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**Interactive Subject Content, Learner Engagement and Clinical Skills Acquisition of
Students at Kenya Medical Training College Campuses' in Rift Valley, Kenya**

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Abstract

Purpose: The training of competent healthcare professionals remains a critical mandate of health education institutions, particularly in contexts such as Kenya where significant skills gaps persist among healthcare workers. Blended learning approaches incorporating interactive subject content (ISC) have the potential to enhance learner engagement (LE) and improve clinical skills acquisition (CSA). However, limited empirical evidence exists on the relationships among these variables. This study aimed to assess the effect of ISC on CSA and examine the mediating role of LE among students in Kenya Medical Training College (KMTC) campuses in the Rift Valley region.

Methodology: A cross-sectional study design was employed targeting 5,519 students and 9 heads of departments (HODs) across nine KMTC campuses. A sample of 373 students was selected using stratified random sampling, while all 9 HODs were purposively included. Data were collected using structured questionnaires and key informant interviews and analyzed using regression and mediation analysis techniques.

Findings: Interactive subject content significantly and positively predicted clinical skills acquisition ($\beta = 0.758$, $p < 0.0001$, 95% CI: 0.672–0.845). Learner engagement partially mediated the relationship between ISC and CSA ($\beta = 0.334$, 95% CI: 0.202–0.457), indicating that while ISC directly enhances CSA, its effect is strengthened through improved learner engagement.

Unique Contribution to Theory, Practice and Policy: Despite the demonstrated effectiveness of interactive subject content in enhancing clinical skills acquisition both directly and through increased learner engagement, gaps persist in the optimal integration of learner-centered strategies within blended learning environments. The findings underscore the pivotal role of learner engagement in strengthening skill acquisition and highlight the need for deliberate incorporation of interactive content in medical training. Enhancing curriculum design, learner-centered instructional approaches and institutional policies to support blended learning, while prioritizing interactivity and engagement, may improve the competence of healthcare trainees in Kenya.

Keywords: *Clinical Skills Acquisition, Interactive Subject Content, Learner Engagement, Blended Learning, Medical and Nursing Education*

JEL Codes: *I21, I23, I25*

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INTRODUCTION

The training of competent healthcare professionals is a fundamental responsibility of health education institutions. Clinical competence is a multidimensional construct, encompassing cognitive skills such as diagnostic reasoning and clinical decision-making; psychomotor skills such as procedural dexterity and physical examination; and interpersonal skills such as communication and teamwork (Cant & Cooper, 2010). These competencies must be systematically developed through well-designed learning experiences. High-quality clinical skills are essential for delivering safe, effective, and patient-centered care, and they directly influence patient outcomes (Mohammad et al., 2024). Almarwani and Alzahrani (2023) concluded that prioritizing clinical competency enables nurses to deliver high-quality care. Consequently, strengthening clinical training remains a priority in health professions education.

Globally, concerns persist regarding a mismatch between training and the competencies required in clinical practice of healthcare workers. Evidence indicates that many healthcare graduates lack essential practical skills, contributing to suboptimal performance in clinical settings. For example, Adely (2021) reported that health institutions employers are facing significant challenges in identifying qualified and skill-endowed candidates to fill pertinent positions, leading to a widespread phenomenon termed as the “healthcare skills gap” or “skills mismatch”. Studies across African contexts have raised questions about the adequacy of training among mid-level healthcare workers, while local research has reported deficiencies in clinical competencies among trainees and practicing clinicians alike. This skills gap underscores the need for innovative and effective pedagogical approaches in medical education. In a study conducted in Nigeria, South Africa, Uganda and Kenya, Couper et al. (2018) questioned the quality of training among mid-level health workers amid existing clinical gap challenges. In Kenya, Kweya et al. (2020) reported substandard clinical performance attributed to insufficient clinical skills among the diploma nursing students in a study at Kenya Medical Training College campuses in western Kenya. In a survey of primary care clinics in the private sector of Nairobi in Kenya, Mohamoud and Mash (2022) concluded that general practitioners lacked essential training in certain areas and were poor in some skills, such as, proctoscopies, contraceptive devices, skin procedures, genograms use and intra-articular injections.

These challenges are particularly pronounced within mid-level training institutions such as KMTC, which produce the majority of frontline healthcare workers in Kenya, accounting for approximately 85% of the country’s mid-level health workforce. KMTC programmes are inherently competency-based, requiring students to acquire and demonstrate practical clinical skills essential for patient care. At the same time, the institution has adopted blended learning approaches to support training across its multiple campuses (KMTC, 2019). Given the scale and skills-intensive nature of this training, there is a critical need for instructional approaches that can effectively support both knowledge acquisition and practical skill development. Interactive subject content is therefore not merely an enhancement but a necessary component of blended learning, as it facilitates active engagement, repeated exposure to clinical scenarios, and application of knowledge in simulated and practice-oriented contexts. These features are particularly important in strengthening clinical skills acquisition among nursing and clinical medicine students, who serve as frontline healthcare providers.

Traditional teaching methods in clinical skills education have largely been teacher-centered, relying heavily on lectures, supervised bedside teaching, and limited experiential learning opportunities (Carter, 2016). However, such approaches have been criticized for their

inadequacy in fostering practical clinical skills. Harmon et al. (2016) stated that traditional, passive lectures were ill-suited for inculcating clinical skills, advocating for experiential, student-centred and practical skill acquisition. Increasingly, evidence supports the adoption of student-centered and experiential learning strategies, including simulation-based training, which has demonstrated superiority over conventional methods in enhancing clinical competence. Shah et al. (2024) in a randomized controlled trial, compared the efficacy of simulation-based training (SBT) versus traditional bedside training (BT) in enhancing clinical skills among medical students. Post-intervention results showed the superiority of SBT group relative to the traditional method, owing to a structured and immersive nature of the former, which allowed for repetitive practice and immediate feedback.

In response to these challenges, blended learning has emerged as a promising pedagogical approach. By integrating face-to-face instruction with digital learning modalities, blended learning enables flexibility, reinforces theoretical knowledge, and promotes active learning (Lockey et al., 2022). It allows students to engage with instructional content repeatedly and apply knowledge in practical contexts, thereby improving retention and skill acquisition. Central to the effectiveness of blended learning is the quality of instructional materials, particularly interactive subject content, which enhances engagement and supports deeper learning.

Despite the growing body of literature on blended learning and clinical education, several important gaps remain. The existing studies have largely examined the direct effects of instructional approaches on learning outcomes, with limited attention to the underlying mechanisms through which these effects occur. In particular, the role of learner engagement as a mediating variable linking instructional design specifically interactive subject content to clinical skills acquisition remains insufficiently explored. In addition, while interactive and technology-enhanced learning strategies have been widely studied in high-resource settings, there is limited empirical evidence from low- and middle-income contexts, including Kenya, where training environments and resource dynamics differ substantially. Lastly, few studies have examined these relationships within mid-level health training institutions such as KMTC, which are responsible for training the majority of frontline healthcare workers and operate at scale. Addressing these gaps is critical for informing the design of effective, contextually relevant blended learning interventions that enhance clinical competence. This study sought to examine the relationship between interactive subject content and clinical skills acquisition, and by determining the mediating role of learner engagement among students in Kenya Medical Training College campuses in the Rift Valley region.

Problem Statement

Despite growing adoption of blended learning in health professions education, significant gaps remain in the effective integration of interactive and learner-centered instructional strategies. In many training institutions, including those in Kenya, pedagogical practices continue to emphasize passive learning approaches, limiting opportunities for active engagement and practical skill development.

Although interactive subject content has been shown to enhance learning outcomes, its specific effect on clinical skills acquisition remains underexplored, particularly within the Kenyan context. Furthermore, while learner engagement is widely recognized as a critical determinant of academic success, its role as a mediating mechanism through which interactive content influences clinical skills acquisition has not been sufficiently examined.

Importantly, the limited integration of interactive subject content has implications beyond educational outcomes. Without adequate opportunities to engage with interactive, practice-oriented learning materials that bridge the theory–practice gap, trainees may enter clinical placements with insufficient procedural confidence and limited readiness to apply skills in real patient settings. This gap in pre-clinical preparation may compromise the quality and safety of patient care, particularly in high-demand training environments such as KMTC, where students serve as frontline providers during clinical rotations.

Existing studies have largely focused on direct relationships between teaching methods and learning outcomes, with limited attention to the underlying processes that drive these outcomes. Notably, there is a lack of empirical evidence examining how learner engagement mediates the relationship between interactive subject content and clinical skills acquisition in health training institutions. This gap limits the ability of educators and policymakers to design evidence-based interventions that effectively enhance clinical competence.

Theoretical framework

This study is grounded in Constructivism theory, which postulates that learning is an active, constructive process in which learners build knowledge through interaction with content, experiences, and their social environment (Mishra, 2023). The theory emphasizes that learners are not passive recipients of information but active participants who construct meaning through engagement, collaboration, and reflection. Consequently, effective learning environments are those that promote active participation, critical thinking, and experiential learning.

To further explain how learning occurs within such environments, this study is also informed by Cognitive Load Theory, which posits that instructional design must account for the limited capacity of working memory (Sweller, 2024). Learning is optimized when extraneous cognitive load (unnecessary mental effort caused by poor instructional design) is minimized, and germane load (mental effort devoted to schema construction and learning) is enhanced. Within blended learning environments, interactive subject content must therefore be carefully designed to avoid cognitive overload while promoting meaningful engagement. Poorly designed multimedia or overly complex interfaces may hinder learning, whereas well-structured interactive content such as guided simulations and scaffolded case scenarios can enhance understanding and facilitate clinical reasoning.

In addition, this study draws on Miller’s Pyramid of Clinical Competence, which conceptualizes clinical competence across four hierarchical levels: knows, knows how, shows how, and does (Hampton et al., 2024). While traditional didactic approaches primarily address the lower levels (knows and knows how), interactive and simulation-based learning environments are particularly suited to developing the “shows how” level, where learners demonstrate the application of knowledge in controlled or simulated clinical contexts (Hampton et al., 2024). This study focuses on this level of competence, as interactive subject content enables learners to practice clinical procedures, apply decision-making skills, and receive feedback in safe, structured environments prior to real patient interaction.

Rapid technological advancements and the increasing complexity of modern healthcare practice necessitate innovative pedagogical approaches. Blended learning (BL), which integrates traditional face-to-face instruction with online learning, has emerged as a viable strategy for enhancing educational outcomes. By combining multiple instructional modalities, BL leverages the strengths of both in-person and digital learning environments. Evidence indicates that blended learning, particularly when incorporating multimedia-rich content,

enhances learners' conceptual understanding, confidence, and motivation (He et al., 2024). It also enables students to reinforce theoretical knowledge through self-paced learning while applying concepts in practical, clinically oriented settings (Lockey et al., 2022). This integration supports active learning, promotes deeper understanding, and allows repeated engagement with complex material, thereby improving knowledge retention. Furthermore, tools such as screen-based simulations, online clinical videos, and interactive case scenarios prepare learners for hands-on practice and enhance engagement during clinical training (Oh, 2022; McGee et al., 2024).

Within this framework, interactive subject content (ISC) is defined as digitally mediated instructional material embedded within blended learning environments that actively engages learners through participation, feedback, and decision-making. ISC including virtual simulations, multimedia case presentations, collaborative digital activities, gamified modules, and problem-based learning platforms aligns closely with constructivist principles by creating immersive and responsive learning environments (Xiang et al., 2022). In this study, ISC includes multimedia instructional videos, interactive quizzes with immediate feedback, case-based scenarios (including branching clinical cases), virtual simulations, and collaborative digital learning activities. These tools are designed to promote active learning, repeated practice, and application of knowledge in clinically relevant contexts. Unlike passive didactic instruction, interactive content promotes active decision-making, immediate feedback, and repetitive practice in safe, controlled settings, thereby enhancing critical thinking and problem-solving skills essential for clinical practice. Empirical studies have demonstrated that interactive digital learning environments significantly improve clinical reasoning, diagnostic accuracy, and learner engagement (Plackett et al., 2022; Macnamara et al., 2021). Virtual patient simulations and branching clinical cases allow learners to experience decision-making consequences in safe environments, thereby strengthening reflective practice and procedural judgment. Seed et al. (2025) stated that multidimensional and interactive subject content, because of its immediacy, interaction, personalization, and feedback, could keep the technology-savvy 'Generation Y' engaged in learning. Static content formats are increasingly perceived as disengaging, particularly in clinical education where realism and interactivity are valued. Gamification and storytelling in BL could foster intrinsic motivation, active participation, promote persistence in completing learning activities, and improve overall student satisfaction. Additionally, features such as gamification and storytelling foster intrinsic motivation, persistence, and overall student satisfaction while improving higher-order competencies such as clinical decision-making and learner confidence (van Gaalen et al., 2021; Imanipour et al., 2022; Andretta et al., 2025). Interactive content has also been shown to enhance learners' self-efficacy and readiness for clinical roles (Wang & Raman, 2025).

A central construct within this framework is learner engagement (LE), defined as the degree to which learners invest cognitive, emotional, and behavioural effort in their learning activities (Schunk & Mullen, 2012). Learner engagement is a critical determinant of academic success and plays a pivotal role in clinical skills acquisition. It has been associated with improved performance, motivation, persistence, and satisfaction (Conrad, 2010; Filak & Sheldon, 2008; Hughes et al., 2008). In blended learning environments, learner engagement is particularly important due to the increased autonomy and responsibility placed on students to actively participate in both online and face-to-face learning activities (Long & Van, 2020). Engaged learners demonstrate higher participation, stronger self-regulated learning behaviors, and superior learning outcomes compared to their less engaged peers (Bond et al., 2021; Battestilli

et al., 2023). Moreover, engagement facilitates deliberate practice, which is essential for procedural mastery and patient safety (De Bruijn-Smolanders & Prinsen, 2024).

Guided by constructivist theory, this study posits that interactive subject content influences clinical skills acquisition (CSA) both directly and indirectly through learner engagement. Specifically, ISC enhances engagement by creating interactive, student-centered learning environments, which in turn promote deeper learning, deliberate practice, and skill mastery. Empirical evidence supports the mediating role of learner engagement in the relationship between innovative teaching strategies and learning outcomes (Lei et al., 2018; Shea & Bidjerano, 2010). However, no known study has explicitly examined learner engagement as a mediator between interactive subject content and clinical skills acquisition within the Kenyan context. This framework therefore provides a basis for understanding the mechanisms through which blended learning and interactive content contribute to the development of clinical competence among healthcare trainees.

METHODOLOGY

A cross-sectional study design was employed to examine the relationships among interactive subject content (ISC), learner engagement (LE), and clinical skills acquisition (CSA). This design was appropriate for assessing associations between variables within a relatively short timeframe.

The study was conducted across nine Kenya Medical Training College (KMTC) campuses in the Rift Valley region of Kenya. The region was selected due to its high concentration of KMTC campuses, enhancing representativeness. KMTC institutions were chosen as they implement blended learning and train approximately 85% of the country's mid-level healthcare workforce (KMTC, 2019). The study focused on nursing and clinical medicine students, who are primary frontline healthcare providers.

The target population comprised 5,519 students and 9 heads of departments (HODs). A sample of 373 students was determined using Slovin's formula for proportions (Ellen, 2020), assuming a 95% confidence level, 5% margin of error, and maximum variability ($p = 0.5$). Stratified random sampling ensured proportional representation across campuses and programmes, while all 9 HODs were included through a census approach to obtain key institutional insights.

Data were collected using structured questionnaires for students and key informant interview schedules for HODs. The instruments were developed based on established literature (e.g., Xiang et al., 2022; Plackett et al., 2022; Macnamara et al., 2021) and aligned with the study constructs. The questionnaire comprised four sections: demographic characteristics, ISC (9 items), LE (7 items), and CSA (13 items), measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Reliability analysis demonstrated high internal consistency, with Cronbach's alpha coefficients of 0.93 (ISC), 0.95 (LE), and 0.94 (CSA). Construct validity was assessed using principal component analysis with varimax rotation, confirming unidimensional factor structures for each construct (Barnes & Forde, 2021).

Data collection was conducted in March to May 2025. Questionnaires were administered electronically, while HODs participated in face-to-face interviews. Ethical approval was obtained from ISERC (Approval number KeMU/ISERC/HSM/17/2024), NACOSTI (Approval number NACOSTI/P/24/41390) and the KMTC Institutional Research Committee, and informed consent was secured from all participants.

Quantitative data were analyzed using descriptive statistics, Pearson's correlation, and linear regression analysis. The effect of ISC on CSA was assessed using ordinary least squares

regression. Mediation analysis was conducted using Hayes' PROCESS macro (Model 4) with 5,000 bootstrap resamples to estimate indirect effects and generate bias-corrected 95% confidence intervals. Statistical analyses were performed using SPSS Version 25 and STATA Version 14, with significance set at $p < 0.05$. Qualitative data from key informant interviews were analyzed thematically to complement quantitative findings.

RESULTS

Sample Characteristics

Of the 373 questionnaires administered to students, 318 were successfully completed, resulting in an 85% response rate. Iwanaga et al. (2025) argued that response rates greater than 70% are acceptable as they decrease the chances of non-response bias. In addition, eight out of nine HODs were interviewed. Slightly more female students were sampled ($n=208$, 54%) relative to males ($n=177$, 46%). Roughly, equal number of female ($n=163$, 51%) and male ($n=155$, 49%) students were sampled. Most students ($n=184$, 58%) were young (<21 years), with a decrement in their number as age increased. The sample consisted mostly nursing students ($n=228$, 72%) compared to those of clinical medicine (28%).

Descriptive Results

Interactive subject content (ISC) was analyzed using descriptive statistics to summarize respondents' levels of agreement across key items related to interactive e-learning in clinical training. The results provide an overview of students' perceptions regarding the role of interactive content in enhancing learning, skill acquisition, and clinical competence (Table 1).

Table 1: Respondents Opinion on Interactive Subject Content

Interactive subject content	SD	D	Mod.	Agree	SA	Mean	Std. Dev
I prepare well for class lessons when lecturers post module objectives on time	8 (2.5%)	11 (3.5%)	47 (14.8%)	149 (46.9%)	103 (32.4%)	4.03	.915
The teaching of theory on time before clinical placements enable me to integrate theory into practice with confidence	7 (2.2%)	32 (10.1%)	56 (17.6%)	157 (49.4%)	66 (20.8%)	3.76	.965
Teaching patient care procedures on time increases my mastery of the skills due to adequate time for practice	0 (0.0%)	46 (14.5%)	76 (23.9%)	107 (33.6%)	89 (28.0%)	3.75	1.019
Interactive features on KMTC e-learning modules enable me to develop collaborative skills for teamwork	10 (3.1%)	38 (11.9%)	67 (21.1%)	144 (45.3%)	59 (18.6%)	3.64	1.016
The interactive e-learning content makes me communicate well with patients during clinical placements	2 (0.6%)	40 (12.6%)	79 (24.8%)	132 (41.5%)	65 (20.4%)	3.69	.957
Engaging with interactive content online improves my ability to apply critical thinking skills in solving patient problems	2 (0.6%)	20 (6.3%)	64 (20.1%)	150 (47.2%)	82 (25.8%)	3.91	.873
Interactive content in e-learning modules improves my interpersonal skills for patients' management	0 (0.0%)	16 (5.0%)	64 (20.1%)	145 (45.6%)	93 (29.2%)	3.99	.835
Interactive content on KMTC e-learning platform helps me retain skills on patient care procedures longer than traditional methods	4 (1.3%)	26 (8.2%)	74 (23.3%)	118 (37.1%)	96 (30.2%)	3.87	.980
The tests given at the end of a theory or practical session on the e-learning platform provide immediate feedback enabling me to improve on weak areas	10 (3.1%)	7 (2.2%)	69 (21.7%)	152 (47.8%)	80 (25.2%)	3.90	.912
Aggregate composite score						3.84	.523

Key: SD=Strongly disagree; Mod=Moderate; D=Disagree; SA=Strongly agree; Std. Dev.=Standard deviation

The respondents generally agreed that well-structured interactive subject content significantly enhances clinical competence (overall mean = 3.84, SD = 0.523), suggesting that interactivity is a critical component of effective blended learning implementation. High mean scores across multiple items reflect positive perceptions of the role of interactive content in developing essential clinical competencies.

Specifically, respondents agreed that interactive features enhance teamwork skills (Mean = 3.64, SD = 1.016), improve communication with patients (Mean = 3.69, SD = 0.957), and strengthen critical thinking in solving patient problems (Mean = 3.91, SD = 0.873). Similarly, interactive content was perceived to improve interpersonal skills in patient management (Mean = 3.99, SD = 0.835) and enhance long-term retention of patient care procedures compared to traditional methods (Mean = 3.87, SD = 0.980). These findings suggest that interactive learning environments support not only cognitive skill development but also interpersonal and professional competencies essential for clinical practice.

In addition, students reported that timely instructional practices contribute to improved learning outcomes. Respondents agreed that they prepare better when lecturers post module objectives on time (Mean = 4.03, SD = 0.915), that teaching theory prior to clinical placement facilitates confident integration of theory into practice (Mean = 3.76, SD = 0.965), and that timely teaching of patient care procedures enhances mastery due to adequate practice time (Mean = 3.75, SD = 1.019). These results highlight the importance of structured and well-sequenced instructional design within blended learning environments.

Qualitative findings corroborated the quantitative results, emphasizing the role of interactive content in enhancing higher-order cognitive and interpersonal skills. Participants noted that interactive approaches such as case-based discussions, simulations, and collaborative activities promote critical thinking and active learning:

“... Interactive discussions and case scenarios encourage students to think critically about patient problems rather than memorizing procedures...” (KII_04, Male, 5th April, 2025).

Similarly, participants highlighted the contribution of collaborative learning platforms to teamwork and communication skills:

“...When students engage in group discussions and online forums, they develop teamwork and communication skills which are very important in clinical settings...” (KII_08, Female, 22nd April, 2025).

Interactive digital content was also perceived to enhance long-term retention and engagement through active participation:

“...Interactive digital content enhances long-term retention since learners actively participate instead of passively listening. Critical thinking improves when students analyze case-based scenarios through online platforms and classroom engagement...” (KII_04, Male, 5th April, 2025).

Learner Engagement

Learner engagement (LE) was analyzed using descriptive statistics to summarize respondents' levels of agreement across key items related to self-directed learning, participation in clinical activities, and collaborative learning. The results provide an overview of students' engagement behaviours in enhancing clinical skills acquisition and overall learning outcomes (Table 2).

Table 2: Respondents Opinion on Learner Engagement

Learner Engagement	SD	D	Mod.	Agree	SA	Mean	Std. Dev.
I spend most of my time doing self-directed studies for it improves my mastery skill/knowledges	10 (3.1%)	7 (2.2%)	69 (21.7%)	152 (47.8%)	80 (25.2%)	3.90	.912
I actively participate in clinical practice sessions, take initiative in learning new skills for it enables gain mastery of patient procedures	7 (2.2%)	5 (1.6%)	22 (6.9%)	204 (64.2%)	80 (25.2%)	4.08	.759
I actively collaborate with my peers during clinical placements to boost skill development on patient procedures	6 (1.9%)	3 (0.9%)	105 (33.0%)	129 (40.6%)	75 (23.6%)	3.83	.864
I spend my free time practicing patient care procedures in the skills laboratory for it enables me master the skills	4 (1.3%)	17 (5.3%)	91 (28.6%)	129 (40.6%)	77 (24.2%)	3.81	.907
I engage in self-directed study to reinforce clinical skills learned in class	3 (0.9%)	3 (0.9%)	101 (31.8%)	154 (48.4%)	57 (17.9%)	3.81	.766
I seek clarification during class sessions for challenging clinical concepts	20 (6.3%)	53 (16.7%)	107 (33.6%)	88 (27.7%)	50 (15.7%)	3.30	1.113
I review recorded lectures/demonstrations to reinforce the clinical procedures taught in class	6 (1.9%)	15 (4.7%)	118 (37.1%)	129 (40.6%)	50 (15.7%)	3.64	.870
Aggregate composite score						3.83	.580

Key: SD=Strongly disagree; D=Disagree; Mod=Moderate; SA=strongly agree; Std. Dev.=standard deviation

The learners perceived their engagement as a significant contributor to the mastery of patient care procedures (aggregate mean = 3.83; SD = 0.580). Overall, respondents generally agreed that self-directed learning, active participation in clinical practice sessions, and peer collaboration enhance their clinical competence and skill development.

Specifically, students reported that dedicating time to self-directed study improves skill mastery, while active participation in clinical practice sessions strengthens clinical competence. In addition, collaboration with peers during training was perceived to enhance the development of procedural skills, highlighting the importance of interactive and participatory learning approaches in clinical education.

Qualitative findings supported these results, indicating that learner engagement is demonstrated through deliberate effort, persistence in practice, and willingness to exceed minimum academic requirements. Participants emphasized that students who invest additional time in independent study tend to perform better in clinical assessments:

“... Students who dedicate extra time to studying procedures on their own tend to perform better during clinical demonstrations...” (KII_02, Female, 27th March, 2025).

Similarly, active participation in clinical settings was identified as a key driver of competence development:

“... Active participation in ward activities builds competence because students learn by doing, not by observing only ...” (KII_04, Male, 5th April, 2025).

Clinical Skills Acquisition

Clinical skills acquisition (CSA) was analyzed using descriptive statistics to summarize respondents’ levels of agreement across key items related to diagnostic ability, decision-making, patient management, and communication in clinical practice. The results provide an overview of students perceived competence in applying knowledge and skills in patient care within blended learning environments (Table 3).

Table 3: Respondents Opinion on CSA

Clinical Skills Acquisition	SD	D	Mod.	Agree	SA	Mean	Std. Dev.
I feel confident in applying the knowledge acquired to make accurate patient diagnosis	5 (1.6%)	2 (0.6%)	79 (24.8%)	165 (51.9%)	67 (21.1%)	3.90	.786
I can prescribe the correct treatment for patients by analyzing information from diverse sources	0 (0.0%)	4 (1.3%)	25 (7.9%)	204 (64.2%)	85 (26.7%)	4.16	.609
I use evidence-based practice to support my decisions to improve patient care outcomes	2 (0.6%)	4 (1.3%)	120 (37.7%)	135 (42.5%)	57 (17.9%)	3.76	.779
Varying learning environments enables me to prioritize tasks/make sound clinical decisions on patient management	3 (0.9%)	17 (5.3%)	50 (15.7%)	169 (53.1%)	79 (24.8%)	3.96	.839
Blended learning approach enables me assess, prioritize, develop appropriate patient care management	3 (0.9%)	0 (0.0%)	106 (33.3%)	162 (50.9%)	47 (14.8%)	3.79	.722
I can apply knowledge learned to make informed decisions in patient care	4 (1.3%)	4 (1.3%)	104 (32.7%)	162 (50.9%)	44 (13.8%)	3.75	.753
I can use the skills learned on patient care procedures to address a variety of patient needs	2 (0.6%)	50 (15.7%)	90 (28.3%)	136 (42.8%)	40 (12.6%)	3.51	.925
I can integrate theoretical concepts with practical skills in a variety of patient case management	0 (0.0%)	22 (6.9%)	96 (30.2%)	161 (50.6%)	39 (12.3%)	3.68	.776
I always communicate patient information to healthcare team effectively	4 (1.3%)	2 (0.6%)	73 (23.0%)	151 (47.5%)	88 (27.7%)	4.00	.804
I collaborate with other healthcare professionals to ensure provision of comprehensive patient care	6 (1.9%)	15 (4.7%)	105 (33.0%)	168 (52.8%)	24 (7.5%)	3.59	.776
I take good history and perform physical examination on patients accurately during their hospital visits	0 (0.0%)	3 (0.9%)	57 (17.9%)	178 (56.0%)	80 (25.2%)	4.05	.683
I make well-informed evidence-based decisions in patient management	8 (2.5%)	7 (2.2%)	73 (23.0%)	150 (47.2%)	80 (25.2%)	3.90	.888
I communicate effectively with patients using clear language to ensure they understand their treatment plans	4 (1.3%)	8 (2.5%)	55 (17.3%)	187 (58.8%)	64 (20.1%)	3.94	.766
Aggregate composite score						3.87	0.392

Key: SD=Strongly disagree; D=Disagree; Mod= Moderate; SA=strongly agree; Std. Dev.=standard deviation

The students perceived blended learning as highly effective in developing clinical skills (aggregate mean = 3.87; SD = 0.392). Overall, there was strong agreement across items reflecting various dimensions of clinical competence, suggesting that blended learning supports both cognitive and practical aspects of skill acquisition.

Specifically, students reported high confidence in applying knowledge to make accurate diagnoses (M = 3.90, SD = 0.786), prescribing appropriate treatments using diverse sources of information (M = 4.16, SD = 0.609), and making sound clinical decisions by integrating lessons from blended learning approaches (M = 3.96, SD = 0.839). These findings highlight the role of blended learning in enhancing clinical reasoning and decision-making skills.

In addition, respondents expressed agreement with their ability to apply knowledge in making informed decisions (M = 3.75, SD = 0.753), integrate theory with practice (M = 3.68, SD = 0.776), and communicate effectively within healthcare teams (M = 4.00, SD = 0.804). Students also reported improved collaboration with other healthcare professionals (M = 3.59, SD = 0.776), competence in performing accurate history taking and clinical examinations (M = 4.05, SD = 0.683), and the use of evidence-based practices in patient care (M = 3.90, SD = 0.888).

Correlations

Correlation analysis was conducted to examine the relationships among clinical skills acquisition (CSA), interactive subject content (ISC), and learner engagement (LE). The results provide an overview of the strength and direction of associations between the study constructs (Table 4).

Table 4: Correlations of the study constructs.

Variables (n=318)	1	2	3
1. CSA	1		
2. ISC	0.660**	1	
3. LEn	0.678**	0.685**	1

Key: CSA=clinical skills acquisition; ISC=Interactive subject content; LEng=learner engagement; ** = correlation significant at .01 level.

Pearson's correlation analysis revealed significant, positive, and moderate relationships between interactive subject content (ISC) ($r = 0.660, p < 0.001$) and learner engagement (LE) ($r = 0.678, p < 0.001$) with clinical skills acquisition (CSA). These findings indicate that higher levels of interactive subject content and learner engagement are associated with increased clinical skills acquisition among students.

Hypotheses Tests

Effects of ISC on CSA

Linear regression analysis showed that interactive subject content (ISC) significantly predicted clinical skills acquisition (CSA) ($\beta = 0.758, SE = 0.044, p < 0.001, 95\% CI [0.672, 0.845]$). This indicates that a one-unit increase in ISC is associated with a 0.758-unit increase in CSA, holding other factors constant. The regression model explained a substantial proportion of variance in CSA ($R^2 = 0.436$), indicating that ISC accounted for approximately 43.6% of the variation in clinical skills acquisition. The Durbin-Watson statistic (1.939) fell within the acceptable range (1-3), suggesting no autocorrelation of residuals. Additionally, inspection of residual plots indicated homoscedasticity, as errors were randomly distributed.

Mediation Analysis

The mediation model was analyzed to examine the relationships among interactive subject content (ISC), learner engagement (LEng), and clinical skills acquisition (CSA). The results provide an overview of the direct and indirect effects of interactive subject content on clinical skills acquisition through learner engagement within blended learning environments (Figure 1).

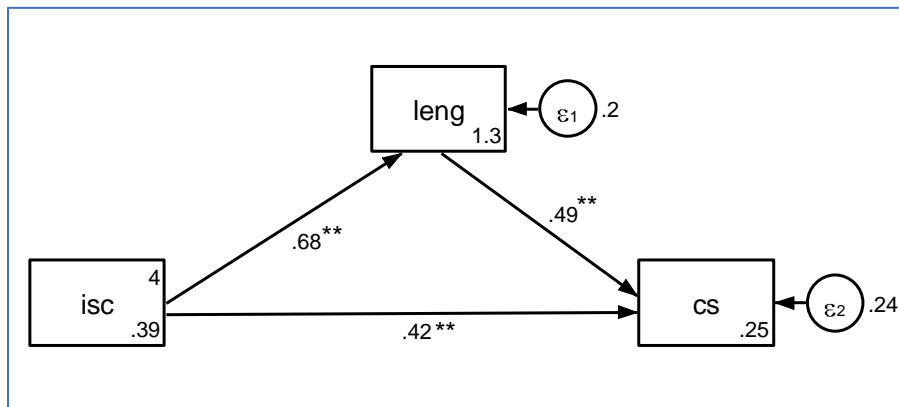


Figure 1: The Mediating Effect of Learner Engagement (LENG) on the Relationship between Interactive Subject Content (LSC) and Clinical Skills Acquisition (CS).

**= relationship significant at .01 level.

Mediation analysis (Figure 1) revealed that ISC had a significant indirect effect on CSA through learner engagement (LE) ($\beta = 0.334$, 95% CI [0.202, 0.457]). This indicates that part of the effect of ISC on CSA operates through its influence on learner engagement. The direct effect of ISC on CSA remained statistically significant ($\beta = 0.424$, 95% CI [0.316, 0.532]), indicating partial mediation. Thus, the total effect of ISC on CSA ($\beta = 0.758$) can be decomposed into a direct effect ($\beta = 0.424$) and an indirect effect mediated by LE ($\beta = 0.334$).

Discussion

The findings revealed significant, positive, and moderate correlations among interactive subject content (ISC), learner engagement (LE), and clinical skills acquisition (CSA). Furthermore, ISC significantly predicted CSA, indicating that higher levels of interactive subject content are associated with improved clinical skills acquisition. These findings are consistent with previous studies (Seed et al., 2025; Xiang et al., 2022; Plackett et al., 2022; Macnamara et al., 2021), which highlight the effectiveness of interactive and technology-enhanced learning approaches in strengthening clinical competence. This study contributes to the limited empirical evidence in Kenya by demonstrating the relationship between ISC and clinical skills acquisition within health professions education.

Several mechanisms may explain this relationship. First, ISC promotes active learning through approaches such as virtual simulations, collaborative digital activities, gamified modules, and problem-solving tasks. This shifts learners from passive recipients of knowledge to active participants in the learning process, consistent with Constructivist Theory, which posits that knowledge is constructed through interaction and experience (Mishra, 2023). Second, digital ISC allows for repeated access to learning materials, enabling learners to review content at their own pace, thereby reinforcing understanding and improving skill acquisition (Oh, 2022; McGee et al., 2024). Third, interactive tools such as virtual patient simulations provide safe

environments for decision-making, enhancing clinical reasoning, diagnostic accuracy, and confidence (Plackett et al., 2022; Macnamara et al., 2021). Additionally, elements such as gamification and storytelling may enhance motivation, persistence, and higher-order competencies, including clinical decision-making and learner confidence (van Gaalen et al., 2021; Imanipour et al., 2022; Andretta et al., 2025).

Mediation analysis further demonstrated that the total effect of ISC on CSA ($\beta = 0.758$) comprises both a direct effect ($\beta = 0.424$) and an indirect effect through learner engagement ($\beta = 0.334$), indicating partial mediation. This suggests that a substantial portion of the influence of ISC on clinical skills acquisition operates through its ability to foster learner engagement. These findings align with prior studies (Battestilli et al., 2023; Lei et al., 2018; Shea & Bidjerano, 2010), which reported that engagement mediates the relationship between instructional design and learning outcomes. However, unlike earlier studies that focused on general academic achievement, this study extends the literature by demonstrating this mediating effect within clinical skills acquisition in the Kenyan context.

The interactive, immediate, and personalized nature of ISC likely enhances learner engagement, particularly among digitally oriented learners, by making learning more dynamic and responsive (Seed et al., 2025). In contrast to static instructional methods, interactive content fosters intrinsic motivation and sustained participation (Imanipour et al., 2022; Andretta et al., 2025). From a constructivist perspective, learners who actively participate, collaborate, and engage with content are more likely to develop deeper understanding and transferable skills (Mishra, 2023). Empirical evidence also shows that learners who invest cognitive, emotional, and behavioural effort in learning activities tend to achieve better outcomes (Schunk & Mullen, 2012). Engaged learners are more likely to participate in self-directed learning and practice opportunities, resulting in superior performance compared to less engaged peers (Battestilli et al., 2023). Learner engagement also facilitates deliberate practice, which is essential for mastery of patient care procedures and safety, particularly in blended learning environments where preparation and active participation are critical (De Bruijn-Smolers & Prinsen, 2024).

The residual direct effect of ISC on CSA ($\beta = 0.424$), independent of learner engagement, suggests that certain features of interactive content contribute to skill development beyond engagement alone. For example, the repetitive and structured nature of ISC modules may enhance skill acquisition through repeated exposure and practice, even in the absence of high engagement levels. Prior research indicates that structured repetition combined with feedback can significantly improve skill mastery regardless of intrinsic motivation levels (Shah et al., 2024).

Conclusion

This study examined the relationship between interactive subject content (ISC) and clinical skills acquisition (CSA) and further determined the mediating role of learner engagement (LE) in this relationship. The findings demonstrate that interactive subject content significantly and positively predicts the acquisition of clinical skills among medical students. In addition, mediation analysis revealed that learner engagement partially mediates this relationship, indicating that ISC influences clinical skills acquisition both directly and indirectly through enhanced engagement. These findings underscore the central role of learner engagement as a key mechanism through which interactive instructional strategies translate into improved learning outcomes. At the same time, the presence of a significant direct effect suggests that well-designed interactive content contributes to clinical skills development beyond

engagement alone. Overall, the study provides empirical evidence supporting the integration of interactive, learner-centered approaches in blended learning environments to enhance clinical competence in health professions education.

Recommendations

Based on the conclusions of this study, it is recommended that health training institutions integrate interactive subject content into blended learning curricula to enhance clinical skills acquisition among students. This can be achieved through the deliberate incorporation of simulations, case-based learning, and other interactive instructional strategies that actively engage learners in the learning process. Curriculum developers should further ensure that instructional materials are designed in a learner-centred manner, with emphasis on collaboration, problem-solving, and experiential learning to strengthen clinical competence.

Institutional support should be strengthened by investing in adequate digital infrastructure, providing continuous faculty training, and offering instructional design support to ensure the effective implementation of blended learning approaches. This will enhance the delivery of interactive and engaging learning experiences across health training programmes. In addition, educators should adopt and consistently apply engagement-focused pedagogies that promote self-directed learning, peer collaboration, and reflective practice, as these are critical in improving learner participation and clinical skills development. Finally, continuous monitoring and evaluation of blended learning interventions should be undertaken to assess their effectiveness and ensure sustained improvement in clinical skills acquisition outcomes.

Declarations

What is already known

Interactive subject content has been shown to enhance clinical skills acquisition both directly and indirectly through its positive influence on learner engagement. Learner engagement is also widely recognized as a key determinant of improved learning outcomes in health professions education.

Unique Contribution to Theory, Practice and Policy

Despite the established benefits of interactive subject content and learner engagement, gaps persist in the optimal integration of learner-centred strategies within blended learning environments. This study contributes to existing knowledge by demonstrating the critical mediating role of learner engagement in strengthening clinical skills acquisition. It further emphasizes the importance of deliberately embedding interactive content within medical training programmes. From a practical and policy perspective, the findings underscore the need to enhance curriculum design, strengthen learner-centred instructional approaches, and align institutional policies to better support blended learning. Prioritizing interactivity and learner engagement may significantly improve the competence of healthcare trainees in Kenya.

Competing Interests

The authors declare that there are no competing interests associated with this study.

Author's Contributions

All authors were involved in the conceptualization of the study, as well as in data collection, analysis, and manuscript preparation.

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