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Bridging the Digital Learning Gap: Institutional Readiness, Infrastructure Constraints, and Faculty Competencies for Online Blended Learning in Medical Training Colleges in Kenya

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Abstract

Introduction

There is clear indication that there remains a gap in adoption and implementation of online blended learning (OBL) in our institutions due to infrastructure and capacity constraints.

Aim

This study assessed the institutional readiness, infrastructure constraints and faculty competencies for online blended learning in Medical Training Colleges (MTCs).

Methods

A quantitative, cross-sectional design was employed using mobile based online questionnaire administered to faculty from six cadres at medical training colleges in Kenya.

Results

A total of 206 faculty members participated in this study. Approximately 60% of participants reported that their institutions offer online blended learning. Nearly three quarters (73.3%) indicated that poor internet connectivity had adversely affected training delivery with only 33.0% considering the available computers sufficient for all students. Lower proficiency was observed in more advanced and innovative pedagogical approaches, particularly gamification (47.0%), flipped classroom strategies (51.7%), and Sharable Content Object Reference Model (SCORM) conversion (55.6%).

Conclusion.

There is a need for investment in digital learning infrastructure, simulation laboratories, and structured competency-based teaching materials to strengthen CMD training outcomes in MTCs. Additionally, there is a need for integrated policy action that combines infrastructure strengthening, digital equity measures, and faculty capacity development for the complete adoption and implementation of Online Blended Learning (OBL) in medical training colleges.

Introduction

Online blended learning (OBL), which integrates both online and classroom instruction, has grown in prominence in the post-pandemic age as a means of driving digital transformation due to the positive impact it has on students' attitudes and performance(1) & (2).

Previous studies on the benefits of virtual learning are conflicted. The online components of blended learning are particularly valued in higher education for their ease of use and adaptability, facilitating the creation and sharing of digital resources(3).

Studies have shown the important role of OBL in improving teaching quality and student satisfaction while efficiently reducing educational costs(4).

While diploma and undergraduate learners may need face-to-face contact with their faculty to sufficiently grasp the required contextual knowledge(5), they may respond favorably to elements of virtual learning such as more comfortable learning environments, or efficient time utilization via the repeatability of video content either on the university's systems, or YouTube(6).

Medical training institutions have an important role to play in the realization of the African Union Agenda 2063(7) through adopting modern technology and innovation including Open, Distance and E-Learning (ODEL) resources to offer opportunities for students to access academic programmes remotely.

According to the Kenyan Government, information communication technologies (ICT) will play a critical role in achieving quality education which is accessible, relevant, and equitable(8).

ICT has been viewed as a useful and promising development for supporting future health care services, especially for the prevention and management of NCDs(9).

Despite growing investments in digital education, the successful implementation of OBL depends on institutional readiness, which encompasses the availability of computer laboratories, adequacy of learning devices, internet stability, classroom educational technology, and uninterrupted power supply(10). Studies in Kenya and other low- and middle-income countries (LMICs) have documented several challenges related to insufficient ICT infrastructure, low digital equity, and unreliable network coverage, all of which may compromise the quality and continuity of digital learning delivery(11)

However, there remains limited empirical evidence on the extent to which health training institutions in Kenya are adequately prepared to support sustainable OBL implementation across multiple regions and institutional hubs.

This study therefore sought to assess institutional readiness and identify key infrastructure constraints affecting the delivery of online and blended learning in medical training colleges in Kenya. By examining technological resources, connectivity, power systems, and perceived adequacy of the learning environment, the findings are expected to inform national and institutional strategies aimed at strengthening digital learning ecosystems and reducing inequities in access to quality health professions education in Kenya.

Methods

Study design

This study employed a cross-sectional study design to assess institutional readiness and identify key infrastructure constraints affecting the delivery of online and blended learning in middle level health training institutions in Kenya. Data collection was conducted between November and December 2024.

Study Setting and Population

The study was conducted across 74 medical training colleges (MTCs) in Kenya (63 State Corporation and 11 faith-based institutions). Publicly sponsored MTCs are the Kenya Medical Training Colleges (KMTCs) while faith based educational institutions include those affiliated with the Kenya Conference of Catholic Bishops (KCCB) and Christian Health Association Kenya (CHAK). The study population included academic faculty from Clinical Medicine and Surgery, Medical Laboratory Sciences, Nursing, Pharmacy, Health Promotion and Community Health, and Nutrition and Dietetics departments.

Sampling and Recruitment

A multistage sampling approach was utilized. To ensure regional representation, MTCs were clustered into six hubs (Counties in parenthesis): *Nairobi* (Nairobi, Nyeri, Murang'a, Kirinyaga, Nyandarua), *Mombasa* (Mombasa, Kilifi, & Kwale), *Embu* (Embu, Meru, Tharaka Nithi, Kitui, Makueni & Garisa,), *Kisumu* (Kisumu, Siaya, Kakamega, Vihiga, Busia, Bungoma, Homa Bay, Migori, & Kisii), *Uasin Gishu* (Eldoret, Trans Nzoia, & Nandi, Turkana & West Pokot), and *Nakuru* (Nakuru, Kericho, Bomet, & Narok). While the study initially aimed to cover all 47 counties, logistical constraints limited the final scope to 32 counties (68% coverage). County selection was based on regional balance, rural -urban reach and existing infrastructure.

Sampling was performed at three stages:

1. Institutional level: After categorizing the 125 MTCs into six clusters corresponding to the six hubs, systematic sampling was employed to select the MTCs to be visited from the six clusters.
2. Departmental level: Within each sampled MTCs, teaching faculty from the six departments (Clinical Medicine and Surgery, Medical Laboratory Sciences, Nursing, Pharmacy, Health Promotion and Community Health, and Nutrition and Dietetics) were purposively selected.
3. Individual level: A sampling frame of all faculty members within the selected departments was generated and participants were randomly selected and invited to participate in the study.

Data Collection and instrument

An online survey technique was used to gather data on faculty perceptions of the importance of OBL competencies and their self-reported proficiency in delivering OBL. The instrument was developed through adaptation of established frameworks in digital pedagogy, online teaching competencies, and blended learning, including domains aligned with the Technological Pedagogical Content Knowledge

(TPACK) framework(12). The tool was however developed by OBL experts and later piloted in Kenya Medical Training College in Machakos County in Kenya.

The questionnaire comprised nine competency domains covering key aspects of OBL delivery: (I) content development, (II) technical proficiency in learning platforms, (III) interactive learning and learner engagement, (IV) multimedia content creation, (V) assessment and feedback, (VI) learner support and progress tracking, (VII) program evaluation and management, (VIII) innovative teaching strategies, and (IX) online learning pedagogical framework. These domains captured a broad range of competencies, including instructional content design, learning management system (LMS) use, webinar facilitation, digital assessment, learner mentoring, program evaluation, and the application of innovative pedagogical strategies such as flipped classroom, problem-based learning, and gamification.

For each item, participants were asked to rate two dimensions: perceived importance and self-reported proficiency. Perceived importance was measured using a 5-point Likert scale ranging from 1 = not at all important to 5 = very important, while proficiency was assessed using a corresponding 5-point Likert scale ranging from 1 = not proficient to 5 = extremely proficient. This dual-rating approach enabled the assessment of both perceived training priorities and existing faculty capacity in OBL implementation.

Statistical Analysis

Quantitative data were subjected to descriptive statistical analysis. Categorical variables, including sex, cadre, education level, age, and years of professional experience, were summarized using frequencies and proportions. Similar descriptive measures were used to characterize faculty perceptions of the importance of OBL and to assess self-reported proficiency across various OBL activities and functional domains. Continuous variables were presented as means ± standard deviations (SD).

Results

Sociodemographic Characteristics of the Participants

The study included 206 participants, predominantly male (54.4%), with a mean age of 39.3 ± 11.2 years. Most participants were aged below 40 years (57.3%), had bachelor-level education or lower (78.2%), and were mainly from the Kisumu (30.1%) and Embu (25.7%) hubs. Nursing (40.8%) and clinical medicine (24.8%) were the most represented cadres. Participants had a mean professional experience of 13.2 ± 11.2 years, with nearly half (49.0%) having less than 10 years of work experience as shown in Table 1.

Table 1
Sociodemographic Characteristics of the Participants

Variables	**n (%)**
Sex	
Male	112(54.4)
Female	94(45.6)
Mean Age (Years)	39.3 ± 11.2
Age group	
< 40 years	118(57.3)
> 40 years	88(42.7)
Hub	
Mombasa	8(3.9)
Eldoret	20(9.7)
Nakuru	21(10.2)
Nairobi	42(20.4)
Embu	53(25.7)
Kisumu	62(30.1)
Education level	
Bachelor and below	161(78.2)
Above bachelor	45(21.8)
Cadre	
Nursing	84(40.8)
Clinical medicine	51(24.8)
Community health	28(13.6)
Medical laboratory	19(9.2)
Nutrition	16(7.8)
Pharmacy	8(3.9)
Mean years of experience	13.2 ± 11.2
Years of experience	

Variables	n (%)
< 10 years	101(49)
10–20 years	60(29.1)
> 20 years	45(21.8)

Availability of OBL educational resources

The findings illustrate the level of availability of OBL educational resources used in teaching CMDs within Medical Training Colleges. Overall, there is a clear dominance of conventional teaching materials over modern, technology-enhanced learning tools. At the upper end, lecture notes (86.8%) were the most readily available resource, followed by Liquid Crystal Display (LCD) projectors (80.5%), whiteboards (79.5%), and published textbooks (78.5%).

In contrast, availability declines markedly for more interactive and digital learning resources. These include video tutorials, flipcharts, and especially simulators (40.5%), learning management systems (37.1%), policy documents (36.1%), IEC materials (30.7%), and storage technologies (25.9%) as shown in Fig. 1.

Institutional Online Blended Learning

Institutional readiness for online/blended learning appeared moderate, with 59.7% of participants reporting that their institutions offer OBL. Although most participants (68.0%) perceived internet downtime as infrequent, nearly one-third (29.6%), reported persistent downtime. Importantly, 73.3% indicated that poor internet connectivity had adversely affected training delivery, underscoring connectivity as a key system-level barrier to effective implementation.

Infrastructure

Although institutional infrastructure for OBL appeared broadly established, important capacity gaps remained. While 83.0% of participants reported the presence of computer laboratories, only 33.0% considered the available computers sufficient for all students. Furthermore, just 21.8% indicated that classrooms were adequately equipped with core educational technology resources necessary for OBL delivery. Notwithstanding these constraints, approximately three-quarters of participants perceived the learning environment and student access to devices as adequate. Although reliable electricity was widely reported (87.4%), the comparatively lower availability of backup power systems (55.3%) points to a potential system-level challenge in ensuring uninterrupted digital learning.

Perceived Importance of Online Blended Learning Activities Among Faculty

Overall, faculty perceived most of the OBL activities as highly important, with high-importance ratings exceeding 80% for most items across all domains.

The activities perceived as having the highest importance among faculty were creating online lessons (93.4%), facilitating active information sharing and engagement with content among learners (92.7%), guiding learners in constructing knowledge through online interactions (92.1%), and adding resources on the learning management system (90.7%).

In contrast, the activities with the lowest perceived importance were gamification (68.2%), the flipped classroom approach (73.5%), and proctoring online examinations (78.8%) as shown in Table 2.

Table 2
Perceived Importance of Online Blended Learning Activities Among Faculty

	Low importance n (%)	Neutral n (%)	High Importance n (%)
Content development			
Authoring OBL appropriate content	5(3.3)	11(7.3)	135(89.4)
Converting written content to SCORM	8(5.3)	13(8.6)	130(86.1)
Creating links to access resources external to OBL	5(3.3)	11(7.3)	135(89.4)
Technological proficiency in learning platform			
Navigating LMS	11(7.3)	7(4.6)	133(88.1)
Uploading videos to LMS	11(7.3)	7(4.6)	133(88.1)
Using collaborative tools to enrich OBL	11(7.3)	9(6)	131(86.8)
Creating users in an LMS	10(6.6)	11(7.3)	130(86.1)
Adding activities(quizzes) on LMS	11(7.3)	8(5.3)	132(87.4)
Adding resources on LMS	10(6.6)	4(2.6)	137(90.7)
Interactive Learning & Engagement			
Creating an online lesson	5(3.3)	5(3.3)	141(93.4)
Conducting webinars with OBL learners	7(4.6)	10(6.6)	134(88.7)
Planning synchronous teaching sessions	14(9.3)	7(4.6)	130(86.1)
Using social media to enrich interactions	8(5.3)	15(9.9)	128(84.8)
Creating WIKIS in the LMS	21(13.9)	19(12.6)	111
Creating discussion forums	8(5.3)	8(5.3)	135(89.4)
Multimedia Content creation			
Creating videos for OBL	10(6.6)	10(6.6)	13186.8)
Editing learning videos	10(6.6)	18(11.9)	123(81.5)
Identifying credible digital references	7(4.6)	15(9.9)	129(85.4)
Assessment and feedback			
Setting exams for OBL students	9(6)	13(8.6)	129(85.4)
Proctoring an online exam	17(11.3)	15(9.9)	119(78.8)

	Low importance n (%)	Neutral n (%)	High Importance n (%)
Content development			
Grading exams for OBL students	7(4.6)	12(7.9)	132(87.4)
Using workshop tools to enhance team learning	7(4.6)	15(9.9)	129(85.4)
Learner Support and Progress Tracking			
Coaching OBL students	8(5.3)	9(6)	134(88.7)
Mentoring OBL students	7(4.6)	10(6.6)	134(88.7)
Tracking learner progress in OBL environment	7(4.6)	8(5.3)	136(90.1)
Counselling of OBL learners	8(5.3)	12(7.9)	131(86.8)
Motivating OBL learners	6(4)	15(9.9)	130(86.1)
Evaluating an OBL learner	6(4)	10(6.6.)	135(89.4)
Constructive feedback to learners as part of course design	7(4.6)	8(5.3)	136(90.1)
Program Evaluation Management			
Evaluating an OBL program	8(5.3)	10(6.6)	133(88.1)
Innovative teaching strategies to enhance learning experiences			
Flipped Classroom	27(17.9)	13(8.6)	111(73.5)
Problem based Learning	7(4.6)	9(6)	135(89.4)
Gamification	28(18.5)	20(13.2)	103(68.2)
Peer teaching	8(5.3)	13(8.6)	130(86.1)
Online Learning Pedagogical Framework			
Learners effectively access and use necessary digital tools for OBL	6(4)	7(4.6)	138(91.4)
Employing techniques to motivate learners at the start of an online blended course	6(4)	9(6)	136(90.1)
Building a sense of community among online blended learners	6(4)	8(5.3)	137(90.7)
Supporting social interaction in a blended learning environment.	5(3.3)	11(7.3)	135(89.4)
Facilitating active information sharing and engagement with content among learners.	6(4)	5(3.3)	140(92.7)

	Low importance n (%)	Neutral n (%)	High Importance n (%)
Content development			
Encouraging participation in online discussions.	6(4)	9(6)	136(90.1)
Guiding learners in constructing knowledge through online interactions.	5(3.3)	7(4.6)	139(92.1)
Helping learners apply online learning to practical scenarios.	9(6)	8(5.3)	134(88.7)
Using assessment techniques to evaluate learning effectiveness in online modules.	6(4)	9(6)	136(90.1)
Integrating opportunities for learner reflection and practical application into the curriculum.	6(4)	9(6)	136(90.1)

Self-Reported Proficiency of Faculty towards OBL activities

Overall, the majority of faculty reported high proficiency across most OBL competencies, with high proficiency ratings generally exceeding 60% for most activities. However, important variations were observed across domains, particularly for advanced digital and innovative pedagogical strategies.

The highest self-reported proficiency levels were observed in creating online lessons (82.8%), providing constructive feedback to learners (77.5%), helping learners apply online learning to practical scenarios (76.8%), and conducting webinars (76.2%), indicating strong faculty competence in core online blended learning functions. In contrast, the lowest proficiency levels were reported for gamification (47.0%), creating WIKIS (51.0%), flipped classroom approaches (51.7%), editing learning videos (55.0%), and SCORM conversion (55.6%), highlighting notable capacity gaps in advanced digital pedagogical and content development skills as shown in Table 3.

Table 3
Self-Reported Proficiency of Faculty towards OBL activities

	Low proficiency n (%)	Moderate proficiency n (%)	High proficiency n (%)
Content development			
Authoring OBL appropriate content	21(13.9)	31(20.5)	99(65.6)
Converting written content to SCORM	22(14.6)	45(29.8)	84(55.6)
Creating links to access resources external to OBL	18(11.9)	36(23.8)	97(64.2)
Technological proficiency in learning platform			
Navigating LMS	25(16.6)	33(21.9)	93(61.6)
Uploading videos to LMS	28(18.5)	30(19.9)	93(61.6)
Using collaborative tools to enrich OBL	24(15.9)	35(23.2)	92(60.9)
Creating users in an LMS	29(19.2)	31(20.5)	91(60.3)
Adding activities(quizzes) on LMS	25(16.6)	25(16.6)	101(66.9)
Adding resources on LMS	25(16.6)	29(19.2)	97(64.2)
Interactive Learning & Engagement			
Creating an online lesson	7(4.6)	19(12.6)	125(82.8)
Conducting webinars with OBL learners	11(7.3)	25(16.6)	115(76.2)
Planning synchronous teaching sessions	17(11.3)	32(21.2)	102(67.5)
Using social media to enrich interactions	17(11.3)	31(20.5)	103(68.2)
Creating WIKIS in the LMS	37(24.5)	37(24.5)	77(51)
Creating discussion forums	16(10.6)	28(18.5)	107(70.9)
Multimedia Content creation			
Creating videos for OBL	23(15.2)	39(25.8)	89(58.9)
Editing learning videos	38(25.2)	30(19.9)	83(55)
Identifying credible digital references	19(12.6)	37(24.5)	95(62.9)
Assessment and feedback			
Setting exams for OBL students	16(10.6)	26(17.2)	109(72.2)
Proctoring an online exam	33(21.9)	27(17.9)	91(60.3)

	Low proficiency n (%)	Moderate proficiency n (%)	High proficiency n (%)
Content development			
Grading exams for OBL students	18(11.9)	21(13.9)	112(74.2)
Using workshop tools to enhance team learning	16(10.6)	32(21.2)	103(68.2)
Learner Support and Progress Tracking			
Coaching OBL students	16(10.6)	24(15.9)	111(73.5)
Mentoring OBL students	15(9.9)	24(15.9)	112(74.2)
Tracking learner progress in OBL environment	15(9.9)	32(21.2)	104(68.9)
Counselling of OBL learners	19(12.6)	33(21.9)	99(65.6)
Motivating OBL learners	15(9.9)	31(20.5)	105(69.5)
Evaluating an OBL learner	11(7.3)	29(19.2)	111(73.5)
Constructive feedback to learners as part of course design	12(7.9)	22(14.6)	117(77.5)
Program Evaluation Management			
Evaluating an OBL program	20(13.2)	24(15.9)	107(70.9)
Innovative teaching strategies to enhance learning experiences			
Flipped Classroom	36(23.8)	37(24.5)	78(51.7)
Problem based Learning	17(11.3)	26(17.2)	108(71.5)
Gamification	40(26.5)	40(26.5)	71(47)
Peer teaching	14(9.3)	36(23.8)	101(66.9)
Online Learning Pedagogical Framework			
Learners effectively access and use necessary digital tools for OBL	14(9.3)	29(19.2)	108(71.5)
Employing techniques to motivate learners at the start of an online blended course	16(10.6)	31(20.5)	104(68.9)
Building a sense of community among online blended learners	13(8.6)	40(26.5)	98(64.9)
Supporting social interaction in a blended learning environment.	14(9.3)	28(18.5)	109(72.2)

	Low proficiency n (%)	Moderate proficiency n (%)	High proficiency n (%)
Content development			
Facilitating active information sharing and engagement with content among learners.	9(6)	35(23.2)	107(70.9)
Encouraging participation in online discussions.	10(6.6)	27(17.9)	114(75.5)
Guiding learners in constructing knowledge through online interactions.	10(6.6)	29(19.2)	112(74.2)
Helping learners apply online learning to practical scenarios.	12(7.9)	23(15.2)	116(76.8)
Using assessment techniques to evaluate learning effectiveness in online modules.	10(6.6)	28(18.5)	113(74.8)
Integrating opportunities for learner reflection and practical application into the curriculum.	11(7.3)	31(20.5)	109(72.2)

Discussion

This study provides important insights into the institutional readiness and infrastructure constraints affecting the implementation of OBL in health training institutions in Kenya. Overall, the findings suggest that while foundational digital learning infrastructure is present in many institutions, significant capacity gaps persist in critical domains necessary for the effective and sustainable delivery of OBL.

Our findings suggest that CMD teaching in MTCs is still predominantly traditional and instructor-centered, heavily dependent on lectures, textbooks, and basic visual aids. While foundational teaching resources are relatively well available, advanced OBL-supporting tools, particularly simulation-based learning, digital learning platforms, and interactive instructional materials—are limited.

Our findings indicate the availability of computer laboratories and reliable electricity supply implying that the basic physical infrastructure for digital learning has been established in many institutions. There is however a discrepancy between the presence of the infrastructure and its adequacy. According to(13), infrastructure resources such as internet access, computers or laptops, webcams, headsets, and printers are necessary for learning and teaching online. A similar study carried out found that slightly more than two thirds of the participants either had blank or had less than 20 university laptops further indicating the inadequacy of infrastructure in our institutions(14).

Similarly, less than one-quarter reported that classrooms were adequately equipped with core educational technologies such as cameras, audio systems, high-speed internet, and interactive whiteboards. These findings suggest that infrastructure presence alone may not translate into functional

readiness, and that adequacy, accessibility, and quality of resources remain major barriers to effective OBL implementation. This pattern has similarly been reported in health professions education settings where institutional infrastructure exists but remains insufficient to meet growing digital learning demands(15).

Internet connectivity emerged as one of the most significant barriers in this study. Although most participants perceived internet downtime as infrequent, nearly one-third reported persistent disruptions, and over 70% acknowledged that poor connectivity had hindered training delivery. This finding is consistent with previous studies from Kenya and other low- and middle-income countries(16–19) where unreliable internet connectivity remains a major systems-level challenge for online education.

The finding that only slightly more than half of the institutions had backup power systems further underscores the vulnerability of digital learning environments in resource-constrained settings. Reliable electricity is a foundational requirement for OBL, particularly for synchronous sessions, digital assessments, and multimedia content delivery. With the frequent power interruptions in Kenya, the absence of uninterrupted power supply (UPS) systems may lead to learning disruptions, reduced learner engagement, and compromised educational continuity. Similar concerns have been raised in other African medical education settings, where power instability and insufficient technological support remain persistent impediments to digital transformation(20, 21).

Despite these infrastructural constraints, a substantial proportion of participants perceived the training environment as generally meeting learner needs and believed that students had access to the devices required for OBL. This finding may reflect increasing digital adaptation among both institutions and learners, particularly following the accelerated adoption of online learning during and after the COVID-19 pandemic. However, perceived adequacy should be interpreted cautiously, as self-reported access does not necessarily equate to equitable or sustained access across all learner groups. Existing evidence from Kenya suggests that digital inequities may persist across institutions, regions, and professional cadres, potentially exacerbating disparities in learning outcomes(22).

Our findings showed higher ratings in creating online lessons, facilitating active learner engagement, guiding knowledge construction through online interactions, and adding resources to the learning management system (LMS) indicating that faculty emphasizes competencies that directly support instructional delivery and learner-centered engagement. These findings align with established digital pedagogy frameworks, particularly the principles of teaching presence and cognitive engagement, which are essential for effective online learning(23).

In contrast, gamification, flipped classroom approaches, and online examination proctoring received comparatively lower importance ratings, although they were still considered important by the majority. This may reflect limited exposure to innovative pedagogical strategies, inadequate institutional support, or contextual challenges related to technology and infrastructure. Lower prioritization of online proctoring may be linked to feasibility concerns in settings with unstable internet connectivity and limited digital assessment systems.

Policy Perspective

The findings of this study have important implications for policy and institutional planning for digital transformation in health professions education in Kenya.

First, the fact that teaching in CMD-related training is still largely lecture-driven and print-based, supported by basic classroom audiovisual tools has important implications:

1. It may restrict the effective implementation of competency-based education, which requires experiential, simulation-driven, and learner-centered strategies.
2. Limited availability of simulators and LMS platforms suggests gaps in supporting clinical skills acquisition, self-directed learning, and continuous assessment.
3. The relatively low presence of Information Education and Communication (IEC) materials and policy documents may also indicate weak integration of standardized competency frameworks into day-to-day teaching practice.

Second, the observed gap between the presence and adequacy of digital infrastructure calls for a shift in policy focus from infrastructure availability to infrastructure functionality and sufficiency. National and institutional policies should move beyond counting physical assets such as computer laboratories and electricity connections to establish minimum standards for OBL readiness, including student to computer ratios, classroom digital equipment requirements, bandwidth thresholds, and reliable backup power systems.

Third, internet instability and limited classroom technologies highlight the need for targeted investments in digital connectivity and resilient power systems, particularly in resource constrained and geographically underserved training institutions. Policymakers should prioritize partnerships with internet service providers, government digital infrastructure programs, and development partners to ensure affordable high-speed connectivity and uninterrupted learning environments. This is especially critical for synchronous teaching, digital assessments, and multimedia-based instruction.

Fourth, the strong faculty emphasis on core competencies such as online lesson development, learner engagement, and LMS resource management presents an opportunity for faculty development policy reforms. Continuous professional development frameworks for health training faculty should institutionalize training in digital pedagogy, learner-centered online facilitation, and advanced instructional approaches such as flipped classroom models, gamification, and authentic online assessment. Such reforms would help transition OBL from basic content digitization toward more innovative and transformative teaching practice.

Finally, the findings underscore the need for equity-sensitive policy approaches. While many participants perceived the learning environment as adequate, self-reported access may mask persistent disparities across regions, institutions, and learner groups. Policies should therefore incorporate digital inclusion

strategies that address differential access to devices, connectivity, and learner support services to prevent widening educational inequities.

Limitations

Participants may have overestimated the adequacy of institutional infrastructure or their own competencies and perceptions regarding OBL.

Second, the use of a cross-sectional study design limits the ability to establish temporal relationships or causal inferences between institutional readiness factors and the effectiveness of OBL implementation. The findings therefore provide a snapshot of the prevailing situation at the time of data collection rather than changes over time.

Third, the assessment of infrastructure readiness was based largely on participant perceptions rather than direct institutional audits or objective measurements. As such, reported availability and adequacy of resources such as internet connectivity, classroom technologies, and backup power systems may differ from actual institutional capacity.

Fourth, although the study included multiple training hubs, the findings may not be fully generalizable to all health training institutions in Kenya, particularly private institutions or those outside the sampled regions. Institutional differences in funding, location, and technological investment may influence readiness levels.

Finally, while the study assessed perceived importance and self-reported proficiency across multiple OBL domains, it did not include objective assessments of faculty digital competencies or learner outcomes, which would have provided a more comprehensive evaluation of OBL readiness and effectiveness.

Despite these limitations, the study provides important multi-site evidence on institutional and faculty readiness for OBL and offers valuable insights for policy and programmatic strengthening.

Conclusion

These results point to a resource environment that supports traditional teaching methods more strongly than modern OBL approaches, suggesting the need for investment in digital learning infrastructure, simulation laboratories, and structured competency-based teaching materials to strengthen CMD training outcomes in MTCs.

In addition, the study demonstrates that while foundational infrastructure for online and blended learning exists in many health training institutions in Kenya, substantial gaps remain in infrastructure adequacy, connectivity reliability, classroom technology, and backup power systems. These constraints continue to undermine the effective and sustainable implementation of OBL.

At the same time, the high importance placed by faculty on competencies related to online lesson design, learner engagement, and LMS use reflects encouraging pedagogical readiness and increasing acceptance of digital learning approaches. However, the lower prioritization of innovative teaching strategies and online assessment modalities suggests that OBL implementation remains concentrated on foundational instructional functions.

These findings therefore indicate that bridging the digital learning gap will require integrated policy action that combines infrastructure strengthening, digital equity measures, and faculty capacity development. Such investments are essential to ensure that OBL contributes to high-quality, resilient, and equitable health workforce training in Kenya.

Abbreviations

CHAK
Christian Health Association of Kenya
CMDs
Cardiometabolic diseases
ESRC
Ethical Scientific and Research Committee
ICT
Information communication Technology
IEC
Information Education and Communication
KCCB
Kenya Conference of Catholic Bishops
LCD
Liquid Crystal Display
LMS
Learning Management System
LMIC
Low- and Middle-Income Countries
MTCs
Medical Training Colleges
NCDs
Non-Communicable Diseases
OBL
Online Blended Learning
SCORM
Sharable Content Object Reference Model
SD
Standard deviation

TPACK
Technological Pedagogical Content Knowledge
UPS
Uninterrupted Power Supply

Declarations

Authors' contributions

J.O& HW, Conceptualization, Research supervision, Project Administration, formal analysis, visualization, methodology and writing the original draft. P.A and M.M Validation and Writing the original draft. All authors have read and approved the manuscript

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

Ethical approval for the study was obtained from Amref Health Africa Ethics Scientific and Research Committee (ESRC) (ref. no. ESRC P1726/2024) and institutional approval from the MTCs and the respective counties before data collection commenced. This study was conducted in accordance with the Declaration of Helsinki. The goal of the research project was thoroughly explained in the consent form. It was explicitly mentioned that the participants had the freedom to decline participation without justifying their decision. All participants provided informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable

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Figures

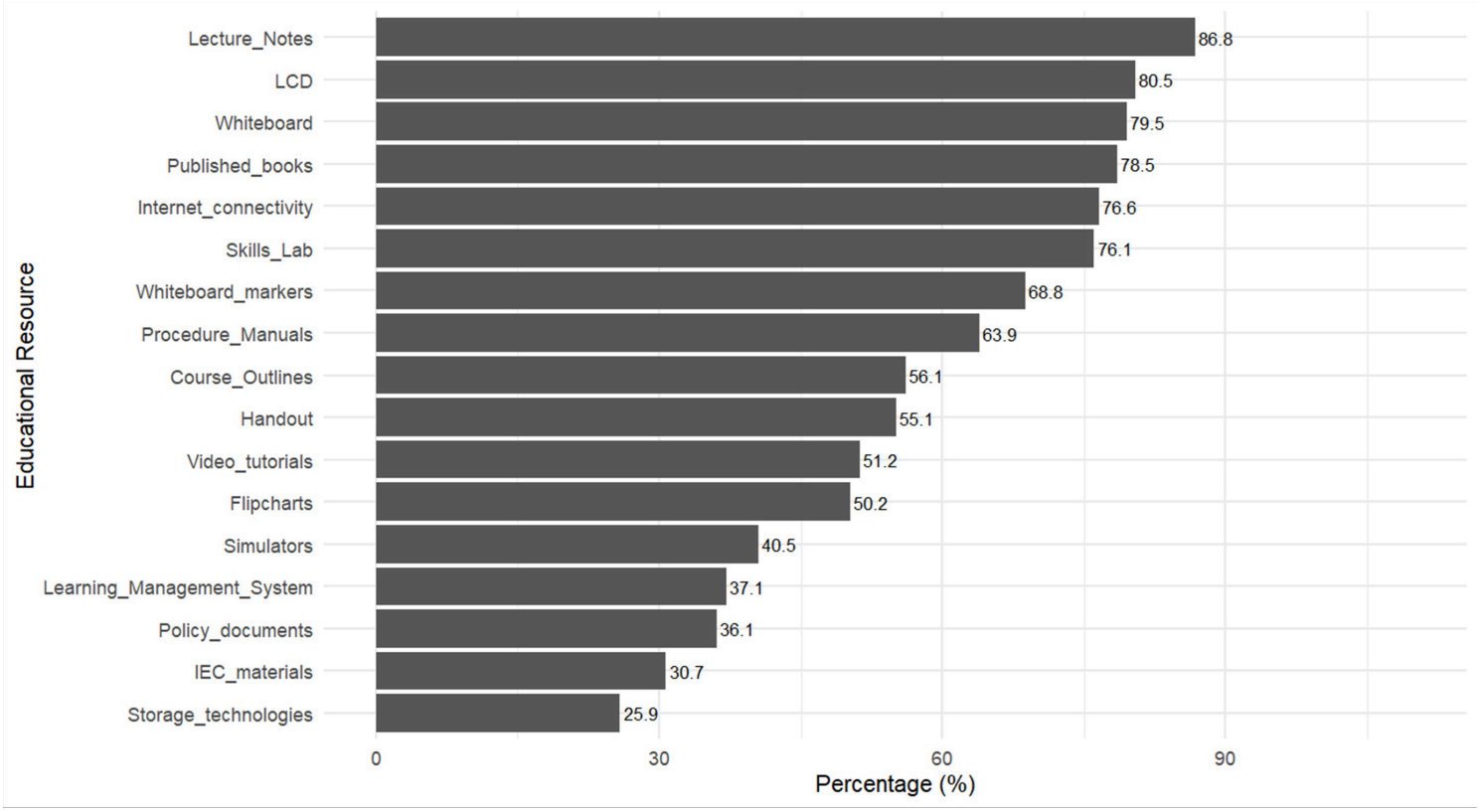


Figure 1

Learning resources for CMD training at MTCs