



Physics teachers' content mastery and students' academic performance in secondary schools in Busia County, Kenya

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ABSTRACT

Students' academic performance in Physics remains a concern in secondary education because the subject requires conceptual understanding, mathematical reasoning and the application of scientific principles. This study examined the relationship between Physics teachers' content mastery and students' academic performance in secondary schools in Busia County, Kenya. The study was guided by Bandura's (1986) Social Cognitive Theory, which explains learning through the interaction of personal, behavioural and environmental factors. A correlational survey design was employed within a broader mixed-methods study. The target population comprised 176 secondary schools, 356 Physics teachers, 3,873 Form Three Physics students and school administrators. Stratified random sampling was used to select schools, simple random sampling to select teachers and students, and purposive sampling to select school administrators. The sample comprised 12 secondary schools, 30 Physics teachers, 240 Form Three students and 10 school administrators. Data were collected using structured questionnaires, a Physics Achievement Test, students' performance records, classroom observations and administrator interviews. Quantitative data were analysed using descriptive statistics and Pearson's product-moment correlation, while qualitative data provided contextual interpretation. Teachers' content mastery received a positive composite rating ($M = 3.9$, $SD = 0.6$), while students' Physics Achievement Test scores had a mean of 56.3 ($SD = 12.4$). Pearson's correlation revealed a positive and statistically significant relationship between teachers' content mastery and students' academic performance ($r = .62$, $p < .05$). The study recommends strengthening Physics teachers' subject-content preparation and continuous professional development, particularly in explaining difficult concepts, addressing misconceptions and connecting new knowledge to learners' prior experiences. The findings suggest that teachers' content mastery is an important factor associated with students' Physics achievement, although the correlational design does not establish causation.

Keywords: Physics teachers, content mastery, academic performance, secondary schools, Busia County.

I. INTRODUCTION

Physics is an important component of science education because it develops learners' understanding of natural phenomena, quantitative reasoning, problem-solving and scientific inquiry. Bao and Koenig (2019). However, students' achievement in Physics continues to present challenges in many secondary-school contexts. The difficulty of the subject is partly associated with its demand for conceptual understanding, mathematical reasoning and the ability to connect theoretical principles with observable phenomena (Yang et al., 2021). The quality of Physics teaching is therefore important in determining the learning opportunities available to students. Among the professional competencies required of teachers, mastery of subject content is particularly important because teachers must possess sufficient conceptual understanding to explain scientific principles accurately, identify misconceptions and respond appropriately to learners' questions. Content knowledge mastery also provides a foundation upon which teachers develop pedagogical decisions concerning how difficult or abstract Physics concepts should be represented to learners.

The relationship between teachers' professional knowledge and students' learning has received considerable attention in education research. Shulman (1986) conception of teacher knowledge emphasised the importance of subject-matter knowledge and pedagogical content knowledge in effective teaching. Similarly, Baumert et al. (2010) demonstrated an association between teachers' professional knowledge and students' academic progress, while Baumert and Kunter (2013) conceptualised professional competence as incorporating teachers' knowledge and skills that support effective classroom instruction. Within Physics subject teaching and learning, teachers require more than general pedagogical



knowledge. They must understand the conceptual structure of Physics and anticipate common misconceptions that learners develop. Fischer and Kauertz (2002) emphasised the importance of professional competencies in Physics teaching, while Gess-Newsome (1999) highlighted the importance of transforming subject content knowledge into forms that learners can understand. Keller et al. (2017) similarly demonstrated the relevance of Physics teachers' professional knowledge to students' achievement and interest.

The Kenyan context provides an important setting for examining this relationship. Oduol (2018), in a study of secondary schools in Busia County, investigated factors associated with poor performance in science subjects. The study involved students and teachers from schools in and outside Busia County and identified instructional methodology, attitudes toward science, home circumstances, absenteeism and inadequacy of instructional materials and physical facilities among factors associated with poor science performance. The study therefore established a broader local concern regarding science achievement, but did not specifically examine the relationship between Physics teachers' content mastery and students' Physics achievement. This distinction is important. Evidence concerning science subjects generally cannot automatically be assumed to represent Physics because Physics has distinctive conceptual and mathematical demands. Furthermore, studies of examination performance alone do not necessarily explain the teacher-related factors associated with students' achievement. There is therefore a need for empirical examination of specific teacher competencies in relation to Physics performance within the local context. The present study addressed this gap by focusing specifically on teachers' mastery of Physics content and its relationship with students' academic performance in secondary schools in Busia County. The study was guided by Bandura's (1986) Social Cognitive Theory, which recognises reciprocal relationships among personal, behavioural and environmental factors in learning. From this perspective, teachers' knowledge and instructional behaviour form part of the social environment through which learners develop understanding, motivation and academic capabilities.

1.1 Problem Statement

Despite the importance of Physics in developing scientific reasoning, problem-solving skills and technological competencies, students' academic performance in the subject remains a concern in secondary-school education. In Busia County, Oduol (2018) identified several factors associated with poor performance in science subjects, including instructional methodologies, inadequate learning resources, absenteeism and learners' attitudes. However, these findings addressed science performance broadly and did not specifically establish the contribution of Physics teachers' content mastery to students' achievement. Teachers' mastery of subject content is essential for explaining abstract concepts, addressing learners' misconceptions and guiding the application of Physics principles to problem-solving. Research has also demonstrated the importance of teachers' professional knowledge in supporting students' learning and academic progress (Baumert et al., 2010; Keller et al., 2017).

Nevertheless, the extent to which Physics teachers' content mastery is associated with students' academic performance in secondary schools in Busia County remains insufficiently established. Evidence from other educational contexts may not fully explain the relationship within the county, given differences in school resources, instructional conditions and learner characteristics. This gap limits the availability of context-specific evidence that could inform teacher professional development and strategies for improving Physics achievement. Therefore, this study sought to examine the relationship between Physics teachers' content mastery and students' academic performance in secondary schools in Busia County, Kenya

1.2 Research Objective

To determine the relationship between Physics teachers' content mastery and students' academic performance in secondary schools in Busia County, Kenya.

1.3 Research Hypothesis

The study tested the following null hypothesis: There is no statistically significant relationship between Physics teachers' content knowledge mastery and students' academic performance in Physics in secondary schools in Busia County, Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Bandura's Social Cognitive Theory

The study was informed by Bandura's Social Cognitive Theory (1986). The theory proposes that learning occurs through reciprocal interaction among personal factors, behaviour and environmental conditions. Within the present study, teachers constitute an important component of the learning environment. Their knowledge of Physics influences how concepts are represented explained and discussed during instruction. Teachers, who demonstrate accurate understanding of Physics can model appropriate scientific reasoning, respond to learners' questions and address misconceptions. The theory therefore provides a useful framework for examining the association between teacher content mastery and student performance without assuming that teacher content mastery alone determines achievement. Students' learning is also shaped by learner characteristics, classroom conditions, instructional resources and other contextual factors.

2.2 Empirical Review

2.2.1 Relationship between Physics teachers' content mastery and students' academic performance

Content mastery refers to a teacher's understanding of the concepts, principles, relationships and applications within the subject being taught. In Physics, this knowledge encompasses both foundational concepts and the ability to explain relationships among physical quantities and phenomena. Shulman (1986) argued that teachers require specialised forms of knowledge that enable them to represent subject matter in ways that are accessible to learners. This perspective is particularly relevant to Physics because many concepts are abstract and cannot be understood adequately through memorisation alone.

Baumert and Kunter (2013) similarly positioned professional knowledge as a central component of teacher competence. Their framework distinguishes different forms of teacher knowledge while recognising the importance of knowledge for effective instruction. Baumert et al. (2010) found that teachers' professional knowledge was associated with students' learning progress, suggesting that the knowledge teachers possess can be reflected in student learning outcomes. In Physics subject teaching and learning, content mastery is especially important because learners frequently develop misconceptions concerning motion, force, electricity, energy, waves and other abstract concepts. A teacher with strong conceptual knowledge is better positioned to recognise incorrect reasoning, provide accurate explanations and connect new concepts with learners' existing knowledge.

Fischer and Kauertz (2002) emphasised the importance of professional competencies specific to Physics teaching. Similarly, Gess-Newsome (1999) noted that teachers' subject knowledge must be transformed into forms that facilitate learning. This implies that content mastery is not simply possession of factual information but includes the ability to use that knowledge meaningfully during instruction.

Keller et al. (2017) further demonstrated the relevance of Physics teachers' pedagogical content knowledge and motivation to students' achievement and interest. Collectively, these studies suggest that teachers' knowledge of Physics provides an important foundation for effective classroom learning. Nevertheless, evidence from other settings cannot be assumed to apply directly to secondary schools in Busia County. Local school conditions, teacher preparation, available resources and learner characteristics may shape the relationship between teacher competence and student achievement. The present study consequently provides empirical evidence from the county-specific context.

III. METHODOLOGY

3.1 Research Design

The study adopted a correlational survey design to examine the relationship between Physics teachers' content mastery and students' academic performance in secondary schools in Busia County, Kenya. The design was appropriate because it enabled the researcher to establish the direction and strength of the relationship between the study variables without manipulating them or inferring causation. Although the broader study employed a sequential explanatory mixed-methods approach, the present article focuses primarily on the quantitative correlational component, with qualitative evidence providing contextual interpretation where relevant.

3.2 Study Area

The study was conducted in secondary schools in Busia County, located in western Kenya. The county was selected because of the documented concerns regarding science performance in its secondary schools and the need to investigate



teacher-related factors associated with students' achievement in Physics (Oduol, 2018). The study focused on Physics teachers and Form Three students in selected secondary schools.

3.3 Target Population

The target population comprised 176 secondary schools, 356 Physics teachers, 3,873 Form Three Physics students and school administrators in Busia County. Physics teachers were the primary respondents for assessing content mastery, while Form Three students provided data on academic performance. School administrators contributed contextual information on Physics instruction and school-level factors that could influence students' learning.

3.4 Sampling and Sample Size

The study sampled 12 secondary schools, 30 Physics teachers, 240 Form Three students and 10 school administrators. Schools were selected through stratified random sampling, while Physics teachers and students were selected through simple random sampling. School administrators were purposively selected because of their leadership responsibilities and knowledge of instructional practices within their schools. Of the 30 sampled Physics teachers, 28 completed the questionnaires, representing a response rate of 93.3%. Similarly, 232 of the 240 sampled students participated in the study, yielding a response rate of 96.7%. All 10 school administrators participated in the qualitative component.

3.5 Data Collection Instruments and Procedures

Data were collected using structured questionnaires, a Physics Achievement Test (PAT), students' Physics performance records, interviews, classroom observations and document analysis. The teacher questionnaire assessed content mastery in explaining Physics concepts, identifying and correcting learners' misconceptions, responding accurately to students' questions, organising concepts logically and connecting new knowledge with learners' prior experiences. Students' academic performance was assessed using the PAT, supplemented by their Physics performance records. Semi-structured interviews with school administrators, classroom observations and document analysis provided additional information for interpreting the quantitative findings. Form Three students were selected because they had acquired substantial exposure to secondary-school Physics content before the final national examination stage.

3.6 Data Analysis

Quantitative data were coded and analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including means and standard deviations, were used to summarise teachers' content mastery and students' academic performance. Pearson's product-moment correlation coefficient was used to establish the direction and strength of the relationship between teachers' content mastery and students' academic performance. Statistical significance was evaluated at the 5% significance level ($p < .05$). Qualitative data from interviews and classroom observations were analysed thematically to provide contextual insights into the quantitative results.

3.7 Ethical Considerations

The study observed relevant ethical principles governing educational research. Participation was voluntary, and informed consent was obtained from adult participants. Appropriate consent and assent procedures were followed for student participants, including parental or guardian consent where required. Confidentiality and anonymity were maintained by excluding personally identifying information from the analysis and reporting. The researcher also sought the necessary research authorisations and institutional permissions before collecting data. Participants were informed of the purpose of the study, their right to decline participation and their freedom to withdraw without penalty. Data were handled securely and used solely for the stated research purposes.

IV. FINDINGS AND DISCUSSION

4.1 Physics Teachers' Content Mastery

The findings indicated that students generally perceived their Physics teachers as having adequate mastery of subject content. The composite mean score was 3.9 (SD = 0.6) on a five-point Likert scale. As presented in Table 1, teachers' ability to identify and correct learners' misconceptions received the highest rating (M = 4.1, SD = 0.5), followed by their ability to explain Physics concepts clearly (M = 4.0, SD = 0.6). The logical organisation and presentation of Physics content recorded a mean of 3.9 (SD = 0.6), while responding to learners' questions confidently and accurately had a mean of 3.8 (SD = 0.7).



Connecting new concepts to learners' prior knowledge and experiences received the lowest rating ($M = 3.7$, $SD = 0.6$), although the overall assessment remained positive.

Table 1

Students' Ratings of Physics Teachers' Content Mastery

Content-mastery indicator	Mean	SD
Identifies and corrects learners' misconceptions effectively	4.1	0.5
Explains Physics concepts clearly and understandably	4.0	0.6
Organises and presents Physics content logically and sequentially	3.9	0.6
Responds to learners' questions with confidence and accuracy	3.8	0.7
Connects new Physics concepts to learners' prior knowledge and experiences	3.7	0.6
Composite mean	3.9	0.6

These findings suggest that students generally perceived their teachers as demonstrating competence in explaining Physics concepts and addressing learning difficulties. The relatively high rating for identifying and correcting misconceptions is particularly relevant because Physics learners may hold intuitive explanations of scientific phenomena that differ from accepted scientific principles. Teachers require sound subject knowledge to identify inaccurate reasoning and guide learners towards scientifically valid explanations. This interpretation is consistent with Shulman (1986) account of teacher knowledge, which emphasises the importance of subject-matter understanding in effective instruction. However, the lower rating for connecting new concepts to prior knowledge suggests an area in which instructional practice could be strengthened. Gess-Newsome (1999) similarly highlighted the importance of transforming subject knowledge into forms that facilitate learners' understanding. It is important to note that these results represent students' perceptions of teachers' content mastery rather than an independent assessment of teachers' actual subject knowledge.

4.2 Students' Academic Performance in Physics

Students' performance on the Physics Achievement Test had a mean score of 56.3 ($SD = 12.4$). The standard deviation indicates variation in achievement among the participating students, suggesting that their demonstrated understanding of the assessed Physics content was not uniform. While the mean provides an overall summary of performance, the variation in scores indicates that students differed in their ability to answer the assessment questions. These differences provide a relevant basis for examining whether students' achievement was associated with their teachers' content mastery. Nevertheless, the extent to which the mean represents satisfactory or unsatisfactory performance depends on the test's maximum score and established performance benchmarks, which should be specified when reporting the results.

4.2 Relationship Between Physics Teachers' Content Mastery and Students' Academic Performance

The study examined the relationship between Physics teachers' content mastery and students' academic performance using Pearson's product-moment correlation coefficient. The results, presented in Table 2, showed a positive correlation between the two variables ($r = .62$, $p < .05$). This indicates that higher reported levels of teachers' content mastery were associated with higher student achievement in Physics. Since the reported probability value was below the predetermined significance level of .05, the null hypothesis that there was no statistically significant relationship between teachers' content mastery and students' academic performance was rejected.

Table 2

Relationship Between Teachers' Content Mastery and Students' Academic Performance

Variables	Pearson's r	p-value
Teachers' content mastery and students' academic performance	0.62	< .05

The positive relationship is consistent with Baumert et al. (2010), who demonstrated the importance of teachers' professional knowledge in students' learning progress. It also aligns with Baumert and Kunter (2013) conceptualisation of professional competence as incorporating knowledge and skills that support effective classroom instruction. Shulman (1986) further argued that teachers need adequate subject-matter knowledge to represent content accurately and make it accessible to learners. In Physics, such knowledge is particularly important because learners must understand abstract scientific principles, interpret mathematical relationships and apply theoretical concepts to practical situations. Teachers who possess



strong content knowledge may be better equipped to clarify difficult concepts, identify misconceptions and provide accurate explanations that support learning.

The qualitative findings provided further contextual insight into the observed association. School administrators reported that teachers with strong subject knowledge were better able to explain difficult concepts, respond to learners' questions and address misconceptions. Classroom observations also indicated that teachers demonstrating a strong command of Physics content could explain abstract principles relate concepts to practical situations and correct inaccurate learner reasoning. These observations help illustrate how teachers' content mastery may be reflected in classroom practice and learning opportunities. The findings are also consistent with Keller et al. (2017), whose work examined the relevance of Physics teachers' professional knowledge to students' achievement and interest.

The finding that connecting new concepts to learners' prior knowledge received the lowest mean rating further suggests that subject mastery should be accompanied by effective approaches to presenting and contextualising content. Knowing Physics is not necessarily sufficient to ensure that learners understand it; teachers must also identify what students already know and build explanations that help them connect existing knowledge with new scientific concepts. This reinforces the distinction between subject-matter knowledge and the ability to make that knowledge accessible through instruction, as emphasised by Shulman (1986) and Gess-Newsome (1999).

Although the correlation of .62 indicates a substantial positive association, the results do not establish that teachers' content mastery caused higher academic performance. Students' achievement may also be influenced by instructional methods, learning resources, motivation, prior achievement and school-level conditions. Furthermore, the study relied partly on students' perceptions when assessing teachers' content mastery, which may not fully correspond to teachers' objectively measured subject knowledge. The findings should therefore be interpreted as evidence of a statistically significant relationship within the sampled secondary schools rather than proof of a direct causal effect. Overall, the quantitative and qualitative findings support the importance of Physics teachers' content mastery as a relevant factor associated with students' academic performance in Busia County.

V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study established a statistically significant positive relationship between Physics teachers' content mastery and students' academic performance in secondary schools in Busia County, Kenya. Students generally rated their teachers positively, particularly in identifying and correcting misconceptions and explaining Physics concepts clearly. The Physics Achievement Test results showed variation in students' performance, while the correlation analysis demonstrated that higher reported levels of teachers' content mastery were associated with higher student achievement ($r = .62, p < .05$). Accordingly, the null hypothesis was rejected. These findings support the importance of subject-matter knowledge in Physics instruction and suggest that strengthening teachers' mastery of Physics content may be a useful component of efforts to improve students' learning. However, given the correlational design, the relationship should not be interpreted as causal, and other learner, teacher and school factors may also contribute to achievement.

5.2 Recommendations

Physics teacher education programmes should strengthen subject-content preparation alongside pedagogical training to ensure that teachers develop a sound understanding of scientific principles and can explain them accurately. Continuous professional development programmes should prioritise challenging Physics concepts, common learner misconceptions and strategies for explaining abstract principles through practical examples. Schools should also promote collaborative planning, peer lesson observation and subject-based professional learning to help teachers improve content delivery and connect new concepts to learners' prior knowledge. In addition, education stakeholders should support access to appropriate instructional materials and practical learning resources that enable teachers to demonstrate and reinforce Physics concepts. Further research should use larger samples, direct assessments of teachers' subject knowledge and longitudinal or multilevel designs to investigate the relationship between teacher content mastery and student achievement across different school contexts.



Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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