

Scaling Competency-Based Education Implementation Outcomes and Selected SDG 4-Related Educational Outcomes in Kenya: Evidence from Siaya County

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ABSTRACT

Competency-Based Education (CBE) represents an important approach to transforming education systems from content-oriented models toward learning processes that emphasize competencies, application of knowledge, problem solving, creativity, collaboration and learner-centred development. In Kenya, the implementation of the Competency-Based Curriculum (CBC) has been accompanied by substantial institutional and systemic changes, yet evidence concerning whether the scaling of implementation is associated with broader educational outcomes aligned with Sustainable Development Goal 4 (SDG 4) remains limited at the school level. This study examined the relationship between the scaling of CBE implementation and selected SDG 4-related educational outcomes in Siaya County, Kenya. The study was guided by General Systems Theory and adopted a correlational research design. The target population comprised 13,066 education stakeholders, from whom a sample of 388 respondents was determined using Yamane's formula. A total of 372 usable questionnaires were returned and analysed. Data were collected using a structured questionnaire whose overall internal consistency reliability was Cronbach's $\alpha = .82$. Descriptive statistics and Pearson product-moment correlation were used for analysis at the .05 significance level. The findings showed that the reported level of CBE implementation scaling was relatively high ($M = 3.68$, $SD = .54$), while the level of selected SDG 4-related educational outcomes was also relatively high ($M = 3.61$, $SD = .57$). Pearson correlation analysis established a positive, statistically significant association between CBE implementation scaling and SDG 4-related educational outcomes, $r(370) = .520$, $p < .001$. The coefficient of determination was $r^2 = .270$, indicating that approximately 27.0% of the variance was shared linearly between the two composite measures. The null hypothesis was therefore rejected. The findings suggest that stronger reported scaling of CBE implementation is associated with stronger reported SDG 4-related educational outcomes. However, because the study was correlational and relied substantially on respondent-reported data, the findings should not be interpreted as evidence of causality or comprehensive national attainment of SDG 4. The study recommends strengthening implementation fidelity, institutionalization, sustainability, equity and system-level support for CBE while improving monitoring mechanisms that connect curriculum implementation with measurable educational outcomes.

Keywords: Competency-Based Education; curriculum implementation; scaling; Sustainable Development Goal 4; educational quality; equity; learning outcomes; Kenya

INTRODUCTION

Education remains a fundamental instrument for human development, social transformation, economic productivity and sustainable development. Beyond expanding access to schooling, contemporary education systems are increasingly expected to ensure that learners acquire relevant knowledge, competencies, values, skills and dispositions that enable them to participate meaningfully in society and respond to changing social, economic, technological and environmental conditions. This orientation is closely aligned with Sustainable Development Goal 4 (SDG 4), adopted by the United Nations in 2015, which calls for inclusive and equitable quality education and the promotion of lifelong learning opportunities for all (United Nations, 2015). The realization of SDG 4 consequently requires education systems to address not only participation and access, but also the quality, relevance, equity, inclusiveness and effectiveness of learning. It is within this broader

transformation of education that Competency-Based Education (CBE) has gained increasing policy and pedagogical significance.

CBE represents a shift from an education system predominantly concerned with the transmission and accumulation of prescribed content toward one that emphasizes what learners are able to know, understand, apply and demonstrate. The approach integrates knowledge, skills, attitudes, values and dispositions and places greater emphasis on learner-centred pedagogy, authentic and experiential learning, formative and competency-based assessment, problem-solving, creativity, collaboration, communication and the practical application of knowledge (Kenya Institute of Curriculum Development [KICD], 2019). In the Kenyan context, the Basic Education Curriculum Framework (BECF) explicitly positions the curriculum around the development and demonstration of competencies, with teachers expected to facilitate differentiated and contextually relevant learning experiences that enable learners to apply what they have learned in meaningful situations (KICD, 2019). In principle, therefore, CBE provides an important mechanism for connecting curriculum content with meaningful learning outcomes and the knowledge, skills, values and competencies required for participation in contemporary society. However, the adoption of a competency-based curriculum does not, in itself, guarantee corresponding changes in classroom practice or educational outcomes. Effective implementation depends on the capacity of curriculum implementers, the availability of appropriate learning resources, pedagogical readiness, assessment alignment, continuous professional development and supportive institutional conditions (KICD, 2019; UNESCO, 2024). Consequently, the critical issue is not merely whether CBE has been formally adopted, but whether the intended reform can be implemented and scaled with sufficient breadth, depth, fidelity, equity and sustainability across educational institutions. This distinction is particularly important because Kenya's continuing investment in teacher capacity building, curriculum implementation and assessment demonstrates that translating curriculum policy into consistent classroom practice remains a central implementation requirement (KICD, 2023; UNESCO, 2024).

The challenge of scaling CBE is consequently more complex than simply increasing the number of schools, teachers or learners formally participating in a curriculum reform. Scaling entails extending effective implementation across diverse educational settings while maintaining the core principles, quality and intended outcomes of the reform (Coburn, 2003; UNESCO, 2024). It therefore encompasses not only the breadth of implementation, but also the depth of pedagogical change, fidelity to competency-based principles, institutionalization of new practices, sustainability of implementation, equity of opportunity and the capacity of educational institutions to adapt implementation to changing contextual conditions (Coburn, 2003; Fixsen et al., 2005). From this perspective, successful scaling of CBE requires coherence among curriculum policy, teacher preparation and professional development, instructional practice, assessment, educational leadership, learning resources and infrastructure, stakeholder participation, and systems for monitoring, feedback and continuous improvement (KICD, 2019; UNESCO, 2024). The concern is therefore not merely whether CBE has been formally adopted, but whether its implementation practices and outcomes can become embedded within routine institutional processes, sustained over time and extended equitably across educational settings in ways that contribute to broader improvements in the quality, relevance and effectiveness of education. This distinction shifts attention from policy adoption and programme reach to the institutionalization, sustainability and quality of implementation outcomes, which are central to understanding whether CBE can contribute meaningfully to the achievement of Sustainable Development Goal 4 (SDG 4).

At the global level, evidence demonstrates that the transition to competency-based education is often constrained by the interaction between policy expectations and established educational practices. UNESCO (2024) emphasizes that progress toward SDG 4 requires countries to translate policy commitments into sustained action addressing inclusion, equity, teacher development, financing and broader systemic transformation. The 2024/5 Global Education Monitoring Report similarly emphasizes the importance of educational leadership in establishing expectations, strengthening collaboration, focusing institutions on learning and developing the people responsible for educational delivery. These observations are particularly relevant to CBE because competency-based reform requires coordinated action among policymakers, education managers, school leaders, teachers, learners, parents and communities.

International empirical evidence further demonstrates that curriculum reform may encounter institutional conditions that limit its implementation. In China, Deng et al. (2024) found that although teachers generally

supported competency-based reform, classroom practices continued in some cases to reflect knowledge transmission and conventional assessment. High-stakes examinations, parental expectations, limited teacher autonomy, workload and time constraints affected the implementation of competency-oriented approaches. The implication is that curriculum reform cannot be effectively scaled when assessment systems, institutional incentives and established teaching practices remain inconsistent with the principles of competency development. Similarly, Mankaew et al. (2024), in examining competency-based curriculum implementation in Thailand, demonstrated the importance of contextual and organizational conditions surrounding schools. Such evidence reinforces the view that scaling CBE is fundamentally a systemic process requiring alignment among curriculum expectations, teacher capacity, assessment, institutional support and the wider educational environment.

The African context presents an even more complex environment for scaling competency-based reforms. Education systems across the continent continue to experience variations in teacher preparation, instructional resources, infrastructure, digital access, assessment capacity, financing and institutional capability. These differences create substantial variation in the capacity of schools to translate national curriculum policies into consistent classroom practices. The African Union's Continental Education Strategy for Africa 2026–2035 places teachers, foundational learning, resources, lifelong learning, gender, equity and inclusion at the center of continental educational transformation. These priorities are directly relevant to CBE because competency development requires teachers who possess appropriate pedagogical and assessment capabilities and schools that have the material and institutional conditions necessary to support learner-centered education.

Evidence from African countries illustrates the importance of these enabling conditions. In Rwanda, Chari et al. (2025), through a systematic review of studies on competency-based curriculum implementation, reported that although the country had developed a relatively strong policy framework, implementation outcomes continued to depend on institutional and classroom-level conditions. Similarly, Rwigema and Andala (2022) established the importance of teacher-related factors, including pedagogical content knowledge, technological skills and teachers' perceptions, in the implementation of competency-based curriculum in Rwandan public primary schools. Comparative evidence from Rwanda and Zimbabwe further indicates that competency-based curriculum implementation is shaped by interacting factors such as language, literacy, assessment, teacher professional development, ICT and instructional practices (Christopher & Jones, 2025). These findings suggest that successful CBE implementation cannot simply be transferred from one context to another; rather, implementation strategies must be adapted to institutional, cultural and socioeconomic realities.

Furthermore, challenges have been reported in Tanzania and Zanzibar. Lema (2026), using national monitoring and evaluation data involving primary school teachers in mainland Tanzania, reported evidence of the adoption of participatory and learner-centred approaches but also identified persistent constraints associated with overcrowded classrooms, uneven distribution of learning materials and limited ICT infrastructure, particularly in rural schools. Mpate (2025) similarly reported challenges involving teacher knowledge, professional development, instructional resources and laboratory facilities in the implementation of competency-based curriculum in Tanzania. In Zanzibar, Ali (2024) found that school leaders faced difficulties supporting competency-based curriculum implementation where appropriate instructional supervision materials were inadequate. Collectively, these African experiences demonstrate that policy adoption represents only the initial stage of educational reform. Sustainable scaling requires the development of institutional capacity, teacher competence, appropriate assessment systems, instructional resources, effective leadership and mechanisms for continuous professional support.

Kenya's experience reflects these broader global and African dynamics. The country introduced the Competency-Based Curriculum (CBC) as a major educational reform intended to develop learners' competencies, values, capabilities and holistic development. The *Basic Education Curriculum Framework* places learner potential, competencies, values and holistic development at the centre of basic education (Kenya Institute of Curriculum Development [KICD], 2019). The reform is also embedded within Kenya's broader educational development agenda, which emphasizes access, participation, equity, inclusion, quality, relevance, governance and accountability. These priorities correspond closely with the multidimensional requirements of SDG 4. Consequently, effective scaling of competency-based implementation has the potential to contribute to educational outcomes associated with SDG 4, particularly where implementation strengthens the quality and

relevance of learning, learner participation, inclusion, competency acquisition and supportive learning environments.

Nevertheless, evidence from Kenya indicates that implementation remains uneven across important dimensions. Mwangi (2025), for example, reported that CBC-specific teacher training was not universal and that teachers who had received relevant training demonstrated greater implementation readiness. The same study identified instructional resource limitations and workload as significant constraints. Maiyuria et al. (2024) similarly identified teacher preparedness, instructional materials and physical infrastructure as important conditions affecting CBC implementation. These findings are reinforced by Nyamosi (2024), who identifies pedagogical, digital, leadership, personal and social, and assessment competencies as important capacities for teachers implementing CBC. Okeyo et al. (2024) further highlight challenges associated with instructional training and supervision among head teachers implementing CBC in Kenyan public primary schools.

Assessment constitutes another important dimension of the scaling challenge. Competency-based education requires assessment approaches that capture learners' ability to apply knowledge, demonstrate skills and develop competencies over time. Where assessment remains dominated by conventional content-recall practices, teachers may experience a contradiction between what the curriculum requires and what the education system rewards. Macheso et al. (2024) emphasize the importance of appropriate competency-based assessment tools, teacher professional development, resources and monitoring in strengthening assessment implementation in Kenyan schools. This suggests that scaling CBE requires more than curriculum dissemination; it requires alignment between curriculum objectives, pedagogical practices, assessment systems and institutional monitoring.

The foregoing evidence indicates that the effectiveness of competency-based reform depends on the extent to which implementation becomes institutionalized across schools rather than remaining dependent on isolated teachers, projects or short-term interventions. Scaling should therefore be understood as a multidimensional process through which effective CBE practices are extended, deepened, institutionalized and sustained across educational settings. In this study, scaling of CBE implementation outcomes is considered in terms of the breadth of implementation, depth of pedagogical change, fidelity to competency-based principles, institutionalization, sustainability, equity and institutional capacity for continuous adaptation. This conceptualization recognizes that a reform may be widely adopted in formal terms while remaining shallow in actual classroom practice.

The connection between CBE scaling and SDG 4 is particularly important because SDG 4 encompasses a broad range of educational aspirations extending beyond curriculum implementation. Its realization involves access and participation, equity and inclusion, quality and relevance of education, acquisition of relevant knowledge and skills, supportive learning environments, qualified teachers and lifelong learning opportunities. Consequently, the contribution of CBE to SDG 4 is likely to depend on whether competency-based practices are implemented consistently and equitably enough to influence these wider educational dimensions. Effective curriculum implementation at classroom level may have limited systemic significance if it is not accompanied by adequate teacher capacity, assessment alignment, resources, leadership, institutional support and sustainability.

Although existing Kenyan studies have generated valuable evidence on teacher preparedness, resources, assessment, supervision and other determinants of CBC implementation, much of the literature has examined these factors separately. Comparatively less empirical attention has been given to the relationship between the scaling of CBE implementation outcomes as a composite institutional process and the realization of educational outcomes aligned with SDG 4. This distinction is important because the presence of individual implementation components does not necessarily demonstrate that the reform has been successfully scaled. A school may have trained teachers but inadequate resources; implement learner-centred pedagogy but retain conventional assessment; or formally adopt competency-based practices without sufficiently institutionalizing them. The empirical question is therefore whether stronger scaling of CBE implementation outcomes is associated with stronger realization of SDG 4-related educational outcomes.

Against this background, the present study examined the relationship between scaling of CBE implementation outcomes and the realization of SDG 4 in Siaya County, Kenya. The study focused on the extent to which the scaling of competency-based implementation is associated with educational outcomes reflecting access and participation, equity and inclusion, quality and relevance of learning, competency development, supportive

learning environments, teacher capacity and lifelong learning opportunities. By examining the relationship between these two constructs at institutional level, the study sought to contribute empirical evidence to the continuing debate on how competency-based educational reforms can move beyond policy adoption toward sustainable, equitable and system-wide educational improvement.

Statement of the problem

Kenya has invested substantially in Competency-Based Education (CBE) as a transformative approach intended to shift education from a predominantly content- and examination-oriented system toward the development of competencies, values, practical skills, learner-centred capabilities and inclusive learning experiences. This reform is also expected to contribute to the realization of Sustainable Development Goal 4 (SDG4), particularly through improved access, equity, inclusion, quality and relevance of education. However, the formal adoption of CBE does not necessarily guarantee its effective scaling across educational institutions. Evidence from Kenya indicates continuing challenges related to teacher preparedness, professional development, instructional materials, infrastructure, assessment practices, workload and institutional support, which may constrain consistent and sustainable implementation of CBE. More importantly, scaling CBE involves not only expanding its coverage but also achieving adequate depth, fidelity, institutionalization, sustainability, equity and capacity to adapt implementation to different educational contexts. Although existing studies have examined individual factors influencing CBE implementation, limited empirical attention has been given to whether the overall scaling of CBE implementation outcomes is statistically associated with the realization of SDG4 outcomes. This creates an important empirical gap because successful scaling of CBE should ultimately be reflected in broader educational outcomes related to participation, equity and inclusion, quality and relevance, competency development, supportive learning environments and continued learning opportunities. Therefore, the study sought to determine the relationship between the scaling of CBE implementation outcomes and the realization of SDG4 in Siaya County, Kenya.

Purpose of the Study

The purpose of the study was to examine the relationship between scaling of Competency-Based Education implementation outcomes and realization of Sustainable Development Goal 4 in Kenya, using evidence from Siaya County.

Objective of the Study

The study was guided by the following objective:

To determine the relationship between scaling of Competency-Based Education implementation outcomes and realization of Sustainable Development Goal 4 in Siaya County, Kenya.

Research Hypothesis

The study tested the following null hypothesis:

H₀: There is no statistically significant relationship between scaling of Competency-Based Education implementation outcomes and realization of Sustainable Development Goal 4 in Siaya County, Kenya.

LITERATURE REVIEW

Scaling Competency-Based Education Implementation Outcomes

Scaling educational reform refers to the process through which an innovation or reform moves beyond limited or localized implementation to become sufficiently widespread, institutionalized, sustainable and effective across an education system. In the context of CBE, scaling should therefore not be understood simply as increasing the number of schools adopting a competency-based curriculum. Rather, it involves expanding the quality, depth, consistency, equity and sustainability of implementation. The distinction between adoption and scaling is particularly important. A curriculum may be officially adopted but implemented unevenly across

schools and classrooms. Similarly, teachers may use competency-based terminology while continuing to employ conventional teaching and examination practices. Deng et al. (2024) demonstrate this problem in China, where teachers expressed support for CBE but continued to rely heavily on conventional knowledge-oriented teaching and assessment. This suggests that scaling should incorporate changes in actual institutional and instructional practices rather than policy adoption alone. The African Union's CESA 2026–2035 reinforces this perspective by placing teachers, resources, leadership, foundational learning, skills, lifelong learning, equity and inclusion within an integrated education transformation framework. Thus, scaling requires simultaneous attention to the human, institutional, material and policy dimensions of education systems. In Kenya, KICD (2019) establishes the policy basis for competency-oriented education through an emphasis on learner potential, competencies and values. However, evidence indicates that implementation capacity varies considerably. Maiyuria et al. (2024) show that teacher preparedness, instructional resources and infrastructure influence CBC implementation. Mwangi (2025) similarly reports differences in implementation readiness according to teachers' exposure to CBC-specific training. Taken together, these studies indicate that scaling requires institutional capacity to ensure that implementation conditions are not concentrated in a small proportion of schools. The implication is that CBE scaling should be assessed through multiple dimensions: coverage, fidelity, depth, institutionalization, sustainability, equity and adaptability. Coverage concerns the extent to which schools, teachers and learners experience the reform. Fidelity concerns whether implementation reflects the principles of competency-based education. Depth concerns the extent to which classroom practices, assessment and institutional routines have changed. Institutionalization refers to whether CBE practices become embedded in organizational systems rather than depending on individual champions. Sustainability concerns whether implementation can continue despite changing personnel, resources or policy conditions. Equity concerns whether disadvantaged learners and schools benefit from the reform. Adaptability concerns the capacity of institutions to adjust implementation to changing learner and contextual needs.

CBE and the Realization of SDG 4

The relationship between CBE and SDG 4 is conceptually strong because both emphasize meaningful learning, inclusion, relevance and the development of capabilities. SDG 4 does not simply call for learners to attend school; it emphasizes inclusive and equitable quality education and lifelong learning. The Global Education Monitoring Report demonstrates that progress toward SDG 4 involves multiple dimensions, including participation, completion, learning proficiency, skills, educational facilities, gender equity and teacher availability. UNESCO's global survey on transformation toward SDG 4 emphasizes that countries must place inclusion, equity and gender equality at the centre of educational transformation while strengthening financing and investment in the teaching profession. This supports the argument that curriculum reform contributes to SDG 4 only when accompanied by wider systemic changes. The relationship can therefore be understood through a pathway. Effective scaling of CBE can strengthen teaching quality by encouraging learner-centred pedagogy; strengthen learning relevance by connecting education with practical competencies; improve assessment by emphasizing continuous evidence of learning; strengthen inclusion by recognizing learner diversity; and promote lifelong learning by developing transferable skills. However, these potential benefits depend upon implementation conditions. The international evidence reinforces this conditional relationship. China's experience shows that competency-based curriculum can be constrained by high-stakes examination cultures. Tanzania's experience demonstrates that learner-centred approaches can coexist with overcrowding and limited ICT resources. Rwanda demonstrates the importance of institutional and classroom conditions. These findings indicate that CBE is not automatically transformative; its contribution to SDG 4 depends on the quality and scale of implementation.

Teacher Capacity and CBE Scaling

Teachers constitute the principal mediators between curriculum policy and learner experience. Consequently, teacher professional knowledge, pedagogical competence, assessment literacy, digital competence and commitment are central to CBE scaling. Tanzania provides similar evidence. Lema (2026) found that teachers generally reported positive perceptions of the revised curriculum and substantial use of participatory approaches, but continuing challenges included overcrowded classrooms, uneven learning-resource distribution and inadequate ICT infrastructure. Mpate (2025) similarly identified inadequate knowledge and irregular CBC training among Biology teachers. The evidence from Rwanda is also consistent. Rwigema and Andala (2022)

found that teacher-related factors, including pedagogical content knowledge and technology skills, were associated with competency-based curriculum implementation. Chari et al. (2025) further demonstrate that implementation operates across policy, institutional and classroom levels rather than solely at the teacher level. Nyamosi (2024) argues that CBC implementation in Kenya requires pedagogical, digital, leadership, assessment, personal and social competencies. Similarly, Mwangi (2025) found that teachers who had received CBC-specific training demonstrated greater implementation readiness than those who had not received such training. The evidence suggests that scaling requires professional development to be continuous rather than limited to introductory curriculum sensitization. Consequently, teacher capacity should be treated as a systemic component of scaling. Professional development should be continuous, collaborative, practice-oriented and linked to classroom evidence. Collaborative professional learning, and instructional supervision can provide mechanisms through which implementation capacity is strengthened.

Assessment alignment and CBE Scaling

Assessment is a critical determinant of whether competency-based reforms become embedded in educational practice. Where examinations continue to reward content recall, teachers and learners may rationally prioritize knowledge transmission even when curriculum documents emphasize competencies. Deng et al. (2024) provide a strong illustration from China, where high-stakes examinations and examination-oriented culture constrained teachers' adoption of competency-oriented practices. The implication is that curriculum reform cannot be successfully scaled without corresponding assessment reform. Kenyan evidence points in the same direction. Macheso et al. (2024) examined competency-based assessment implementation and emphasized the use of appropriate competency-based assessment tools, professional development, resources and monitoring. These findings suggest that assessment literacy should form an integral component of teacher professional development. The relationship with SDG 4 is particularly important. If assessment accurately captures competencies, educational institutions can identify learners who require additional support, monitor progress and provide differentiated learning opportunities. Conversely, poorly aligned assessment can undermine learner-centred pedagogy and reproduce inequalities. Consequently, scaling CBE requires alignment among curriculum objectives, classroom pedagogy, assessment instruments, feedback mechanisms and progression decisions.

Instructional resources, infrastructure and digital capacity

Educational resources provide the material conditions under which CBE can be implemented. Competency-based learning frequently requires practical activities, collaborative learning, digital tools, learning materials, laboratories, workshops and flexible learning environments. Tanzania provides a comparable case. Lema (2026) identified uneven access to supplementary materials and limited ICT infrastructure, particularly in rural schools. Mpate (2025) identified inadequate laboratory space and teaching resources among Biology teachers. Nigeria also demonstrates similar systemic constraints. Musa et al. (2026), found inadequate training, insufficient instructional resources, overcrowded classrooms and weak administrative support among constraints to competency-based curriculum implementation in Gombe State. Maiyuria et al. (2024) found that instructional materials, teacher preparedness and physical infrastructure were important dimensions of CBC implementation in Kenya. The findings demonstrate that curriculum expectations can exceed institutional capacity where schools lack adequate resources. These findings are significant for SDG 4 because inadequate infrastructure and digital access can create unequal learning opportunities. Consequently, scaling CBE should be accompanied by resource allocation mechanisms that prioritize disadvantaged schools and learners rather than distributing resources uniformly without regard to need.

Institutional leadership, stakeholder engagement and CBE Scaling

Educational transformation requires institutional leaders who can coordinate teachers, mobilize resources, facilitate professional learning, monitor implementation and engage stakeholders. The 2024/5 Global Education Monitoring Report identifies leadership for learning, collaboration and professional development as central dimensions of effective educational leadership. This is particularly relevant to CBE because implementation involves substantial changes in teaching, assessment and organizational routines. Dadi Ali (2024) provides empirical evidence from Zanzibar showing that school leaders required appropriate instructional supervision materials to support teachers in implementing CBC. The implication is that leadership must move beyond administrative compliance toward instructional support. Rwanda's experience similarly emphasizes institutional

coordination. Chari et al. (2025) identify policy, institutional and classroom levels as interconnected components of implementation. Thus, scaling requires collaborative institutional arrangements through which leaders, teachers, parents, learners, government agencies and communities contribute to implementation. In Kenya, such collaboration is especially relevant because curriculum implementation requires coordination among KICD, the Ministry of Education, Teachers Service Commission, school leaders, teachers, parents, assessment agencies and local communities. Collaborative leadership can therefore be viewed as a contextual and enabling mechanism through which CBE scaling may be strengthened, without being treated as the primary independent variable in the present model.

Synthesis of the Literature

Despite evidence of role of scaling of CBE implementation outcomes, the reviewed literature nevertheless reveals a significant empirical gap. Most studies examine factors affecting CBE implementation rather than examining the relationship between the scaling of CBE implementation outcomes and the realization of SDG 4. Furthermore, studies often examine individual implementation components independently, whereas SDG 4 requires a multidimensional perspective encompassing access, equity, quality, learning, skills, inclusion, teachers and lifelong learning. The present study addresses this gap by treating CBE scaling as a multidimensional independent variable and SDG 4 realization as the dependent variable. The approach shifts the analytical question from whether CBE is being implemented *to* whether stronger and more extensive CBE implementation outcomes are associated with stronger realization of SDG 4.

Theoretical Framework

The study was guided by General Systems Theory developed by von Bertalanffy (1968). Systems Theory conceptualizes an organization or social institution as a system consisting of interconnected components whose interactions influence the functioning and outcomes of the whole system. Applied to education, a school is an open system consisting of interacting components including learners, teachers, school leaders, curriculum, assessment, resources, infrastructure, families, communities and government agencies. These components interact with one another and with the wider educational environment. Consequently, curriculum reform cannot be implemented effectively through isolated changes in curriculum documents alone. The theory is relevant to CBE because successful implementation requires interaction among curriculum design, teacher capacity, pedagogy, assessment, leadership, resources, institutional practices and external policy support. Scaling therefore involves strengthening the relationships among these components so that CBE becomes embedded within routine institutional practice. The theory further suggests that educational outcomes emerge from interactions among system components rather than from a single intervention. Accordingly, the study expected stronger implementation scaling to be associated with stronger educational outcomes aligned with SDG 4.

METHODOLOGY

Research Design

The study adopted a correlational research design because it sought to determine the direction, strength and statistical significance of the relationship between scaling of Competency-Based Education (CBE) implementation outcomes and selected school-level outcomes related to the realization of Sustainable Development Goal 4 (SDG 4), without manipulating the study variables. The design was appropriate for examining naturally occurring variations in the extent to which CBE implementation was scaled and corresponding variations in SDG 4-related educational outcomes. Pearson's product-moment correlation coefficient was used to estimate the strength and direction of the association between the two variables. Since correlational research does not establish temporal precedence or causal relationships, the findings are interpreted as evidence of statistical association rather than evidence that scaling CBE implementation causes realization of SDG 4.

Target Population

The target population comprised school leaders and teachers involved in basic education in Siaya County, Kenya. The population consisted of 620 primary school head teachers, 246 principals, 6,500 primary school teachers,

2,500 junior school teachers and 3,200 senior school teachers, giving a total target population of 13,066. This population was considered appropriate because school leaders and teachers are directly involved in the implementation, institutionalization and scaling of CBE and are therefore positioned to provide information on both implementation outcomes and related educational outcomes. The total population of 13,066 formed the basis for determining the minimum required sample size.

Sample Size

Yamane's (1967) formula was used to estimate the minimum sample size at a 5% level of precision:

$$n = N / [1 + N(e^2)]$$

Where:

n = required sample size

N = target population

e = level of precision

Using N = 13,066 and e = .05:

$$n = 13,066 / [1 + 13,066(.05^2)]$$

$$n \approx 388.$$

Accordingly, approximately 388 respondents constituted the sample size for the study. However, 372 questionnaires from the respondents were returned and considered fit for data analysis. This represents a return-rate of 95.9% which is very acceptable in a research study.

Data Collection Instrument

Data were collected using a structured questionnaire developed to measure the two study variables. The questionnaire was considered appropriate because the study required standardized data from respondents on multiple dimensions of CBE implementation and selected school-level SDG 4-related educational outcomes. Structured questionnaires are particularly useful in quantitative research where information must be collected systematically across a defined group of respondents using uniform questions and response categories, thereby facilitating comparison, coding, and statistical analysis (Creswell & Creswell, 2018; Taherdoost, 2022). In addition, the use of a consistent response scale enabled the researcher to quantify respondents' assessments and compute composite scores for the respective study variables.

The first section measured scaling of CBE implementation outcomes using dimensions reflecting the breadth, depth, fidelity, sustainability, and institutionalization of CBE implementation. These dimensions included teacher preparedness, curriculum implementation, learner-centred pedagogy, competency-based assessment, instructional resources, digital capacity, institutional support, equity, and sustainability. The second section measured selected school-level SDG 4-related outcomes, including educational access and participation, equity and inclusion, quality and relevance of learning, competency development, supportive learning environments, and opportunities for continued learning. The selection of these dimensions was guided by the study's conceptualization of CBE implementation and the broader SDG 4 emphasis on inclusive, equitable, quality education and lifelong learning opportunities (United Nations, 2015; UNESCO, 2024).

The items were structured using a consistent response scale to facilitate the computation of composite scores for the two variables. The structured format also reduced variation arising from differences in question administration and provided data suitable for descriptive and inferential statistical analysis (Creswell & Creswell, 2018; Taherdoost, 2022). The dependent variable was therefore operationalized as a school-level measure of selected SDG 4-related educational outcomes, rather than as a comprehensive measure of national SDG 4 attainment. This distinction was necessary because national SDG 4 attainment encompasses a much broader

range of indicators and population-level measures than could reasonably be captured through a school-based questionnaire (United Nations, 2015; UNESCO, 2024).

Validity and Reliability

Face Validity of the Research Instrument

Face validity was assessed through expert review before the main data collection. The questionnaire was reviewed by experts in educational administration, curriculum studies, educational research, and Competency-Based Education. The reviewers examined the instrument for clarity, relevance, appropriateness of language, logical sequencing, ambiguity, duplication, and suitability of the response options. These aspects are consistent with established guidance for evaluating the content and comprehensibility of measurement instruments, which emphasizes item relevance, comprehensiveness, comprehensibility, and appropriateness of response options (Mokkink et al., 2018; Terwee et al., 2018; Mokkink et al., 2025).

The reviewers also assessed whether the items appeared appropriate for measuring the two study variables: scaling of CBE implementation outcomes and selected school-level SDG 4-related educational outcomes. Feedback from the experts was used to revise, clarify, and reorganize items before pilot testing. Such iterative expert assessment is consistent with contemporary recommendations that instrument developers use expert input to evaluate whether items adequately represent the intended constructs and whether their wording is sufficiently understandable to the intended respondents (Terwee et al., 2018; Mokkink et al., 2025).

The expert review therefore provided evidence of the apparent appropriateness, clarity, and comprehensibility of the instrument for the intended study population. However, this evidence should not be interpreted as statistical evidence of construct validity. Expert review primarily provides evidence concerning the content and apparent suitability of an instrument, whereas construct or structural validity requires empirical evaluation of the relationships among items and the underlying constructs (Mokkink et al., 2018; Mokkink et al., 2025).

Reliability of the Research Instrument

Reliability was assessed using Cronbach's alpha coefficient to determine the internal consistency of items measuring the study variables. The analysis examined the extent to which items intended to measure the same construct produced consistent responses. Cronbach's alpha remains a widely used index of internal consistency; however, its interpretation should consider the number of items, dimensionality of the scale, and purpose of measurement rather than relying on a single universal cut-off value (Taber, 2018; Hayes & Coutts, 2020). For this study, a Cronbach's alpha coefficient of $\alpha \geq .70$ was considered an acceptable minimum for research purposes, while coefficients of approximately .80 or above were interpreted as indicating good internal consistency. These thresholds were used as practical guidelines rather than absolute criteria.

The reliability assessment was undertaken during pilot testing. Items that showed weak contribution to the internal consistency of their respective scales were reviewed before administration of the final instrument. The final questionnaire produced an overall Cronbach's alpha coefficient of $\alpha = .82$, indicating good internal consistency of the instrument. This coefficient provided satisfactory evidence that the items demonstrated an adequate degree of internal consistency for the subsequent main data collection (Hayes & Coutts, 2020; Taber, 2018). It should, however, be noted that a high Cronbach's alpha does not by itself establish unidimensionality or construct validity; evidence of validity requires additional empirical and theoretical assessment of the measurement structure.

Data Analysis

The completed questionnaires were coded, cleaned, and analysed using appropriate statistical procedures. Descriptive statistics were first used to summarize the study variables. Frequencies and percentages were used to describe categorical characteristics, while means and standard deviations were used to summarize the continuous composite scores for scaling of CBE implementation outcomes and selected school-level SDG 4-related educational outcomes. The mean provided an indication of the average level of respondents' scores, whereas the standard deviation indicated the extent of variation around the mean. Descriptive statistics are

appropriate for organizing and summarizing quantitative data before undertaking inferential analysis (Creswell & Creswell, 2018). Composite scores were computed from the relevant questionnaire items to obtain overall measures of scaling of CBE implementation outcomes and selected school-level SDG 4-related educational outcomes. The use of composite scores is appropriate where several items are designed to represent different aspects of the same underlying construct, provided that the items demonstrate adequate reliability and are conceptually coherent (Taber, 2018; Hayes & Coutts, 2020). The resulting composite scores were subsequently used in the correlational analysis.

Pearson's product-moment correlation coefficient was then used to determine the direction, magnitude, and statistical significance of the linear relationship between scaling of CBE implementation outcomes and selected school-level SDG 4-related educational outcomes. Pearson's r is appropriate for assessing the strength and direction of a linear association between two quantitative variables and is consistent with a correlational research design where the variables are observed without experimental manipulation (Pennsylvania State University, 2026a, 2026b). Before interpreting the correlation, the relevant assumptions, including linearity and the influence of extreme observations, were considered because violations can affect the magnitude and interpretation of Pearson's correlation coefficient (Pennsylvania State University, 2026a).

The analysis employed a two-tailed test at the 0.05 level of significance because the study tested whether the population correlation differed from zero without restricting the alternative hypothesis to either a positive or negative direction. The null hypothesis was rejected when the obtained p -value was less than 0.05 and was not rejected when the p -value was greater than or equal to 0.05. The expression "not rejected" is preferred to "retained" because failure to obtain statistical significance does not demonstrate that the null hypothesis is true; it indicates that there is insufficient statistical evidence to reject it at the specified significance level (Pennsylvania State University, 2026c).

The coefficient of determination, r^2 , was also computed by squaring Pearson's correlation coefficient to indicate the proportion of shared statistical variance between the two variables. The coefficient of determination provides an indication of the amount of variation that the two variables have in common within their linear association. However, because the study employed a correlational design, r^2 was interpreted as shared statistical variance rather than causal variance explained. A statistically significant correlation does not, by itself, establish that variation in CBE implementation scaling causes variation in SDG 4-related educational outcomes (Pennsylvania State University, 2026a, 2026b).

FINDINGS AND DISCUSSION

Relationship between Scaling of Competency-Based Education Implementation Outcomes and Realization of SDG 4

The objective of the study was to determine the relationship between scaling of Competency-Based Education (CBE) implementation outcomes and realization of Sustainable Development Goal 4 (SDG 4) in Siaya County, Kenya. Pearson Product-Moment Correlation Coefficient was used to establish the direction, strength and statistical significance of the relationship between the two variables. The independent variable was measured using indicators of the breadth, depth, fidelity, sustainability, institutionalization, equity and capacity of CBE implementation, while the dependent variable was measured using selected school-level indicators of SDG 4 realization, including access and participation, equity and inclusion, quality and relevance of learning, competency development, supportive learning environments and opportunities for continued learning. The results are presented in Table 1.

Table 1 Pearson Product-Moment Correlation between scaling of CBE Implementation Outcomes and Realization of SDG 4

Variables	CBE Implementation Scaling	SDG 4 Realization
CBE Implementation Scaling	1.000	.520**

SDG 4 Realization	.520**	1.000
Sig. (2-tailed)	—	< .001
N	372	372

Note. Correlation is significant at 0.01 level (2-tailed).

Source: Field Data, 2026

From Table 1, the Pearson correlation coefficient between scaling of CBE implementation outcomes and realization of SDG 4 was $r = .520$, with a two-tailed significance level of $p < .001$ and a sample size of 372 respondents. The positive correlation indicates that higher levels of scaling of CBE implementation outcomes were associated with higher levels of realization of SDG 4. The magnitude of the correlation coefficient ($r = .520$) indicates a moderate positive relationship between the two variables. The direction of the relationship is positive, implying that improvements in the extent, depth, consistency and sustainability of CBE implementation corresponded with improvements in indicators associated with inclusive, equitable and quality education. The significance value of $p < .001$ is smaller than the predetermined significance level of $\alpha = .05$. Therefore, the observed relationship is statistically significant. The finding provides sufficient statistical evidence to reject the null hypothesis that there is no statistically significant relationship between scaling of CBE implementation outcomes and realization of SDG 4 in Siaya County. The coefficient of determination was subsequently calculated by squaring the Pearson correlation coefficient. Thus, approximately 27.04% of the variance in the SDG 4 realization index was statistically associated with variation in CBE implementation scaling. The remaining 72.96% represents variation not accounted for by this bivariate association and may be related to other educational, institutional, socioeconomic, policy and contextual factors. It is important to emphasize that the coefficient of determination does not mean that CBE scaling caused 27.04% of SDG 4 realization. The study employed a correlational, design; consequently, the result establishes association rather than causation.

Hypothesis Testing

The null hypothesis stated:

H_0 : There is no statistically significant relationship between scaling of Competency-Based Education implementation outcomes and realization of Sustainable Development Goal 4 in Siaya County, Kenya. The Pearson correlation analysis produced a statistically significant positive relationship, $r(370) = .520$, $p < .001$. Since the probability value was less than the 0.05 significance level, the null hypothesis was rejected.

Table 2: Pearson correlation between scaling of CBE implementation outcomes and realization of SDG 4

Variables	N	Pearson r	r^2	p -value	Decision
Scaling of CBE implementation outcomes and realization of SDG 4	372	.520	.2704	< .001	Reject H_0

Source: Field Data, 2026

The study therefore concludes that there was a statistically significant positive relationship between scaling of CBE implementation outcomes and realization of SDG 4 in the study area.

DISCUSSION OF FINDINGS

The study established a positive and statistically significant relationship between scaling of CBE implementation outcomes and selected school-level outcomes related to the realization of SDG 4 in Siaya County, Kenya. The Pearson correlation coefficient of $r(370) = .520$, $p < .001$ indicates a moderate positive association. This finding suggests that schools reporting higher levels of breadth, depth, consistency, institutionalization and sustainability in CBE implementation also tended to report stronger outcomes related to access, participation, inclusion,

learning quality, competency development and supportive learning environments. The finding is important because it indicates that the potential contribution of CBE to SDG 4 is not necessarily derived from the formal adoption of a competency-based curriculum alone, but from the extent to which competency-based principles are translated into sustained institutional and classroom practices.

The moderate rather than very strong magnitude of the relationship is also theoretically and practically significant. CBE implementation takes place within a wider education system in which teacher capacity, leadership, assessment practices, instructional resources, digital infrastructure, class size, school context and policy support can influence educational outcomes. Consequently, scaling CBE is unlikely to account for all variation in SDG 4-related outcomes. The coefficient of determination ($r^2 = .2704$) indicates approximately 27.04% shared variance between the two measures, leaving substantial variation attributable to factors outside the bivariate relationship examined in this study. The finding therefore supports an interpretation of CBE scaling as one potentially important component of broader education-system transformation rather than as a single determinant of SDG 4 realization.

The finding that scaling of CBE implementation outcomes was positively and significantly associated with realization of SDG 4 suggests that implementation of competency-based education has greater potential to contribute to educational transformation when it is sufficiently broad, deep, consistent, equitable and sustainable. The correlation coefficient of $r = .520$ indicates a moderate positive association, implying that institutions reporting stronger CBE implementation scaling also tended to report stronger realization of selected SDG 4-related educational outcomes. The finding is consistent with the argument of UNESCO (2024) that achieving SDG 4 requires education systems to move from policy commitments toward coordinated implementation involving teachers, financing, inclusion, equity and systemic transformation. The present finding provides empirical support for this position by demonstrating that stronger scaling of an education reform aligned with competency development is associated with stronger educational outcomes corresponding to the objectives of SDG 4. Similarly, Mwangi (2025) found that teachers who had received CBC-specific training demonstrated greater readiness to implement the curriculum than teachers who had not received such training. This finding helps explain the present result because scaling is unlikely to produce stronger SDG 4 outcomes unless the people responsible for translating curriculum policy into classroom practice have the necessary competencies and support. Likewise, Maiyuria et al. (2024) established that teacher preparedness, instructional materials and physical infrastructure were important factors influencing CBC implementation in Kenya. The consistency between this evidence and the present finding suggests that CBE scaling is dependent on the availability of institutional conditions that enable teachers and learners to engage effectively with competency-based practices. Where such conditions improve, the capacity of CBE to contribute to educational quality, relevance and equity is likely to increase. The finding is also consistent with Nyamosi (2024), who identified pedagogical, digital, assessment, leadership, personal and social competencies as important teacher capacities for CBC implementation in Kenya. This supports the interpretation that scaling is not simply a matter of increasing curriculum coverage. Rather, effective scaling requires strengthening the professional and organizational capacities that enable teachers to implement competency-based learning meaningfully. The assessment dimension provides another explanation for the positive relationship. Macheso et al. (2024) demonstrated the importance of competency-based assessment tools and their utilization in Kenya. Competency-based education requires assessment approaches that provide evidence of what learners can understand, apply, create and demonstrate. When assessment is aligned with competency development, teachers are better positioned to identify learning gaps, provide feedback and support differentiated learning. These processes directly support the quality and equity dimensions of SDG 4.

The present finding also corresponds with evidence from Rwanda. Rwigema and Andala (2022) found that teacher-related factors, including pedagogical content knowledge, technology skills and teacher perceptions, influenced implementation of the competency-based curriculum. Chari et al. (2025), in their systematic review of Rwanda's competency-based curriculum, similarly demonstrated that implementation operates across policy, institutional and classroom levels. The convergence between these findings and the present study reinforces the argument that CBE scaling must involve coordinated changes across several levels of the education system. Evidence from Tanzania provides further support but also illustrates the conditions under which implementation may be constrained. Lema (2026) reported generally positive teacher perceptions and widespread use of participatory approaches in the revised curriculum, but identified overcrowded classrooms, uneven access to

learning materials and inadequate ICT infrastructure as continuing challenges. These findings suggest that even when teachers are willing to implement competency-oriented practices, systemic resource constraints can weaken the extent to which curriculum reform translates into improved educational outcomes. Similarly, Mpate (2025) identified inadequate teacher knowledge, irregular professional development, insufficient teaching and learning resources and inadequate laboratory facilities among challenges affecting competency-based curriculum implementation in Tanzania. The finding reinforces the present study's interpretation that the relationship between CBE scaling and SDG 4 realization depends upon the quality of implementation conditions. It further corresponds with evidence from China, Deng et al. (2024) found that teachers generally supported competency-based education but continued to experience pressure from high-stakes examinations, parental expectations, workload and limited autonomy. Consequently, teachers sometimes retained conventional teaching and assessment practices despite the formal adoption of competency-oriented reforms. This contrasts with the positive association observed in the present study and suggests that the strength of the CBE-SDG 4 relationship may depend on whether scaling involves substantive transformation of teaching and assessment rather than merely expansion of policy coverage.

The Nigerian evidence provides a further comparative perspective. Musa et al. (2026) reported that teachers in Gombe State experienced challenges involving inadequate training, limited resources, overcrowded classrooms and weak administrative support. These findings demonstrate that scaling competency-based education in another African context faces implementation constraints similar to those identified in Kenya and Tanzania. Consequently, the present finding should be understood within a wider African pattern in which curriculum reform requires simultaneous investment in teacher capacity, resources, infrastructure and institutional support. The finding is also consistent with the African Union Commission's (2025) Continental Education Strategy for Africa 2026–2035, which presents education transformation as requiring coordinated attention to teachers, foundational education, resources, lifelong learning, equity, gender and inclusion. Thus, CBE scaling can contribute to SDG 4, but its contribution is likely to be strongest when curriculum reform is embedded within a broader education-system transformation strategy. Evidence from the 2024/5 Global Education Monitoring Report and studies such as Ali (2024) indicates that leadership, instructional supervision and collaboration can strengthen the conditions under which curriculum reforms are implemented. Thus, institutional leaders who facilitate teacher collaboration, professional learning, stakeholder participation and instructional monitoring may help convert CBE policy into sustained implementation outcomes.

The present finding provides empirical support for the proposition that scaling the implementation of competency-based education is associated with stronger realization of SDG 4-related educational outcomes. The moderate correlation found in this study is more plausibly explained by a broader conception of scaling encompassing implementation depth, fidelity, sustainability, institutionalization, equity and supporting conditions. However, the evidence should be interpreted cautiously because the study was based on correlational research design and conducted in one Kenyan county because it does not provide definitive evidence of a causal pathway from CBE scaling to national SDG 4 attainment.

Summary of the Finding

The study established a positive and statistically significant relationship between scaling of CBE implementation outcomes and selected school-level outcomes related to SDG 4 realization in Siaya County, Kenya. Pearson's product-moment correlation produced $r(370) = .520, p < .001$, based on 372 valid responses. The null hypothesis was therefore rejected. The coefficient of determination, $r^2 = .2704$, indicates that the two measures shared approximately 27.04% of their variance. The finding indicates that stronger scaling of CBE implementation was associated with stronger SDG 4-related educational outcomes. However, because the study employed a correlational design, the result should be interpreted as evidence of association rather than causation. The finding further suggests that CBE scaling operates within a broader system of teacher capacity, leadership, assessment, resources, infrastructure, institutional support and contextual conditions.

CONCLUSION

The study concludes that scaling of Competency-Based Education implementation outcomes is positively and significantly associated with selected school-level outcomes related to the realization of Sustainable

Development Goal 4 in Siaya County, Kenya. The finding indicates that schools demonstrating greater breadth, depth, consistency, institutionalization and sustainability of CBE implementation also tend to report stronger outcomes relating to educational participation, equity and inclusion, learning quality, competency development and supportive learning environments. However, the moderate magnitude of the relationship indicates that CBE scaling is only one component of a wider set of factors influencing SDG 4-related educational outcomes. The study therefore concludes that Kenya's pursuit of SDG 4 should treat CBE scaling as an integrated education-system transformation process requiring sustained teacher development, aligned assessment, adequate resources, effective institutional leadership, equitable implementation and continuous monitoring rather than as a curriculum adoption exercise alone.

RECOMMENDATIONS

Strengthen continuous teacher professional development

The Ministry of Education and relevant teacher-management institutions should institutionalize continuous professional development focused on competency-based pedagogy, assessment literacy, differentiation, digital learning and evidence-informed instructional practice. Professional development should be sustained and school-based rather than limited to initial curriculum sensitization.

Align Assessment with Competency Development

Assessment systems should be progressively aligned with competency-based learning objectives. Teachers should be supported to use formative assessment, performance-based tasks, portfolios, projects and other appropriate evidence of competency development.

Strengthen resource provision

Government and other education stakeholders should ensure adequate instructional materials, laboratories, digital infrastructure, connectivity and learner-support resources. Resource allocation should prioritize schools and communities experiencing the greatest educational disadvantages.

Develop Integrated CBE-SDG 4 Monitoring Systems

Educational monitoring systems should explicitly connect CBE implementation indicators with SDG 4 outcomes. Monitoring should include learner participation, inclusion, competency attainment, transition, completion, assessment outcomes, teacher capacity and learning environments.

Promote Equity in CBE Scaling

Scaling strategies should deliberately address disparities between schools and learner groups. Particular attention should be given to rural schools, learners with disabilities, economically disadvantaged communities and institutions experiencing shortages of teachers, infrastructure and digital resources.

LIMITATIONS OF THE STUDY

The study has several limitations. First, the correlational design does not permit causal conclusions. The observed association between CBE scaling and SDG 4 realization cannot therefore be interpreted as proof that CBE scaling directly causes improvements in SDG 4 outcomes. Second, the study relied substantially on questionnaire data, which may be influenced by respondent perceptions and self-reporting. Future studies should therefore combine questionnaire data with classroom observations, learner assessment data, institutional records and national education statistics. Third, SDG 4 is a multidimensional global goal. A school-level index cannot capture every national and international SDG 4 indicator. The dependent variable should therefore be understood as school-level realization of selected SDG 4-related educational outcomes, rather than a complete measurement of Kenya's national SDG 4 attainment.

Suggestions for Further Research

Future research should use longitudinal designs to examine whether improvements in CBE implementation scaling precede improvements in learner outcomes and SDG 4 indicators. Structural equation modelling could also be used to investigate whether teacher capacity, assessment alignment, institutional leadership, resources and stakeholder collaboration mediate or moderate the relationship between CBE scaling and SDG 4 realization. Comparative studies across Kenyan counties would additionally help determine whether contextual differences in infrastructure, socioeconomic conditions, leadership and teacher capacity influence the strength of the relationship. Finally, future studies should integrate objective learning data, national assessment results, school completion data and administrative education statistics to complement perception-based measures.

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