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Smartphone-based augmented reality in English learning under Kenya's competency-based curriculum: Engagement, vocabulary and implementation

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Abstract

Smartphone-based augmented reality (AR) can connect digital text, images, audio and interactive objects with learners' physical environments, potentially making language learning more contextualised and participatory. This desktop review examines the potential contribution of smartphone-based AR to learner engagement and English vocabulary learning under Kenya's Competency-Based Curriculum (CBC), and considers the pedagogical, infrastructural and management conditions that may shape implementation in public secondary schools. The paper draws on selected peer-reviewed empirical research, systematic reviews, meta-analytic evidence and Kenyan curriculum documentation. The reviewed literature suggests that AR can support language-learning gains and motivation, while mobile AR and broader mobile-assisted vocabulary learning offer opportunities for multimodal practice, retrieval and contextual use. However, positive attitudes should not be treated as proof of improved achievement: effects vary by age group, learning objective, intervention duration, instructional design and assessment method. The evidence base also contains limitations, including small samples, inconsistent measures and relatively little context-specific evidence from Kenyan public secondary schools. In the Kenyan CBC context, AR may support communication and collaboration, critical thinking, creativity and digital literacy when activities are explicitly aligned with learning outcomes. Implementation is constrained by unequal device access, data costs, connectivity, electricity, teacher preparedness, accessibility and the availability of locally relevant resources. The paper concludes that AR should be approached as a pedagogical and

school-implementation strategy rather than a technological end in itself. It recommends structured teacher development, low-cost and offline-capable resources, equitable access arrangements, clear learner-protection guidelines and empirical evaluation in Kenyan schools.

Key terms: augmented reality; smartphone-assisted learning; English language learning; vocabulary acquisition; learner engagement; Competency-Based Curriculum; digital literacy; Kenya.

1.0 Introduction

1.1 Background of the Study

Digital technologies are changing the resources available to teachers and learners, but their educational value depends on how they are incorporated into teaching, assessment and school organisation. Augmented reality overlays digital content—such as text, sound, images or three-dimensional objects—onto a view of the physical environment. In language education, this can allow learners to connect words and expressions with visual representations, familiar objects, places and communicative tasks. Smartphone-based AR is potentially attractive because a mobile device can combine a camera, screen, audio and interactive software in one portable tool.

Evidence from language-learning research is promising but requires careful interpretation. Cai, Pan and Liu (2022), in a meta-analysis of 21 studies, reported positive pooled effects of AR on language-learning gains and motivation. Their analysis also indicated that learner characteristics and intervention duration influenced outcomes. In a study of 130 secondary students in Spain, Marrahi-Gomez and Belda-Medina (2024) found positive attitudes and higher motivation associated with AR-based instruction, but no statistically significant difference in grammar performance between AR-supported and conventional instruction. These findings suggest that motivation, participation and achievement are related but distinct outcomes.

Vocabulary is a relevant focus because learning a word involves more than recognising its visual form. Learners need to connect form and meaning, understand usage, retrieve words over time and apply them in speaking and writing. Mobile AR may support these processes by linking words to visual, auditory and contextual cues. A recent systematic review of 33 studies reported promising findings for vocabulary knowledge, retention and transfer, while identifying access, usability and methodological limitations (Rosnaningsih et al., 2026). A broader review of mobile-assisted English vocabulary learning likewise highlighted multimodal practice and spaced repetition, while noting that collocations, lexical organisation and contextual use remain underexplored (Duan et al., 2026).

These possibilities are relevant to Kenya's CBC, which emphasises the development and application of competencies rather than the memorisation of content alone. However, technology integration in public schools is also a leadership and management issue. Decisions are needed about teacher preparation, resource allocation, device sharing, data protection, classroom rules, inclusion and monitoring. Consequently, the question is not simply whether AR can be used in English lessons, but under what pedagogical and institutional conditions it may be useful, feasible and equitable.

1.2 Statement of the Problem

International studies and reviews indicate that AR may improve aspects of language learning and learner motivation, but effects are not uniform across skills, age groups or instructional settings. Some studies report stronger motivation without a statistically significant advantage in measured language achievement. Much of the available evidence has been generated outside Kenya, and findings cannot

automatically be assumed to transfer to Kenyan public secondary schools operating under CBC. Schools may face unequal access to smartphones, data and electricity, variable connectivity, limited teacher confidence and a shortage of locally relevant learning resources. There is therefore a need for a context-sensitive synthesis that examines the potential contribution of smartphone-based AR to engagement and vocabulary learning while considering curriculum alignment and the school-level conditions required for implementation. This paper addresses that need through a desktop review and identifies priorities for future empirical research in Kenyan public secondary schools; it does not report primary data from Kathiani Sub-County.

1.3 Objectives of the Study

To examine how smartphone-based AR may contribute to learner engagement in English language learning.

To synthesise evidence on the potential contribution of smartphone-based AR to English vocabulary acquisition.

To consider how AR-supported activities may align with competencies emphasised in Kenya's CBC.

To identify pedagogical, technological and management challenges that may affect implementation in Kenyan public secondary schools.

To propose strategies for effective, inclusive and sustainable implementation and identify priorities for further research.

1.4 Research Questions

1. How may smartphone-based AR contribute to learner engagement in English language learning?
2. What does the reviewed literature indicate about AR and English vocabulary acquisition?
3. How may AR-supported English activities contribute to CBC competency development?
4. What challenges may affect smartphone-based AR implementation in Kenyan public secondary schools?
5. What school-level strategies may support effective and equitable implementation?

2.0 Literature Review

2.1 Theoretical Framework

This review is anchored on two complementary theoretical perspectives: Constructivist Learning Theory (Piaget, 1952; Vygotsky, 1978) and the Technology Acceptance Model (Davis, 1989).

Constructivist Learning Theory explains how learners construct knowledge through interaction with learning experiences and contextualised environments, while TAM explains factors influencing the acceptance and use of technology among teachers and learners. Together, the theories provide a framework for examining both the pedagogical value of smartphone-based augmented reality (AR) in English language learning and the practical conditions that influence its adoption in schools. The combination of the two perspectives is particularly relevant because successful integration of AR requires both meaningful learning experiences and user acceptance of the technology.

2.1.1 Constructivist learning perspective

A constructivist perspective views learning as an active process in which learners interpret information

and connect new knowledge with prior experience. AR may support this process by situating language within meaningful visual or physical contexts. For example, learners might scan a teacher-prepared image associated with an unfamiliar word, examine a short explanation, listen to pronunciation and then use the word in a sentence or dialogue. The educational value lies not in scanning the image itself, but in the cognitive and communicative activity that follows. If learners merely watch animations without retrieving, explaining or applying new vocabulary, the activity may produce enjoyment without durable learning.

2.1.2 Technology Acceptance Model

The Technology Acceptance Model (TAM) proposes that perceived usefulness and perceived ease of use influence acceptance of technology (Davis, 1989). In school settings, teachers are more likely to adopt AR when it is manageable, reliable and demonstrably relevant to learning objectives. Learners may welcome an application but still struggle with device compatibility, connectivity or confusing interfaces. TAM is therefore useful for considering adoption, but it does not by itself establish whether AR improves learning. For this review, it is complemented by a pedagogical focus on learning objectives, active processing, practice and assessment.

2.2 Empirical Studies

2.2.1 AR and language-learning outcomes

Cai et al. (2022) synthesised 21 studies published between 2008 and 2020 and reported a pooled effect estimate of 0.93 for language-learning gains and 0.42 for motivation. These results suggest potential benefits, but a pooled estimate should not be interpreted as a guarantee that every AR intervention will be effective. The included studies differed in learner age, instructional context and duration, and the authors identified intervention duration and educational level as relevant moderators. Their review supports cautious experimentation with AR as a supplementary resource, accompanied by evaluation of specific outcomes.

Evidence from secondary education reinforces this qualification. Marrahi-Gomez and Belda-Medina (2024) compared AR-based and printed instruction for English comparative and superlative forms with 130 learners aged 14–15. Students exposed to AR reported stronger motivation and positive perceptions, but the study did not detect a statistically significant difference in grammar performance between groups. Although grammar learning is not the same as vocabulary acquisition, the study is pertinent because it demonstrates why learner satisfaction should not be used as a substitute for achievement measures.

2.2.2 AR and vocabulary acquisition

Vocabulary learning involves receptive knowledge, productive use, pronunciation, contextual appropriateness and retention. AR may help learners connect unfamiliar words with concrete referents or simulated contexts. Rosnaningsih et al. (2026) reviewed 33 studies on mobile AR for early English vocabulary acquisition and identified gamified, contextualised and lexical-database-based applications. Their synthesis reported promising outcomes for vocabulary knowledge, retention and transfer, alongside generally positive motivation and usability. However, the review also noted small samples, inconsistent assessment tools and digital-access barriers, which limit generalisation to other settings and age groups.

Duan et al. (2026) reviewed 36 empirical studies on mobile-assisted English vocabulary learning published from 2019 to 2025. The review reported benefits associated with multimodal input, interactive exercises and spaced repetition, while identifying limited attention to collocations, lexical organisation and contextual usage. Since this review covers mobile learning more broadly rather than AR alone, it

provides supporting—not direct—evidence for smartphone-based AR. Taken together, the reviews suggest that AR should be integrated with repeated retrieval, feedback, contextual sentence-making and later assessment rather than used as a one-off visual demonstration.

2.2.3 Learner engagement: a qualified interpretation

Engagement can be considered behavioural (participation and persistence), emotional (interest and confidence) and cognitive (attention, reasoning and effortful processing). AR may stimulate curiosity and increase willingness to participate, particularly when it offers a new way to explore language. Yet novelty can fade, and high activity levels do not necessarily mean learners are processing vocabulary deeply. Teachers should therefore design activities that require learners to explain word meanings, distinguish near-synonyms, use words in new contexts, collaborate and reflect. Engagement measures should be paired with vocabulary tests, writing or speaking tasks, and delayed checks of retention.

2.2.4 CBC competency alignment

Kenya's Basic Education Curriculum Framework foregrounds competencies and learner-centred learning (Kenya Institute of Curriculum Development [KICD], 2017). AR could support communication and collaboration through paired vocabulary challenges and group explanations; critical thinking through selecting the most appropriate word for a context; creativity through learner-generated digital stories or annotated scenes; and digital literacy through purposeful and responsible use of digital tools. These are potential contributions, not automatic effects. A lesson demonstrates competency development only when the activity and assessment make the intended competency visible.

For instance, learners could use a teacher-prepared AR vocabulary set connected to a local environmental or community theme. In groups, they identify key words, discuss meaning and pronunciation, write a short paragraph using selected words, and provide peer feedback. The teacher assesses accuracy, contextual appropriateness, collaboration and responsible use of devices. This design makes technology subordinate to the language objective and provides evidence of learning.

2.2.5 Implementation and school management

Implementation involves more than access to an application. Teachers require time to select or create appropriate content, test it on available devices, anticipate technical problems and design alternative activities. School leaders may need to plan shared-device arrangements, connectivity budgets, staff mentoring, technical support and monitoring. Equity is central: personal smartphone ownership cannot be assumed, and learners may differ in data access, disability-related needs, language background and confidence with digital tools. Offline or low-data resources, school-provided devices and non-digital alternatives can reduce exclusion.

Classroom guidance is also necessary. Schools should define when devices may be used, how learners access approved content, how photographs and personal information are protected, and what happens when a device or network fails. AR should not require learners to purchase equipment or data as a condition of participation. These considerations are particularly important if a pilot is to be scaled beyond a small, well-resourced group.

2.3 Research Gap

Existing literature demonstrates the potential of augmented reality to enhance learner motivation, engagement, and selected language-learning outcomes. However, the evidence base remains fragmented in several respects. First, much of the research has been conducted in Europe, Asia, and

other international contexts, limiting the generalisability of findings to Kenyan public secondary schools. Second, many studies focus on learner perceptions and motivation without adequately examining long-term vocabulary retention and academic achievement. Third, reviews of mobile-assisted language learning frequently combine augmented reality with other mobile technologies, making it difficult to isolate the specific contribution of smartphone-based AR. Finally, limited attention has been given to implementation factors such as teacher readiness, resource availability, leadership support, equity, and sustainability within developing-country contexts. Consequently, there remains a need for context-sensitive analyses that examine the educational potential of smartphone-based AR within Kenya's Competency-Based Curriculum and identify conditions necessary for effective implementation in public secondary schools. This desktop review addresses this gap by synthesising current evidence relating to learner engagement, vocabulary acquisition, curriculum alignment, implementation challenges, and future research priorities

3.0 Methodology

This study adopted a targeted narrative desktop-review design to examine the potential contribution of smartphone-based augmented reality (AR) to English language learning under Kenya's Competency-Based Curriculum (CBC). Narrative reviews are appropriate for synthesising evidence from multiple sources, identifying themes, and generating contextual insights regarding emerging educational innovations (Creswell & Creswell, 2018). It synthesises selected peer-reviewed empirical research, systematic reviews, meta-analytic evidence and relevant Kenyan curriculum documentation. The source set was assembled iteratively during manuscript development by identifying publications relevant to the review questions and checking bibliographic details against journal or publisher records and official curriculum documentation. The principal sources discussed in detail are Cai et al. (2022), Marrahi-Gomez and Belda-Medina (2024), Rosnaningsih et al. (2026), Duan et al. (2026), Davis (1989) and the Kenya Institute of Curriculum Development (KICD, 2017). This is an interpretive narrative synthesis, not a systematic review or meta-analysis; it does not calculate a new effect size or claim exhaustive coverage of all published research.

Sources were selected for their relevance to one or more review questions: language-learning outcomes, vocabulary acquisition, engagement, curriculum alignment or implementation. Meta-analyses and systematic reviews were used to understand broader patterns, while the empirical secondary-school study by Marrahi-Gomez and Belda-Medina (2024) informed discussion of the distinction between motivation and measured performance. KICD's Basic Education Curriculum Framework provided the Kenyan curriculum reference point. The synthesis compared reported benefits, limitations and implementation conditions and organised the discussion into five themes: engagement, vocabulary acquisition, CBC competencies, implementation barriers and school-level strategies. The review did not apply a pre-registered protocol, fixed database search strings, formal screening counts or a standardised quality-appraisal tool; therefore, it does not report search totals or represent the source set as exhaustive.

The review has methodological limitations. It does not provide a PRISMA flow diagram, a comprehensive database-by-database search log or a formal risk-of-bias appraisal; it should therefore not be described as a systematic review. The sources differ in populations, outcomes and methods, and some examine mobile-assisted learning broadly rather than AR specifically. No primary data were collected from Kenyan learners, teachers or schools, and no empirical claims are made about effects in Kathiani Sub-County. Because the study analyses published literature and public curriculum documents only, it involved no human participants, and participant consent was not applicable. Any future school-based study would require relevant institutional, research and school permissions and appropriate safeguards for learners.

4.0 Findings and Discussion

4.1 AR and learner engagement

Across the sources reviewed, a recurring potential benefit of AR is increased interest, positive attitudes and motivation. Cai et al. (2022) reported a positive pooled effect on motivation, while Marrahi-Gomez and Belda-Medina (2024) found more favourable motivation and perceptions among secondary learners exposed to AR. This convergence supports the view that AR can make some language activities more appealing. Nevertheless, the secondary-school study did not find a statistically significant advantage in grammar performance, illustrating that affective responses and learning outcomes should be evaluated separately.

For Kenyan English lessons, engagement should be treated to learning rather than the final objective. Teachers should ask learners to retrieve words from memory, explain meanings, use target vocabulary in sentences and apply words in unfamiliar contexts. School-level monitoring should include participation and learner feedback, but also performance measures. This approach avoids treating novelty or enjoyment as evidence that the intervention has achieved its instructional purpose.

4.2 AR and vocabulary acquisition

The reviewed mobile-AR and mobile-assisted vocabulary reviews suggest that visual, auditory and interactive features may support word learning, retention and transfer (Duan et al., 2026; Rosnaningsih et al., 2026). The likely benefit is strongest when digital cues help learners connect form, meaning and context, and when the lesson includes repeated practice. However, the reviews also identify methodological weaknesses and limited attention to deeper vocabulary knowledge. A learner may recognise a labelled object but still be unable to use the word accurately in speech or writing.

An appropriate classroom design would therefore combine an AR encounter with pronunciation practice, learner-generated examples, retrieval after a delay and teacher feedback. Vocabulary assessment should distinguish immediate recognition from productive use and delayed retention. Since the reviewed evidence does not directly establish outcomes in Kenyan public secondary schools, these practices should be treated as promising design principles to test, not as proof of local effectiveness.

4.3 Potential contribution to CBC competencies

AR may support CBC competencies when the task makes the competency explicit. Collaborative scanning and discussion may create opportunities for communication and collaboration; selecting and defending a word choice may exercise critical thinking; creating a short digital story may support creativity; and navigating approved tools responsibly may develop digital literacy. Yet the same competencies can be developed through non-digital methods. The contribution of AR must therefore be judged by the quality of the learning task and evidence of learner performance, not by the presence of technology.

A useful implementation principle is to begin with the English learning outcome and then decide whether AR adds value. If a printed image, real object or teacher demonstration achieves the same goal more reliably and inclusively, AR may not be necessary. Where AR provides meaningful context, interaction or feedback unavailable through simpler means, its use may be justified.

4.4 Barriers to implementation

The literature points to access and usability barriers, including device compatibility, internet availability and digital literacy (Rosnaningsih et al., 2026). For Kenyan public schools, these concerns should be

considered alongside data costs, electricity, technical support, teacher workload, availability of suitable content and school rules on personal devices. A smartphone-based intervention that assumes every learner owns a compatible device could deepen existing inequalities. Content that depends on continuous high-speed connectivity may also be unreliable in some school settings.

Teacher readiness and school leadership are equally important. Teachers need practical support in choosing curriculum-aligned content, managing group work, protecting learner privacy and assessing outcomes. Leaders need to consider total costs, equitable access and sustainability rather than purchasing devices without a plan for classroom use. Implementation should also include accessibility checks and a non-digital alternative so that learners are not disadvantaged by disability, device failure or connectivity problems.

4.5 Strategies for effective and equitable implementation

Educational technology initiatives frequently fail because schools focus on acquiring technology rather than integrating it into pedagogy (KICD, 2017; Davis, 1989). Effective implementation of AR therefore requires comprehensive planning involving teacher preparation, curriculum alignment, technical support, learner protection, and continuous evaluation. School leaders should ensure that technology adoption decisions are guided by educational objectives and evidence of learner benefit rather than enthusiasm for innovation alone. Sustainable implementation requires balancing innovation, accessibility, cost-effectiveness, and educational value.

5.0 Conclusion and Recommendations

5.1 Conclusion

This review indicates that smartphone-based augmented reality offers considerable potential for enriching English language learning by providing contextualised, multimodal, and interactive learning experiences. The strongest evidence relates to learner motivation, engagement, and vocabulary development, although findings vary according to instructional design, intervention duration, learner characteristics, and assessment approaches. Consequently, AR should not be viewed as a guaranteed solution for improving language achievement but rather as a pedagogical tool whose effectiveness depends on thoughtful instructional application and supportive implementation conditions.

For Kenya’s CBC, AR may provide opportunities to practise communication, collaboration, critical thinking, creativity and digital literacy. Such contributions must be deliberately designed and assessed. The review does not establish the effectiveness of AR in Kathiani Sub-County or in Kenyan public secondary schools generally; it provides a reasoned basis for local piloting and empirical investigation. AR should be considered a possible pedagogical and implementation tool—not a substitute for sound teaching, equitable provision or school leadership.

5.2 Contribution to Knowledge

This review contributes to the growing body of knowledge on educational technology integration by synthesising current evidence regarding the pedagogical and implementation potential of smartphone-based augmented reality in English language learning. The review highlights the distinction between learner motivation and academic achievement, demonstrates the relevance of AR within Kenya’s Competency-Based Curriculum, and identifies implementation requirements that may influence effectiveness in public secondary schools. The study further contributes a conceptual framework for future empirical investigations of AR-supported English learning in Kenyan educational settings.

5.3 Recommendations

1. Teacher professional development: Provide practical training in curriculum-aligned AR lesson design, vocabulary instruction, assessment, troubleshooting, digital citizenship and learner protection.
2. Curriculum alignment: Require each AR activity to specify the English learning outcome and intended CBC competency. Avoid adopting AR solely because it is novel.
3. Equitable access: Use shared school devices, small-group rotations, offline or low-data resources and equivalent non-digital alternatives. Do not make personal device ownership or learners' ability to purchase data a condition of participation.
4. Locally relevant resources: Develop or adapt vocabulary materials using familiar Kenyan contexts, while checking linguistic accuracy, cultural relevance, accessibility and suitability for learners' age groups.
5. School leadership and management: Include technology pilots in resource planning, teacher mentoring, technical support, risk assessment and monitoring. Review cost and sustainability before scaling up.
6. Assessment: Evaluate vocabulary recognition, productive use and delayed retention alongside learner engagement. Where feasible, compare AR-supported lessons with a clearly specified conventional approach.
7. Safety and inclusion: Establish rules for approved applications, privacy, photography, online access, responsible smartphone use and support for learners who cannot use a particular device or interface.

5.4 Areas for Further Research

Future studies should test smartphone-based AR in Kenyan public secondary schools, including schools in Kathiani Sub-County, without assuming that international findings will be replicated. A feasible first study could compare an AR-supported vocabulary unit with conventional instruction, using baseline and post-intervention tests, a delayed retention measure and a structured engagement instrument. The study should document device access, connectivity, teacher preparation, lesson duration and the precise learning tasks used. Mixed-methods work could also explore teachers' and learners' experiences, while school-level research could examine leadership support, costs, inclusion and sustainability. Larger and longer-term studies would help establish whether any learning gains persist and whether the approach is practical across different school contexts.

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