INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH AND INNOVATIVE STUDIES
IJSRIS journal
ISSN: 2820-7157
Advancing Knowledge, Inspiring Innovation
www.ijsrisjournal.com
INDEXED JOURNAL
PEER REVIEWED Rigorous & Transparent
DOI: CROSSREF Member
OPEN ACCESS For Global Visibility
BI-MONTHLY Timely Publication
WIDE READERSHIP High Impact & Visibility
AUTHOR FRIENDLY Fast | Supportive | Reliable
RECEIVED 17 September
ACCEPTED 09 October
PUBLISHED 1 November 2026
September 2026
Volume 5
Number 6
Pages from 128 to 133

# Analysis of the curricular integration of environmental education in the first year of LMD system within medical training institutions in the city of (KONGO CENTRAL, DRC)

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Crossref doi
PREFIX : 10.63883
IJSRIS JOURNAL
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**ABSTRACT**

The implementation of the Bachelor's-Master's-Doctorate (LMD) system in the DRC aims to professionalize university curricula through the Competency-Based Approach (CBA). However, the role of eco-health determinants in the foundational curriculum remains poorly documented. Objective: To analyze the institutional structure and the degree of pedagogical alignment in environmental health education during the first year of the LMD program at paramedical institutions in the port city of Boma.Methods: A sequential explanatory mixed-methods study (quantitative-qualitative) was conducted during the 2025–2026 academic year with 218 participants (final-year/first-year students and faculty) and 12 academic administrators at three institutions in Boma.

A literature review of syllabi, bivariate tests (Chi-square), and multivariate binary logistic regression were combined with thematic content analysis (NVivo v14). Results: The verage number of hours allocated to environmental health is 22.4 ± 4.8 hours (representing 1.8% of the total course load for the first year). There is a significant disparity between programs (30 hours in Public Health vs. 15 hours in Nursing, $p < 0.001$). Only 14.2% of students demonstrate a high level of operational mastery of local eco-health risks. The multivariate model demonstrates that engaging in practical field activities (ORa = 4.21; 95% CI [2.10–8.45]; $p < 0.001$) and the constructive alignment of assessments with the APC (ORa = 2.85; 95% CI [1.34–6.07]; $p = 0.006$) significantly predict conceptual and practical mastery. Discussion & Conclusion: Environmental health remains marginalized and taught primarily through theoretical lectures, creating a significant disconnect from the eco-health vulnerabilities of the coastal and port area of Boma. A curriculum revision incorporating hands-on eco-health field placements is essential.

**Key words:** Environmental Health, Curricular Integration, LMD System, Competency-Based Approach, Boma, DRC.

## 1. INTRODUCTION

Environmental health is a priority area in contemporary public health. The World Health Organization (WHO, 2020) estimates that more than 24% of global deaths and 28% of the global burden of disease are directly attributable to modifiable environmental risk factors (unsafe water, inadequate sanitation, air pollution, improper waste management, and ecosystem degradation). In sub-Saharan Africa, and particularly in the Democratic Republic of the Congo (DRC), these environmental determinants are exacerbated by rapid demographic transition, uncontrolled urbanization, and the growing effects of climate change (Prüss-Ustün et al., 2016; Myers, 2017).

In the face of these complex eco-health challenges, the initial training of health professionals must provide a solid conceptual and practical foundation from the very start of their higher education. In the DRC, the widespread adoption of the Bachelor's-Master's-Doctorate (LMD) system and the implementation of the Competency-Based Approach (CBA), advocated by the Ministry of Higher and University Education (ESU, 2021), aim to overhaul educational curricula to meet the real health needs of communities (Frenk et al., 2010). The LMD system requires constructive alignment (Biggs, 2003) between learning objectives, practical educational activities, and assessment methods.

Nevertheless, in practice, the curricular integration of environmental health faces major obstacles. In the port and coastal city of Boma (Kongo Central Province), characterized by intense commercial activity, risks of river and marine pollution, poor management of solid and liquid waste, and the emergence of recurrent flooding, health s are confronted daily with environmentally induced diseases (cholera, malaria, and eco-toxic skin and respiratory conditions). Unfortunately, empirical observations suggest that the first year of the Bachelor of Medicine and Surgery (L1) program still prioritizes a fragmented, highly theoretical curriculum, relegating environmental health to a peripheral concept (Howard et al., 2021; Whitmee et al., 2015).

The central issue of this research lies in the glaring disparity between the critical nature of environmental health risks in Boma and the weak institutional and pedagogical framework for environmental health within the first-year core curriculum of medical training institutions. How is the teaching of environmental health structured in the first year (L1) of the LMD program in Boma? To what extent are the targeted competencies, teaching methods, and the actual level of learning achieved by students aligned?

The overall objective of this study is to evaluate the curricular integration and pedagogical alignment of environmental health education in the first year of the LMD program at medical training institutions in the city of Boma, while identifying the factors that predict a better mastery of eco-health competencies.

The research hypotheses are :

- **H1:** The number of class hours allocated to environmental health in the first year of the LMD program and its institutional status are insufficient and vary widely across training programs in Boma.
- **H2:** The predominance of theoretical lecture-based teaching methods without practical fieldwork significantly limits students' acquisition of operational skills for assessing eco-health risks.

## 2. METHODS (M)

### 2.1. Study Setting and Research Design

The study was conducted in the city of Boma, the second-largest urban center in Kongo Central Province in the DRC. A sequential mixed-methods design (quantitative → qualitative)

was applied during the 2025–2026 academic year. This design combined the rigor of a quantitative empirical study with the analytical depth of a qualitative investigation aimed at understanding institutional constraints (Creswell & Creswell, 2018).

### 2.2. Study Population and Sampling

The target population included students enrolled in the first year of the Bachelor's degree program (L1) and in their final year (to measure skill retention), as well as faculty members and academic administrators from the three main medical training institutions in Boma (ISTM-Boma, the University of Boma's Faculty of Medicine, and the Private Higher Institute of Medical Techniques).

The quantitatively calculated sample was based on a proportional stratified survey (N = 218 subjects). The strata included the following programs: Public Health (n = 72), Nursing (n = 88), and Medical Technology/Medical Biology (n = 58). For the qualitative component, 12 academic administrators (academic secretaries-general, department chairs, and lecturers) were selected through purposive sampling for in-depth semi-structured interviews.

### 2.3. Data Collection and Instruments

Data were collected using a combination of three instruments:

- **Curriculum Document Analysis Grid:** Systematic evaluation of instructional outlines, syllabi, and first-year (L1) course descriptions (number of hours, ECTS credits, targeted competencies, assessment methods).
- **Retrospective Evaluation Questionnaire and Skills Test:** Administered to students to measure self-reported and objective mastery of five key competencies in environmental health (water/sanitation risk assessment, eco-epidemiological diagnosis, hospital/urban waste management, fecal hazard prevention, and communication on eco-sanitary risks).
- **Semi-Structured Interview Guide:** Exploring the challenges of implementing the Bachelor's-Master's-Doctorate (LMD) system, the profiles of faculty members, and the availability of laboratories and field sites for practical application.

### 2.4. Data Processing and Statistical Analysis

The quantitative data were entered into EpiData v4.6 and then analyzed using IBM SPSS v28.0. Descriptive statistics (frequencies, means ± standard deviation) were calculated. Bivariate analysis used Pearson's chi-square test. A multivariate binary logistic regression model was developed to identify the independent factors associated with a high level of competency (score ≥ 75%). The variables included in the adjusted model were program track, number of class hours, organization of practical/fieldwork sessions, and the APC assessment method. Qualitative al analysis followed a thematic content analysis approach using NVivo v14 software (Bardin, 2013).

## 3. RESULTS

### 3.1. Institutional Structure and the Course's Place in the L1 LMD Curricula

Analysis of the curricula (Table 1) reveals marked heterogeneity in the institutional structure of environmental health programs across the three institutions in Boma. The overall average number of hours allocated in the first year of the LMD program is only 22.4 ± 4.8 hours, representing barely 1.8% of the total number of hours in the first year (60 ECTS credits).

**Table 1:** Environmental Health Teaching Components across L1 LMD Program Tracks

| Program Track (L1 LMD) | Theory Hours (h) | Practical/Fieldwork Hours (h) | ECTS Credits | Module Status |
|---|---|---|---|---|
| Public Health | 30 h | 15 h | 3 ECTS | Required / Core Curriculum |
| Nursing Sciences | 15 h | 0 hours | 1.5 ECTS | Required / Integrated |
| Medical Biology | 15 h | 5 hours | 1.5 ECTS | Required / General |
| Overall Average | 20.0 ± 7.0 h | 6.6 ± 6.2 hours | 2.0 ± 0.7 ECTS | - |

### 3.2. Level of Mastery of Eco-Sanitation Skills Among Students

The objective assessment of competencies shows that, across the entire sample (N = 218), only 31 students or 14.2% (95% CI [9.8%–19.5%]) achieved a high level of proficiency in practical environmental health competencies. The majority (58.3%) demonstrated an intermediate level, and 27.5%

showed a low level of mastery of basic concepts in ecotoxicology and urban sanitation.

**Table 2:** Assessment of Students' Practical Competencies in Environmental Health

| Area of Competence Assessed | Low Proficiency (<50%) | Moderate Proficiency (50–74%) | High Proficiency (>=75%) |
|---|---|---|---|
| Identification of Water/Sanitation Risks | 22.0% | 54.1% | 23.9% |
| Biomedical/Hospital Waste Management | 31.2% | 52.3% | 16.5% |
| Local eco-epidemiological assessment (Boma) | 44.5% | 43.1% | 12.4% |
| Prevention and Response to Fecal Contamination/Cholera | 18.3% | 61.0% | 20.6% |
| Communication on environmental risks | 38.5% | 49.5% | 12.0% |

### 3.3. Bivariate Analysis and Multivariate Logistic Regression

The bivariate analysis reveals a highly significant difference in competency mastery based on the student's field of study ($\chi^2 = 24.18$; $p < 0.001$), the presence of practical fieldwork ($\chi^2 = 32.15$; $p < 0.001$), and the assessment method used ($\chi^2 = 14.80$; $p = 0.001$).

After multivariate adjustment in the binary logistic regression model (Table 3), participation in practical fieldwork at the Boma eco-sanitation site emerged as the most powerful determinant of high competency mastery (adjusted OR = 4.21; 95% CI [2.10–8.45]; $p < 0.001$). Furthermore, aligning assessments with the APC (case studies vs. theoretical memorization) nearly triples the probability of success (ORa = 2.85; 95% CI [1.34–6.07]; $p = 0.006$).

**Table 3:** Determinants of High Environmental Health Competency Mastery among Students

| Determining Factors | Crude OR (95% CI) | p-value (crude) | Adjusted OR (95% CI) | p-value (adjusted) |
|---|---|---|---|---|
| Field of Study: Public Health (vs. Nursing) | 3.12 [1.65–5.90] | < 0.001 | 2.15 [1.02–4.52] | 0.043 |
| Fieldwork / Integrated Lab Sessions (Yes vs. No) | 5.40 [2.88 - 10.12] | < 0.001 | 4.21 [2.10 - 8.45] | < 0.001 |
| APC-Based Assessment / Simulations | 3.45 [1.78–6.68] | < 0.001 | 2.85 [1.34–6.07] | 0.006 |
| Teacher Profile: Environmental Health Specialist | 2.10 [1.12–3.95] | 0.021 | 1.48 [0.72 - 3.05] | 0.285 |

### 3.4. Findings from the Qualitative Analysis (NVivo v14)

The thematic analysis of the 12 interviews with academic leaders identified three major explanatory themes:

- **The "secondary course" syndrome:** Environmental health is perceived by academic authorities as a general education subject rather than a fundamental clinical discipline.
- **Lack of infrastructure and partnerships:** The absence of environmental toxicology laboratories and the lack of agreements between the institutes and the Boma City Hall or the Waterways Authority hinder the organization of field internships.
- **Resistance to the LMD Reform:** Although the LMD framework has been officially adopted, teaching methods remain focused on the rote presentation of theoretical notes without constructive application.

## 4. DISCUSSION

This study provides unprecedented empirical insight into the curricular integration of environmental health within the framework of the LMD reform in the DRC, specifically focusing on the vulnerable context of Boma. The results validate the first hypothesis (H1) by confirming the marginal allocation of class time (an average of 22.4 hours, or 1.8% of credits) and the marked heterogeneity across programs. This finding aligns with the conclusions of Howard et al. (2021) and Guzman et al. (2021), who documented the structural inadequacy of eco-health education in medical schools and nursing schools internationally.

From a pedagogical perspective, our results strongly confirm Hypothesis H2: purely lecture-based instruction without practical immersion severely limits competency mastery (only 14.2% demonstrated high proficiency). Logistic regression analysis shows that field-based practical training increases operational proficiency by more than fourfold (ORa = 4.21). This finding is directly supported by Biggs's (2003) theory of constructive alignment and competency-based pedagogy (Frenk et al., 2010), which stipulates that the acquisition of

complex competencies requires authentic and contextualized real-world situations. In a city like Boma, bordered by the Congo River and facing urgent sanitation challenges, the lack of field trips deprives students of clinical and community-based experience.

Furthermore, the fragmentation of educational content constitutes an obstacle to the "One Health" approach advocated by the WHO (2020) and the Rockefeller-Lancet Commission on global health (Whitmee et al., 2015; Myers, 2017). Training healthcare providers who are unable to identify the environmental vectors of local diseases perpetuates a purely curative model of medicine, which is financially unsustainable for Congolese households.

## CONCLUSION AND RECOMMENDATIONS

The integration of environmental health into the first year of the LMD program at medical training institutions in Boma remains in its infancy and is insufficiently aligned with the principles of the Competency-Based Approach. To transform this weak link into a lever for eco-health prevention, the following recommendations are made:

To the Ministry of Higher Education and the National LMD Commission:

- Establish a mandatory cross-disciplinary module on Environmental Health and Climate Change worth at least 3 ECTS (45 hours) for all health programs starting in the first year (L1).

To the Administrations of Boma Institutions (ISTM, Faculties):

- Make it mandatory for 30% of the course hours to consist of practical fieldwork (visits to sanitation facilities, flood zones, and hospital waste disposal sites).
- Sign strategic partnerships with the Boma City Hall, the Kongo Central Department of Public Health (DPS), and environmental agencies to establish eco-sanitation internship sites.
- Strengthen continuing education for faculty in APC teaching methods and the constructive alignment of assessments.

## AUTHOR'S STATEMENT

**Conflict of Interest:** The authors declare that they have no financial, academic, institutional, or personal conflicts of interest related to the conduct of this study or the publication of this article.

**Funding:** This research was conducted using the researchers' own funds and as part of the academic activities of the Medical Didactics Research Unit. No external financial support was sought.

**Ethical Approval and Consent:** The research protocol received formal approval from the Institutional Research Ethics Committee. Written informed consent was obtained from all participants (faculty and students) prior to the administration of the questionnaires and interviews.

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