

Twenty-first-century readiness of Thai Doctor of Veterinary Medicine curricula: A documentary analysis using the competency-based veterinary education 2.0 framework

Pongphol Pongthaisong^{1*} Manakant Intrakamhaeng¹

Abstract

Twenty-first-century veterinary practice demands graduates who combine clinical expertise with professional competencies including communication, financial literacy, evidence-based practice, and One Health awareness. Whether Thai Doctor of Veterinary Medicine (DVM) curricula systematically develop these competencies has not been evaluated across the full national cohort. This study assessed the 21st-century readiness of all 11 accredited Thai DVM programs using the Competency-Based Veterinary Education 2.0 (CBVE 2.0) framework (AAVMC Council, 2024). Program Learning Outcomes (PLOs) and course specifications from Thai Qualifications Framework curriculum specification documents (TQF-2; ๒๕๖๒.๒) were analyzed using deductive content analysis against all 9 CBVE 2.0 domains, with inter-rater reliability established by Cohen's kappa (pilot $\kappa = 0.80$; full coding $\kappa = 0.82$). A Clinical Readiness Index (CRI; Domains 1–4) and 21st Century Professional Index (21C-PI; Domains 5–9) were calculated per program. Upon recalculation from the authoritative domain coverage matrix, CRI ranged from 75 to 100%, and 21C-PI ranged from 60 to 90%, with an Overall Readiness Index (ORI) range of 68–95%. Seven of 11 programs achieved High overall readiness (ORI $\geq 80\%$); four programs (KKU, MUT, RMUTTO, RMUTSV) demonstrated Moderate-High readiness. Financial and Practice Management (D8) was absent or only partially addressed in most programs; antimicrobial resistance (AMR) stewardship and digital health literacy showed inconsistent PLO-level expression across the national cohort. These findings document that Thai DVM curricula adequately prepare graduates for traditional clinical roles but require systematic reform to embed professional competencies, with Veterinary Council of Thailand (VCT) accreditation standard revision identified as the primary policy lever for national-level improvement.

Keywords: CBVE 2.0, competency-based education, curriculum analysis, One Health, Thailand, veterinary education

¹Faculty of Veterinary Sciences, Mahasarakham University, Maha Sarakham 44000, Thailand

*Correspondence: pongphol.p@msu.ac.th (P. Pongthaisong)

Received March 25, 2026

Accepted May 28, 2026

<https://doi.org/10.56808/2985-1130.4044>

Introduction

The veterinary profession is undergoing a transformation that extends well beyond clinical medicine. Veterinarians are increasingly called upon to lead One Health initiatives bridging human, animal, and environmental health; to implement antimicrobial stewardship programs critical to global health security; to navigate digital health technologies transforming diagnostics and data management; and to sustain long-term professional resilience in a workforce facing high rates of burnout and mental health challenges (Cake *et al.*, 2021; Nantavisai *et al.*, 2022). These demands define what is increasingly termed '21st century veterinary readiness': the capacity of a newly graduated veterinarian to function effectively not just as a clinician but as a professional, communicator, collaborator, scientist, and business person.

The Competency-Based Veterinary Education 2.0 (CBVE 2.0) framework, published by the Association of American Veterinary Medical Colleges (AAVMC) in 2024 (AAVMC Council, 2024), represents the most comprehensive published instrument for assessing this breadth of graduate readiness. Building on the original CBVE model (2018) and the North American Veterinary Medical Education Consortium (NAVMEC) roadmap (2011), CBVE 2.0 defines 9 domains of competence, 32 competencies, and associated developmental milestones. Critically for this study, the framework explicitly delineates a 'Clinical Cluster' (Domains 1–4: Clinical Reasoning, Individual Animal Care, Population Animal Care, Public Health) from a '21st Century Professional Cluster' (Domains 5–9: Communication, Collaboration, Professionalism, Financial and Practice Management, Scholarship). This distinction provides a natural analytical structure for evaluating the balance between traditional and emerging professional competencies in any DVM curriculum.

Thai DVM programs operate under the Veterinary Council of Thailand (VCT) accreditation standards and the Thai Qualifications Framework for Higher Education (TQF: HED; referred to as มคอ. in Thai), both of which require programs to demonstrate graduate outcomes across five TQF domains. While the TQF provides a general higher education framework, it does not specifically operationalize the professional competencies increasingly demanded of veterinarians, particularly in domains such as financial management, digital health literacy, and sustainable career resilience. CBVE 2.0 fills this gap with a veterinary-specific, evidence-based competency model that has been adopted or is under adoption by more than 11 AAVMC member institutions (Banse *et al.*, 2024) and has been cross-mapped to One Health competencies (Baines *et al.*, 2024), AMR learning outcomes (AAVMC/APLU, 2017), and health informatics competencies (Ouyang *et al.*, 2021). Disciplinary cross-mapping of CBVE domains to specific subject areas, such as veterinary pharmacology, has further demonstrated the framework's utility for curriculum alignment across individual courses (Hawes *et al.*, 2025).

This study addresses three research questions: (1) To what extent do Thai DVM curricula address each of the 9 CBVE 2.0 domains at the PLO and curriculum

specification level? (2) What is the CRI and 21C-PI for each institution? (3) Which CBVE 2.0 domains represent the greatest gaps in Thai DVM curricula?

Materials and Methods

Study design and data source: This study employed deductive content analysis (Elo and Kyngäs, 2008) of the Thai Qualifications Framework curriculum specification documents (TQF-2; มคอ.2) from all 11 accredited Thai DVM programs (Supplementary Note S1). Analysis units included PLO statements, course learning objective summaries, and practicum/clinical rotation competency statements as documented in TQF-2 sections 2 and 4. Where course learning outcomes (CLOs) were present in the document, these were included to enable curriculum-depth analysis beyond PLO statements.

Analytical framework: CBVE 2.0: The CBVE 2.0 framework (AAVMC Council, 2024) was used as the *a priori* coding taxonomy. All 9 domains and their 32 competency descriptions served as the main coding categories. Supplementary coding keywords were developed for four embedded competency themes: (1) One Health, using Baines *et al.* (2024) cross-mapping of One Health sub-competencies to CBVE D4; (2) AMR stewardship, using the WHO (2018) competency framework and AAVMC/APLU (2017) AMR learning outcomes; (3) Digital health and health informatics, using Day-1 competencies for veterinary health informatics (Ouyang *et al.*, 2021); (4) Graduate employability and resilience, using the VetSet2Go five-domain capability framework (Cake *et al.*, 2021). These four themes were coded as subcomponents within their parent CBVE domains (D4, D7, and D9, respectively).

Coding protocol and inter-rater reliability: Two independent coders applied a three-point coding scale to each CBVE 2.0 domain for each program: 0 = absent (no PLO, CLO, or course description substantively addresses the domain); 1 = partial (at least one PLO or course addresses an aspect of the domain but coverage is incomplete relative to the full CBVE competency description); 2 = full (multiple PLOs and/or courses provide comprehensive coverage of the domain as defined by CBVE 2.0). Anchor examples from the coding codebook illustrate this scale: for Domain 8 (Financial and Practice Management), a code of 0 was assigned when no PLO or course addressed business planning, budgeting, or practice economics; a code of 1 was assigned when at least one course covered basic entrepreneurship or business concepts, even if the domain was not explicitly stated in program-level PLOs; a code of 2 would require financial management to be explicitly stated in program-level PLOs and supported by multiple courses. For Domain 4 (Public Health/One Health), a code of 1 was assigned when zoonotic disease and food safety content were present, but AMR stewardship, ecological One Health framing, and digital disease surveillance were absent; a code of 2 required PLO-level coverage spanning all three sub-themes. For Domain 5 (Communication), a code of 1 was assigned when communication PLOs referenced

basic clinical communication only, without covering active listening, audience adaptation, or professional documentation as specified in CBVE 2.0. A codebook with complete operational definitions, inclusion/exclusion criteria, and anchor examples for all 9 domains was developed prior to coding. The CBVE assessment toolkit (Foreman *et al.*, 2024) provided additional guidance for operationalizing domain-level performance indicators within the coding protocol.

Pilot coding of 20% of PLO statements ($n = 21$) achieved Cohen's $\kappa = 0.80$ (almost perfect agreement; weighted $\kappa_w = 0.82$), following which full coding proceeded. Final overall $\kappa = 0.82$ ($\kappa_w = 0.84$, almost perfect). All statistical analyses were performed using R version 4.4.1 (R Core Team, 2024), with kappa coefficients calculated using the irr package (Gamer *et al.*, 2019). All coding disagreements were resolved through structured consensus discussion before entering the coverage matrix.

Readiness indices: The Clinical Readiness Index (CRI) was defined as: $CRI = \text{sum}(D1-D4) / (2 \times 4) \times 100\%$, representing the proportion of maximum possible clinical domain coverage achieved. The 21st Century Professional Index (21C-PI) was defined as: $21C-PI = \text{sum}(D5-D9) / (2 \times 5) \times 100\%$. The Overall Readiness Index (ORI) = $(CRI \times 0.5) + (21C-PI \times 0.5)$, equally weighting clinical and professional dimensions. The Overall Coverage Index (CI) = $\text{count}(\text{domains with code} \geq 1) / 9 \times 100\%$. The equal weighting of CRI and 21C-PI in the ORI reflects the conceptual design of CBVE 2.0 itself, which positions clinical and professional competencies as co-equal pillars of graduate readiness (NAVMEC, 2011; AAVMC Council, 2024), consistent with VetSet2Go findings that employers value professional competencies alongside clinical skills (Cake *et al.*, 2021). Sensitivity analyses using CRI:21C-PI weights of 70:30 and 60:40 produced identical readiness-level classifications for 9 of 11 programs, with only MUT and PSU shifting one classification level under the 70:30 weighting, confirming robustness to reasonable weighting assumptions.

Programs were classified as High (ORI $\geq 80\%$), Moderate-High (60–79%), Moderate (40–59%), or Low ($< 40\%$).

Result

CBVE 2.0 domain coverage matrix: Table 1 presents the full CBVE 2.0 domain coverage matrix across all 11 programs. All 11 programs achieved full (2) or partial (1) coverage of Domains 1–3 (Clinical Reasoning, Individual Animal Care, Population Animal Care). Domain 7 (Professionalism) and Domain 6 (Collaboration) achieved full (2) coverage in all 11 programs, driven by universal inclusion of professional ethics, veterinary legislation, and teamwork PLOs. Domain 8 (Financial and Practice Management), as its curriculum includes a course addressing basic practice management and entrepreneurship in the veterinary context. Accordingly, 7 of 11 programs received a code of 0 (absent) for D8, with KU, WU, MSU, and CU

demonstrating partial coverage through business management or entrepreneurship elective content. Domain 5 (Communication) was coded partial (1) in 5 programs where PLOs addressed basic clinical communication only, without covering the full CBVE communication spectrum. Domain 4 (Public Health/One Health) achieved full coverage in only 4 programs (CU, CMU, PSU, WU).

Clinical Readiness Index and 21st Century Professional Index: Table 2 presents recalculated CRI, 21C-PI, and overall readiness classification for each program, based on the authoritative coding matrix in Table 1. Seven of 11 programs achieved High overall readiness (ORI $\geq 80\%$): CU, KU, CMU, MU, PSU, WU, and MSU. Four programs (KKU, MUT, RMUTTO, RMUTSV) demonstrated Moderate-High readiness (ORI 60–79%). No program fell below Moderate-High. CRI ranged from 75 to 100%, and 21C-PI ranged from 60 to 90%. 21C-PI demonstrated substantial variation: CU and WU achieved 21C-PI of 90%, while KKU, MUT, RMUTTO, and RMUTSV achieved 60%. This variation within a nominally harmonized curriculum system warrants systematic investigation.

Gap analysis by CBVE 2.0 domain: Across all 11 programs, Domain 8 (Financial and Practice Management) demonstrated the highest Gap Analysis Index (GAI; mean 91%), followed by D4 Public Health/One Health embedded themes (mean GAI for AMR stewardship sub-competency = 73%; mean GAI for digital health informatics sub-competency = 82%). Within D4, sub-competencies addressing “Engaging and working across disciplines” and “Identifying social and ecological determinants of health” were absent from 9 of 11 programs, while “Recognizing zoonotic disease transmission” was present in all programs, confirming that One Health coverage remains narrowly focused on disease-based dimensions. This pattern aligns with the six core One Health competency domains framework (Frankson *et al.*, 2016), in which ecological and inter-sectoral dimensions are designated as advanced competencies expected to develop post-graduation.

AMR stewardship sub-competency coverage was partial in 7 programs and full in 2 (CU, CMU). The “Diagnostic stewardship and surveillance” domain of the WHO (2018) AMR framework was absent from all 11 programs at the PLO level, though CLO-level coverage may exist without PLO-level expression.

Discussion

This study demonstrates that Thai DVM curricula are strong in clinical competency development but systematically underprepare graduates for the 21st-century professional demands codified in the CBVE 2.0 framework. The near-universal absence or partial expression of Financial and Practice Management (D8) represents a critical gap. Veterinary practice management, business planning, and financial viability are central challenges for new graduates entering solo or group practice, a career path that the majority of Thai veterinary graduates pursue. The NAVMEC report (2011) identified practice

management as one of eight core competencies for 21st-century veterinary education; fourteen years later, this remains the most systematically underaddressed domain in Thai DVM programs.

Table 1 CBVE 2.0 domain coverage across 11 Thai DVM programs (0 = absent, 1 = partial, 2 = full).

CBVE 2.0 Domain	Cluster*	CU	KU	CMU	KKU	MU	MUT	PSU	RMU	TTO	WU	RMU	TSV	MSU
D1. Clinical Reasoning	Clinical	2	2	2	2	2	2	2	2	2	2	2	2	2
D2. Individual Animal Care	Clinical	2	2	2	2	2	2	2	2	2	2	2	2	2
D3. Population Animal Care	Clinical	2	2	2	1	2	1	2	1	2	1	2	1	2
D4. Public Health / One Health	Clinical	2	2	2	1	1	1	2	1	2	2	1	1	1
D5. Communication	21C	2	1	2	1	2	1	2	1	2	2	1	2	2
D6. Collaboration	21C	2	2	2	2	2	2	2	2	2	2	2	2	2
D7. Professionalism	21C	2	2	2	2	2	2	2	2	2	2	2	2	2
D8. Financial and Practice Management	21C	1	1	0	0	0	0	0	0	0	1	0	1	1
D9. Scholarship/EBVM	21C	2	2	2	1	2	1	1	1	1	2	1	1	1

*Cluster: Clinical = CBVE Domains 1–4 (Clinical Competency Cluster); 21C = CBVE Domains 5–9 (21st Century Professional Cluster). Green = full (2); yellow = partial (1); red = absent (0).

Table 2 Clinical Readiness Index (CRI), 21st Century Professional Index (21C-PI), and overall readiness classification.

Institution	Domains covered (n/9)	CI (%)	21C domains covered (D5–D9)	21C-PI (%)	Profile	Readiness level
CU	9/9	100	5/5	90	CRI=100%; 21C-PI=90%	High
KU	9/9	100	5/5	80	CRI=100%; 21C-PI=80%	High
CMU	8/9	88.9	4/5	80	CRI=100%; 21C-PI=80%	High
KKU	8/9	88.9	4/5	60	CRI=75%; 21C-PI=60%	Moderate-High
MU	8/9	88.9	4/5	80	CRI=88%; 21C-PI=80%	High
MUT	8/9	88.9	4/5	60	CRI=75%; 21C-PI=60%	Moderate-High
PSU	8/9	88.9	4/5	70	CRI=100%; 21C-PI=70%	High
RMUTTO	8/9	88.9	4/5	60	CRI=75%; 21C-PI=60%	Moderate-High
WU	9/9	100	5/5	90	CRI=100%; 21C-PI=90%	High
RMUTSV	8/9	88.9	4/5	60	CRI=75%; 21C-PI=60%	Moderate-High
MSU	9/9	100	5/5	80	CRI=100%; 21C-PI=80%	High

CI = Overall Coverage Index; CRI = Clinical Readiness Index; 21C-PI = 21st Century Professional Index; ORI = Overall Readiness Index. Readiness levels: High ORI ≥ 80%; Moderate-High ORI 60–79%.

These findings can be interpreted through the lens of established curriculum design frameworks. Biggs and Tang's (2011) constructive alignment model holds that graduate competencies must be explicitly articulated at the intended curriculum level (PLOs)

before they can be systematically assessed and enacted. The gap between clinical strength and professional competency weakness in Thai DVM programs reflects a structural misalignment between what graduates are expected to do professionally and what the curriculum

formally claims to develop. Tyler's (1949) curriculum design rationale similarly emphasizes that educational objectives must be clearly stated to guide course design, assessment, and resource allocation. Harden's SPICES model (Harden *et al.*, 1984) further suggests that a shift from topic-based to competency-based design is necessary for professional competencies to achieve parity with clinical skills in the enacted curriculum.

An essential framing consideration applies to the interpretation of all findings in this study. The variation in 21C-PI values across Thai programs reflects meaningful differences in curriculum revision timescales, institutional contexts, and strategic priorities, not in institutional quality or graduate competence. This study does not rank or compare institutions competitively. Rather, its primary purpose is to provide a national-level evidence base to inform systemic VCT accreditation reform.

The partial One Health coverage pattern, strong in zoonosis and food safety content but weak in socio-ecological One Health framing, is consistent with findings by Baines *et al.* (2024), who identified six One Health sub-competencies absent and 19 requiring augmentation when cross-mapped to CBVE 2.0 Domain 4. The gap in digital health and health informatics coverage (absent in 9/11 programs at the PLO level) is especially consequential given Thailand's national digital economy policy. Ouyang *et al.* (2021) identified four veterinary health informatics Day-1 competencies, all of which were absent from Thai DVM PLO statements.

The revised readiness classification, seven High and four Moderate-High programs, reflects a generally strong foundation across Thai DVM institutions, with differentiation primarily driven by 21C-PI variation. CU and WU both underwent recent curriculum revisions (B.E. 2568) explicitly guided by competency-based outcomes frameworks. The Moderate-High profile at KKU, MUT, RMUTTO, and RMUTSV is partly attributable to older curriculum revision dates (B.E. 2563) predating the growing global emphasis on professional competencies in veterinary education. A comparable national-level competency mapping exercise in Korea demonstrated that establishing explicit graduation competencies drove measurable improvements in veterinary curriculum alignment (Nahm *et al.*, 2023), suggesting that formal competency policy is a necessary precondition for sustained curriculum development.

Several limitations apply. First, and most importantly, this study measures the written or intended curriculum as documented in TQF-2 specifications, not the enacted or experienced curriculum. The distinction between written curriculum documents and actual teaching practice is a well-established challenge in curriculum research (Glatthorn *et al.*, 2018). Competencies may be actively taught through clinical rotations, case-based learning, and extracurricular activities even when not explicitly articulated in PLO statements. The PLO-level gaps documented in this study should therefore be understood as gaps in curriculum intent articulation, which may or may not correspond to gaps in curriculum delivery. Future research using CLO-level

analysis, clinical log books, graduate surveys, and employer interviews would provide a more complete picture of the enacted curriculum.

Second, the CBVE 2.0 framework, while internationally prominent, was developed primarily in a North American context; some domain descriptions may not fully translate to Thai cultural and regulatory contexts. Third, the 21C-PI calculation treats all five 21st-century domains equally, though arguable priorities may differ in the Thai context.

In conclusion, Thai DVM curricula demonstrate robust clinical competency development (CRI 75–100%), with seven of 11 programs achieving High overall readiness (ORI $\geq$ 80%). Systematic underperformance in 21st-century professional competency domains (21C-PI 60–90%, mean 77%) is driven primarily by gaps in Financial and Practice Management (D8), digital health literacy, and socio-ecological One Health framing. CU and WU provide instructive models of high-readiness curriculum design through competency-based revision. Embedding CBVE 2.0 professional competency domains, particularly D8, expanded One Health sub-competencies (D4), and digital health informatics (D9), into the next VCT accreditation standard cycle would advance the national veterinary education system toward 21st-century fitness. Importantly, these findings reflect gaps in the written curriculum and should be interpreted alongside evidence from the enacted curriculum in future research. The AAVMC, through the CBVE 2.0 framework, and WOA, through its One Health and veterinary public health mandate, together represent the key international stakeholders whose standards Thai veterinary education should aspire to meet, as an investment in the long-term relevance, employability, and global competitiveness of Thai DVM graduates.

Future research should triangulate these PLO-level findings with Course Learning Outcome analysis, graduate perception surveys, and employer satisfaction data across the Thai VEE system.

Acknowledgments

The authors thank the AAVMC for open-access availability of the CBVE 2.0 framework. No external funding was received for this study.

Statement of author contributions: **Pongphol Pongthaisong:** Conceptualisation, Methodology, Data curation, Formal analysis, Project administration, Writing – original draft. **Manakant Intrakamhaeng:** Formal analysis, Writing – review and editing, Validation, Supervision.

Declaration of artificial intelligence use: During the preparation of this work, the authors used Claude AI (Anthropic) for reference list formatting and document preparation. The authors take full responsibility for the integrity, accuracy, and originality of the work.

References

- AAVMC Council on Outcomes-based Veterinary Education 2024. Competency-Based Veterinary Education (CBVE) 2.0 Model. Washington DC: Association of American Veterinary Medical Colleges.
- AAVMC/APLU 2017. AMR Learning Outcomes: AAVMC/APLU National Action Plan to Address Antibiotic Resistance. Washington DC: Association of American Veterinary Medical Colleges and Association of Public and Land-grant Universities.
- Baines AE, Errecaborde K, Ames TR, Goldsmith TJ, Kinzer H, Mahero M, Molitor T, Molgaard L, Pelican K, Ponder JB, Travis DA, Willette M, Wolf TM, Zou X and Wells SJ 2024. One Health as a core component of veterinary medicine: defining Day-1 public health competencies for the veterinary workforce. *J Vet Med Educ.* 51: 176–184.
- Banase HE, Kedrowicz A, Michel KE, Burton EN, Yvorchuk-St Jean K, Anderson J, Anderson S, Barr MC, Boller E, Chaney K, Dyer Inzana K, Matthew SM, Rollins D, Salisbury SK, Schmidt P, Smith N and Trace C 2024. Implementing competency-based veterinary education: a survey of AAVMC member institutions on opportunities, challenges, and strategies for success. *J Vet Med Educ.* 51: 155–163.
- Biggs J and Tang C 2011. Teaching for Quality Learning at University. 4th ed. Maidenhead, UK: McGraw-Hill/Open University Press. 416 pp.
- Cake M, Bell M, Cobb K, Feakes A, Hamood W, Hughes K, King E, Mansfield CF, McArthur M, Matthew S, Mossop L, Rhind S, Schull D and Zaki S 2021. Employability as a guiding outcome in veterinary education: findings of the VetSet2Go project. *Front Vet Sci.* 8: 687967.
- Elo S and Kyngäs H 2008. The qualitative content analysis process. *J Adv Nurs.* 62: 107–115.
- Foreman JH, Read EK, Coleman MC, Danielson JA, Fogelberg K, Frost JS, Gates MC, Hinckley-Boltax A, Hodgson JL, Lyon S, Matthew SM and Schoenfeld-Tacher R 2024. Development and use of the competency-based veterinary education (CBVE) assessment toolkit. *J Vet Med Educ.* 51: 203–208.
- Frankson R, Hueston W, Christian K, Olson D, Lee M, Valeri L, Hyatt R, Anelli J and Rubin C 2016. One health core competency domains. *Front Public Health.* 4: 192.
- Gamer M, Lemon J, Fellows I and Singh P 2019. irr: Various Coefficients of Interrater Reliability and Agreement. R package version 0.84.1. [Online]. Available from: <https://CRAN.R-project.org/package=irr>. Accessed January 2025.
- Glatthorn AA, Boschee F, Whitehead BM and Boschee BF 2018. Curriculum Leadership: Strategies for Development and Implementation. 5th ed. Thousand Oaks, CA: SAGE Publications. 504 pp.
- Harden RM, Sowden S and Dunn WR 1984. Educational strategies in curriculum development: the SPICES model. *Med Educ.* 18: 284–297.
- Hawes M, Fajt V and Werners AH 2025. Mapping disciplinary competencies and learning outcomes to the competency-based veterinary education framework using veterinary pharmacology as an example. *J Vet Med Educ.* 52: 725–733.
- Nahm SS, Lee K, Chun MS, Kang J, Kim S, Jeong SM, Chung JY and Ryu PD 2023. Establishing veterinary graduation competencies and its impact on veterinary medical education in Korea. *J Vet Sci.* 24: e41.
- Nantavisai S, Pagdepanichkit S, Jattuchai J, Sawangmake C, Choisunirachon N, Tiawsirisup S and Suradhat S 2022. Perspectives on veterinary education in Thailand. *J Vet Sci.* 23: e86.
- NAVMEC Board of Directors 2011. The North American Veterinary Medical Education Consortium (NAVMEC) looks to veterinary medical education for the future: Roadmap for veterinary medical education in the 21st century: responsive, collaborative, flexible. *J Vet Med Educ.* 38: 320–327.
- Ouyang ZB, Hodgson JL, Robson E, Havas K, Stone E, Poljak Z and Bernardo TM 2021. Day-1 competencies for veterinarians specific to health informatics. *Front Vet Sci.* 8: 651238.
- R Core Team 2024. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing. [Online]. Available from: <https://www.R-project.org/>. Accessed January 2025.
- Tyler RW 1949. Basic Principles of Curriculum and Instruction. Chicago, IL: University of Chicago Press. 128 pp.
- WHO 2018. WHO Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance. WHO/HIS/HWF/AMR/2018.1. Geneva, Switzerland: World Health Organization. [Online]. Available from: <https://apps.who.int/iris/handle/10665/272766>. Accessed January 2025.