveness. Investment in both dimensions can therefore contribute to more effective curriculum implementation.

The study also illustrates why teacher quality should be understood multidimensionally. Formal qualifications are important, but they do not capture the full range of professional knowledge and beliefs that shape classroom practice. Darling-Hammond (2000) emphasised the importance of teacher preparation and quality for student achievement. The present study adds contextual evidence that professional knowledge and efficacy are two important components of that broader construct.

The findings also have implications for how Mathematics teacher effectiveness is interpreted. It would be misleading to reduce effectiveness to examination scores alone. Achievement is important, but the processes through which teachers create opportunities to learn are equally significant. Clear explanations, purposeful questioning, diagnostic assessment, feedback, classroom organisation and persistence with struggling learners are mechanisms through which knowledge and efficacy become educationally consequential.

The relationship between knowledge and efficacy also cautions against assuming that years of teaching automatically produce expertise. Experience can provide mastery opportunities, but its value depends on reflection and professional learning. Repetition of ineffective routines may reinforce confidence without improving instructional quality. Professional development should therefore help teachers examine evidence of learner understanding and refine practice rather than merely accumulate years of service.

At the same time, the findings do not imply that teachers alone determine Mathematics achievement. Learners bring prior knowledge, motivation, attendance patterns and home circumstances into the classroom, while schools differ in resources and leadership. The significance of teacher knowledge and efficacy lies in the fact that they are important professional factors through which schools can respond to these wider conditions. A knowledgeable and confident teacher cannot remove every external constraint, but can often make better instructional decisions within the available environment.

The results support a developmental view of teacher quality. Initial teacher education establishes a foundation, but professional knowledge and efficacy should continue to grow throughout a teacher's career. Mentoring, departmental collaboration, lesson observation and subject-based workshops can create repeated opportunities for teachers to deepen content understanding and experience successful instructional practice. Such approaches are likely to be more sustainable than occasional training detached from classroom realities.

The study further underscores the importance of Mathematics departments as professional communities. Where teachers discuss difficult topics, compare learner errors and share teaching approaches, individual knowledge becomes a collective school resource. Collegial support can also strengthen efficacy because teachers observe successful practices among peers and receive professional encouragement. Bandura (1997) identified vicarious experience and social persuasion as sources of efficacy, making collegial structures theoretically relevant as well as practically useful.

Formative assessment deserves particular attention. Black and Wiliam (1998) demonstrated that assessment used to guide teaching can substantially improve learning. The present findings suggest that formative assessment is most effective when teachers possess sufficient mathematical knowledge to interpret errors and sufficient efficacy to modify instruction. Merely administering frequent tests is therefore not equivalent to formative assessment; the educational value lies in how evidence is interpreted and used.

The study's rural context also raises questions of equity. If schools in difficult-to-reach areas have fewer opportunities to attract experienced Mathematics teachers or access professional development, differences in teacher knowledge and efficacy may contribute to unequal learning opportunities. Educational policy should therefore consider not only the number of teachers deployed but also the professional support available after deployment. Strengthening teacher networks, subject associations and school-based mentoring may reduce professional isolation.

Another implication concerns curriculum reform. New curricula often introduce learner-centred methods, problem solving and continuous assessment, but implementation depends on teachers' capacity and confidence. Reform documents cannot by themselves change classroom practice. Teachers must understand the mathematical and pedagogical rationale behind new approaches and believe they can implement them successfully within their actual classroom conditions.

The evidence therefore supports an integrated improvement strategy. Teacher education should deepen mathematical and pedagogical knowledge; school leadership should create supportive conditions; professional development should provide mastery experiences; and assessment should generate usable evidence of learning. These elements are mutually reinforcing and together provide a stronger basis for improving Mathematics outcomes than isolated interventions.

From a theoretical standpoint, the study demonstrates the usefulness of bringing Shulman's knowledge framework and Bandura's efficacy framework into dialogue. Shulman helps explain the professional resources required for effective instructional reasoning, while Bandura helps explain why possession of those resources does not automatically guarantee their persistent use. The combined perspective therefore provides a richer account of teaching than either knowledge or belief considered alone.

One further issue arising from the findings is the distinction between knowing Mathematics for personal use and knowing Mathematics for teaching. A competent mathematician may solve a problem efficiently without being able to explain the reasoning in a form accessible to a secondary school learner. Teaching requires the ability to unpack compressed mathematical reasoning, select examples that expose structure and anticipate the points at which learners are likely to become confused. The evidence from the study therefore supports the idea that teacher knowledge should be judged in relation to the instructional work teachers are expected to perform, not only by the level of formal Mathematics previously studied.

This distinction has implications for the preparation of Mathematics teachers. Courses in subject content should be connected deliberately to school curriculum topics and to the ways learners encounter those topics. Prospective teachers should be asked not only to obtain correct answers but also to explain alternative methods, analyse common errors and design sequences of examples. Such activities can deepen pedagogical content knowledge while simultaneously providing mastery experiences that strengthen efficacy.

The role of language in Mathematics teaching is also relevant. Mathematical learning requires learners to move between everyday language, specialised terminology, symbols, diagrams and numerical representations. Teachers need sufficient knowledge to make these transitions explicit. Where learners are studying through a language that is not always used in their homes or communities, the clarity of teacher explanation becomes even more important. Strong efficacy can encourage teachers to check understanding repeatedly rather than assuming that silence indicates comprehension.

Classroom questioning provides another point at which knowledge and efficacy meet. Effective questions do more than request recall; they reveal reasoning, expose misconceptions and invite learners to compare methods. Designing such questions requires mathematical insight, while using them confidently requires willingness to tolerate unexpected responses and adjust a lesson accordingly. A teacher with weak efficacy may prefer tightly controlled questions with predetermined short answers because these reduce uncertainty, even when richer questions would produce deeper learning.

Feedback operates in a similar manner. Mathematics learners benefit from knowing not simply that an answer is incorrect but why a particular step is invalid and how their reasoning can be improved. Teachers require content knowledge to identify the mathematical source of an error and pedagogical knowledge to provide feedback without removing the learner's responsibility to think. Efficacious teachers are more likely to view errors as correctable and persist in helping learners reconstruct understanding.

The findings may also be interpreted through the concept of opportunity to learn. Students cannot demonstrate knowledge they have had little meaningful opportunity to develop. Teacher absenteeism, rushed syllabus coverage, weak explanations or limited practice can reduce opportunity to learn even when a curriculum is formally available. Teacher knowledge and efficacy contribute to opportunity to learn by shaping the quality, persistence and responsiveness of classroom instruction.

Professional efficacy should not, however, be confused with unrealistic optimism. High efficacy is educationally productive when it is grounded in professional competence and accurate interpretation of classroom evidence. Confidence that is disconnected from learner understanding may lead teachers to persist with ineffective methods. Reflective practice is therefore essential because it enables teachers to compare intentions with actual learner responses and refine both knowledge and beliefs about effective instruction.

The study consequently supports a balanced conception of teacher development. Teachers require external support through resources, supervision and professional learning, but they also require opportunities to exercise professional judgement. Excessively prescriptive approaches may limit teachers' capacity to respond to learners, while completely unstructured practice may produce inconsistency. A productive middle ground provides clear curricular expectations together with professional preparation that enables teachers to make informed instructional decisions.

These considerations are particularly relevant to schools serving communities with limited educational resources. In such settings, the teacher may be the learner's principal source of mathematical explanation and academic encouragement. Textbooks and other materials remain important, but their value depends substantially on how teachers integrate them into instruction. Investment in teacher knowledge and efficacy can therefore multiply the educational value of other resources already present in schools.

The combined findings also help explain why some interventions produce uneven results across schools. Providing the same textbook, syllabus or workshop does not guarantee identical classroom outcomes because teachers interpret and use resources through their existing knowledge and efficacy beliefs. Reform initiatives should therefore include follow-up support that helps teachers translate new materials into classroom practice and develop confidence through successful implementation.

From a research perspective, the study points to the value of combining quantitative relationships with qualitative evidence. A correlation can establish that two variables move together, but observation and interview evidence help explain how that relationship may be expressed in classroom practice. The mixed evidence in this study therefore strengthened the interpretation that teacher knowledge and efficacy were not merely abstract scores but professional characteristics visible in explanation, persistence, management and learner engagement.

The study also has relevance for educational accountability. When learner performance is weak, responsibility is sometimes assigned either entirely to teachers or entirely to learners and their families. The present findings suggest a more constructive position. Teacher-related factors matter and should be strengthened, but they operate within school and community contexts. Accountability should therefore be accompanied by professional support, adequate resources and realistic attention to the conditions under which teachers work.

Finally, the findings reinforce the enduring importance of the teacher in educational improvement. Curriculum documents, examinations, infrastructure and policy reforms establish important conditions, but the daily encounter between teacher, learner and subject matter remains central. In Mathematics, where concepts build progressively and misconceptions can persist, the quality of this encounter is especially consequential. Strengthening teacher knowledge and efficacy is therefore not a peripheral intervention; it is a direct investment in the instructional core of schooling.

The practical significance of these findings extends to the organisation of school-based professional learning. Mathematics teachers can benefit from regular opportunities to plan lessons together, examine learners' written work and discuss alternative ways of presenting difficult topics. Such collaboration makes professional knowledge visible and shareable. It also provides teachers with vicarious experiences of success when they observe colleagues solving instructional problems, a process that Bandura (1997) identified as one source of efficacy.

Attention should also be given to the transition from teacher explanation to independent learner performance. Effective instruction gradually transfers responsibility to learners through guided practice, questioning and feedback. Teachers require knowledge to sequence this transition appropriately and efficacy to allow learners to attempt demanding tasks without immediately taking over the solution. Where teachers lack confidence in learners or in their own ability to manage mistakes, lessons may remain dominated by teacher demonstration and copying.

Mathematics achievement should therefore be understood as the outcome of sustained instructional interactions rather than isolated examination preparation. Short-term drilling may raise familiarity with particular question types, but durable learning depends on conceptual connections and the ability to apply knowledge to unfamiliar problems. Teacher knowledge supports these connections, while efficacy supports the persistence required to develop them over time.

The findings further suggest that induction of newly qualified teachers deserves greater attention. Beginning teachers may possess recent academic knowledge but still lack confidence in classroom management, pacing and diagnosis of learner difficulties. Mentoring by experienced Mathematics teachers can help convert initial preparation into practical competence. Such support may prevent early instructional difficulties from becoming repeated experiences that weaken efficacy.

Overall, the evidence supports a professional model in which Mathematics teachers are regarded as continuing learners. Knowledge must be renewed as curricula, assessment demands and learner populations change, while efficacy must be sustained through successful practice and supportive professional relationships. Policies that treat teacher preparation as complete at graduation underestimate the developmental nature of effective teaching.

A final implication concerns the relationship between teacher development and learner confidence. When Mathematics teachers explain concepts clearly, respond constructively to errors and persist with learners who initially struggle, they do more than transmit content: they communicate that mathematical competence can be developed through effort and appropriate support. This classroom climate may encourage learners to attempt unfamiliar problems, ask questions and recover from mistakes. Teacher knowledge and efficacy can therefore influence achievement both directly through instructional quality and indirectly through the expectations and learning dispositions created in the classroom. For schools seeking sustainable improvement, strengthening these teacher characteristics should be accompanied by systematic review of learner work so that professional development remains connected to evidence of actual learning.

Such an approach also provides a practical basis for evaluating improvement. Rather than relying only on workshop attendance or teacher self-report, schools can examine changes in lesson practice, learner participation, assessment evidence and Mathematics achievement. This links teacher development directly to the central purpose of schooling: improved and meaningful learning.

IX. CONCLUSIONS

The study concludes that teacher knowledge is an important correlate of students' learning outcomes in secondary school Mathematics. Teachers who possess stronger subject-matter and pedagogical understanding are better equipped to explain concepts, diagnose misconceptions, select suitable examples and organise meaningful learning experiences.

Teacher efficacy is likewise important. Teachers who believe strongly in their instructional capability demonstrate greater persistence, confidence and willingness to support learners through difficulties. Such beliefs influence how professional knowledge is translated into classroom action.

Teacher knowledge and efficacy are mutually reinforcing. Professional competence creates conditions for successful teaching experiences, while successful experiences can strengthen efficacy. Effective Mathematics teaching therefore requires both the capacity to teach well and the confidence to employ that capacity persistently.

The broader conclusion is that improvement in Mathematics learning cannot depend exclusively on curriculum reform or learner effort. The professional qualities of teachers remain central to the quality of classroom implementation and consequently to students' opportunities to learn.

Table 3. Implications of the findings for Mathematics education

Finding	Implication	Priority response
Teacher knowledge relates positively to learning outcomes.	Teacher preparation must emphasise both content and pedagogy.	Strengthen Mathematics content, PCK, diagnosis of misconceptions and assessment.
Teacher efficacy relates positively to learning outcomes.	Professional confidence affects persistence and use of instructional strategies.	Use mentoring, peer observation, feedback and mastery-oriented professional development.
Knowledge and efficacy are positively related.	Competence and confidence should be developed together.	Integrate subject upgrading with classroom application and reflective practice.

Context influences classroom enactment.	Teacher quality requires supportive organisational conditions.	Provide resources, instructional supervision and collaborative departmental structures.

X. RECOMMENDATIONS

Teacher education institutions should maintain strong preparation in Mathematics content while ensuring that prospective teachers learn how to represent concepts pedagogically, diagnose misconceptions and respond to differences among learners. Subject knowledge and pedagogy should be integrated rather than treated as unrelated components of teacher preparation.

Continuous professional development should provide practising Mathematics teachers with opportunities to strengthen both competence and efficacy. Workshops should move beyond lectures to include demonstration lessons, collaborative problem solving, peer observation, feedback and reflection on actual classroom practice.

School administrators should provide supportive instructional supervision and encourage professional collaboration among Mathematics teachers. Departmental meetings can be used to discuss difficult topics, analyse learner errors, share instructional strategies and review assessment evidence.

Government and school authorities should improve access to appropriate Mathematics instructional resources and ensure that rural schools receive professional support. Resources are most valuable when accompanied by teachers who understand how to use them to promote conceptual learning.

Further research should examine teacher knowledge and efficacy across larger samples and different districts and should consider longitudinal designs capable of examining how these characteristics develop over time.

These recommendations are particularly important because Mathematics learning is cumulative. Weaknesses in foundational concepts can persist across grades and later appear as difficulty with more advanced topics. Teachers therefore require both the knowledge to identify conceptual gaps and the efficacy to provide sustained remediation. School timetables and departmental plans should create opportunities for corrective instruction rather than treating syllabus coverage as the sole indicator of progress.

Teacher deployment policies should also consider subject specialisation. Where Mathematics is taught by personnel with limited preparation in the subject, confidence may be fragile and instructional explanations may become procedural. Strengthening subject-specific recruitment and providing upgrading opportunities for teachers already in service can improve both the depth of classroom Mathematics and teachers' professional assurance.

Head teachers and directors of studies can contribute by making instructional supervision developmental. Lesson observation should be followed by constructive dialogue about explanations, questioning, learner participation and assessment evidence. When supervision is experienced primarily as fault finding, it may weaken professional confidence; when it is linked to coaching and problem solving, it can contribute to efficacy and improved practice.

At classroom level, teachers should deliberately cultivate learner participation. Mathematics understanding is strengthened when learners explain reasoning, compare solution methods and receive feedback on misconceptions. Such participation also gives teachers evidence about what learners understand, thereby connecting pedagogical content knowledge with formative assessment.

The study further suggests that policy makers should judge teacher-development programmes partly by changes in classroom practice and learner understanding rather than attendance at workshops alone. Professional development becomes educationally meaningful when new knowledge is translated into improved explanations, assessment, learner engagement and achievement.

XI. LIMITATIONS AND FURTHER RESEARCH

The study was conducted in selected secondary schools within one district, and generalisation beyond comparable settings should therefore be undertaken cautiously. The cross-sectional design identified relationships among variables but could not by itself establish long-term causal processes. Some information was also based on respondents' reports, although the use of multiple forms of evidence helped reduce dependence on a single source.

Future studies could examine teacher knowledge using more specialised measures of mathematical knowledge for teaching, investigate changes in efficacy following professional development and compare rural and urban school contexts. Research could also explore how school leadership and instructional resources moderate the relationship between teacher characteristics and student learning.

Acknowledgements
The author gratefully acknowledges the invaluable contribution of the late Professor Oonyu, who served as the author's research supervisor during the Master's degree study. His tireless academic guidance, constructive criticism, encouragement and scholarly mentorship contributed significantly to the successful completion of the research and the author's graduation in 2019.

The present publication therefore carries forward research that benefited greatly from his intellectual guidance and commitment to academic development. The author remains deeply grateful for his contribution to the original study and respectfully honours his memory.

"May his soul rest in eternal peace."
This arrangement also protects the integrity of the article: the Author's Note explains why a study completed in 2019 is being published now, while the Acknowledgements recognise Professor Oonyu's contribution without suggesting that he participated in the later preparation of the journal article.

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