

Curricular Variables and Topics Studied in Veterinary Immunology Courses at Several Latin American Universities †

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Competencies approach is a strategy advised by academicians, international organizations with competence in education (e.g., UNESCO), and those related to veterinary medicine practice (e.g., OIE [World Organisation for Animal Health, formerly International Office of Epizootics] and PANVET [Pan-American Association for Veterinary Sciences]) to answer society's demands for professionals. In Latin American universities, important initiatives to adopt competencies approach were developed by Tuning América Latina and VINCULAENTORNO (project developed by several international institutions, including IESALC from UNESCO [International Institution for Higher Education in Latin America and the Caribbean] focused on the entailment of universities with their environment, to foster social and economic sustainable development) more than a decade ago. In Venezuela, renewed efforts concerning curricular revision were carried out by academicians, taking into account the recommendations made by peer reviewers, during the accreditation process with ARCU-SUR regarding veterinary programs. The present document explores curricular designs of immunology for veterinary students in different universities to determine common characteristics, in order to obtain valuable information for future curricular plans. Veterinary Immunology courses from 24 universities in six Latin-American countries were examined, searching for common content. Other curricular variables, e.g., instructional models, hours planned for theoretical and laboratory activities, educational credits, position in curricular trees, previous requirements, and implementation dates, were considered. The average \pm standard deviation of immunology issues studied among the universities was 31 ± 7.9 of the 63 listed topics, and the similarity was 79.2% ($n = 19$ courses), but other significant differences and curricular variations were recorded. This article describes novel aspects of curricular facts of this biomedical area in Latin America; these results may be valuable to design future curricular planning and a unified and precise curriculum on veterinary courses.

INTRODUCTION

Education is considered a universal human right (1) ratified on constitutional documents from several Latin American countries (2). Several organizations focus their efforts on offering this important resource to people (3) because societies demand the best educational systems to promote national development (4). Therefore, a continual institutional improvement is required, particularly for those dedicated to professional training (4), to confront these new challenges, and the Competence approach in education is usually adopted (3, 5–7).

The concept of “Competencies” in education states that professional profiles should be determined according to the requirements of their societies (5). Multiple benefits could be obtained using this approach: a) increase of regional academic cooperation resulting in a larger number of occupational fields for graduates (2, 3, 8–12), b) promotion of a higher curriculum consistency, thus lowering local particularities (5, 8, 13), and c) fostering implementation of student-focused learning/teaching methods (3).

Higher-education institutions (HEIs) (14) and academicians have postulated the professional competencies in the case of veterinary teaching (15, 16), starting from self-sufficient individuals with autonomous learning proficiency (10), to abilities in the Public Health domain and animal husbandry issues (17–19), especially zoonotic disease re-emergence, biosecurity risks, and matters related to the safe production of animal-derived foods (10, 14, 16, 17, 19–22).

Desired competencies for veterinarians include proper handling of animal species (23, 24), participation in the “One Health” concept in multidisciplinary healthcare teams (19, 25), and strengthening generic abilities (teamwork, communication and management skills, ongoing training

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†Supplemental materials available at <http://asmscience.org/jmbe>

Las Competencias como enfoque, es una estrategia recomendada por académicos, organizaciones internacionales en materia de educación (Ej.: UNESCO) y aquellas relacionadas con la práctica de la Medicina Veterinaria (Ej.: OIE y PANVET), para responder las demandas de la sociedad hacia los profesionales. En las universidades Latinoamericanas se han implementado importantes iniciativas para adoptar el enfoque de las Competencias, mediante los proyectos Tuning América Latina y VINCULAENTORNO hace más de una década. En Venezuela, los académicos han renovado sus esfuerzos realizando revisiones curriculares, tomando en consideración las recomendaciones hechas por colegas y pares evaluadores durante los procesos de acreditación del sistema ARCU-SUR, particularmente en los programas de Ciencias Veterinarias. El presente documento explora los diseños curriculares de Inmunología para estudiantes de Veterinaria de diferentes universidades, para determinar características comunes y así obtener información valiosa para futuras planificaciones curriculares. Los cursos de Inmunología Veterinaria de 24 universidades de seis naciones Latinoamericanas fueron examinados, en búsqueda de contenidos comunes; también fueron consideradas otras variables curriculares, por ejemplo, el modelo del diseño instruccional, horas teóricas y prácticas planeadas, créditos educativos, ubicación en el árbol de prelación curriculares, requerimientos previos y fechas de implementación. El promedio \pm desviación estándar del número de tópicos de Inmunología estudiados entre las universidades fue de 31 ± 7.9 , de un total de 63 enumerados, por lo que la similitud fue de 79.2% ($n=19$ cursos), pero también se registraron otras diferencias significativas y variaciones curriculares. Este artículo describe aspectos nóveles del currículo de esta área de las ciencias biomédicas aplicado en instituciones de educación superior en Latinoamérica. Estos resultados podrían ser de importancia para las futuras planeaciones curriculares, así como para el diseño de un currículum unificado y preciso para los cursos de Inmunología Veterinaria.

and professional development, research, and so on) (23, 24), without disregarding traditional attitudes toward the clinical medical care of pets and interests in agricultural production (19, 21).

Several Latin American HEI websites indicate that the Competencies approach has been implemented in their educational programs in the veterinary sciences, confirming previous reports (26), highlighting the priority given to different areas such as clinical diagnosis, therapeutics, and preventive medicine. A basic background and training in bioscience will then be sufficient to manage those roles. Consequently, HEIs have included courses focused on immunology as part of their undergraduate programs (14, 17, 27–29).

The importance of biosciences to the training of veterinarians has been widely documented (14, 17, 29, 30). This work analyzed some curricular variables and syllabi contents of Veterinary Immunology courses from several universities in six Latin American countries. The information would be of great value to future planning on Veterinary Sciences teaching processes (like regional ratification of professional degrees or “equivalency” and accreditations programs). Also, it could guide educational research regarding requirements for professional exercise (29), closely related to Competencies, considering that this approach has been widely promoted in Latin American HEIs for the past 20 years (5).

METHODS

This is a descriptive and documental research (31), with the analysis of syllabi or related documents from 24 public or private HEIs (Table I). The courses were related to Veterinary Immunology and focused on undergraduate students, they were developed inside classrooms or laboratories, and online activities were also considered as complementary resources to be implemented.

Appendix I shows the overall methodology of this work. This is a cross-sectional study (32) with cluster sampling (33). The documents were generously provided by the respective institutional staff or were extracted from institutional websites. The material was carefully reviewed, considering the immunology topics declared as learning objectives. Curricular variables, e.g., instructional model of the documents (according to Generations sorting system, commonly used by Latin-American HEI curricular specialists) (5), hours of theoretical and laboratory activities planned, educational credits (EC), position in the curricular tree, prerequisites for the Immunology course, and implementation date, were also reviewed.

Data frequencies among HEIs were recorded, charted, and graphed. Central tendency and dispersion (standard deviation) measurements were calculated in some instances. InfoStat software (Student version; InfoStat group, Universidad Nacional de Córdoba [www.infostat.com.ar/index.php?mod=page&id=37&lang=en]) was used for several statistical analyses with 95% confidence ($p \leq 0.05$):

- Fisher’s exact test was used to detect significant differences among proportions (34).
- Spearman’s correlation coefficient was calculated among values like EC and other curricular variables.
- Multivariate statistics were developed (clustering analysis) to detect commonalities and differences among Veterinary Immunology courses. Several linkage algorithms and distance measurement models were tested, trying to fit the data to the theoretical and mathematical principles. Finally, the best fit topological dendograms were selected according to the highest cophenetic correlation indexes (35).

RESULTS

General characteristics of documents

Analysis of documents from 24 institutions (Table 1) established that 50% ($n = 12$) belong to the second generation of instructional designs (5, 36, 38) and 12 correspond

to the third generation (50%), eight (33%) of these having been elaborated according to the Competencies approach, and four (17%) to the holistic model.

The oldest instructional design analyzed was from 2004 (HEI number 10) (Table 2), and it fit the Competencies approach (14), together with seven more, which were more recent documents. The date of publication

TABLE 1.
Higher education institutions reviewed in this research.

| Country | Institution | Key Number Identification | Source |
|-----------|--|---------------------------|---|
| Chile | Universidad Iberoamericana de Ciencias y Tecnología | 1 | Provided by Dra. Marcia Jarpa Hernández |
| | Universidad de Viña del Mar | 2 | Provided by Dr. José Luis Marcos Camus |
| Colombia | Universidad Antonio Nariño | 3 | http://www.uan.edu.co/medicina-veterinaria-plan-de-estudios |
| | Universidad de Santander | 4 | Provided by Dr. Fernando Acebedo Serrano |
| | Universidad de CES | 5 | Provided by Dr. Leonardo Gómez Giraldo |
| | Universidad de Ciencias Aplicadas y Ambientales | 6 | Provided by Dr. Marco Leal García |
| | Universidad de Tolima | 7 | Provided by Dra. Mallerly Valderrama Castro |
| México | Universidad Nacional Autónoma de México | 8 | http://www.fm.vz.unam.mx/fm.vz/p_estudios/Asignaturas/Obligatorias/5o%20semestre/INMUNOLOGIA_VETERINARIA.pdf |
| | Universidad Autónoma de Zacatecas | 9 | http://veterinaria.uaz.edu.mx/documents/439416/bcde570b-80cc-4e94-9fa0-b56953132a06 |
| | Universidad Autónoma de Baja California | 10 | Provided by Dra. Rosa M. Bermúdez |
| | Universidad de Tamaulipas | 11 | Provided by Dr. Julio Hinojosa H. |
| Argentina | Universidad de Colima | 12 | Provided by Dr. Omar F. Prado Rebolledo |
| | Universidad Nacional de Río Negro | 13 | Provided by la Dra. Lidia Gogorza |
| | Universidad Nacional del Litoral | 14 | Provided by M.V. Sergio Parra |
| | Universidad Nacional de La Plata | 15 | Provided by Lic. Carlos Alfredo Vázquez |
| | Universidad Nacional de Río Cuarto | 16 | http://www.ayv.unrc.edu.ar/images/archivos/3_carreras/3.1_grado/Medicina%20Veterinaria/Plan%20de%20estudio%20de%20veterinaria/veterinaria%203/3077.pdf |
| | Universidad Católica de Salta | 17 | http://www.ucasal.edu.ar/htm/agro-veterinaria/programas/123.75-1920.pdf |
| | Universidad del Nordeste | 18 | http://www.vet.unne.edu.ar/uploads/archivos/48ba45e17589d3ebe024ab70bbeda23ef17d5504.pdf |
| | Universidad del Salvador | 19 | http://vete.usal.edu.ar/archivos/vete/docs/programa_virologia__2014.pdf |
| Uruguay | Universidad Nacional de la Pampa | 20 | Provided by M.V. MSc. Nicolás Álvarez Rubianes |
| | Universidad de la República | 21 | Provided by Dr. Rodrigo Puentes |
| | Venezuela | 22 | Provided by institutional academic staff. |
| | Universidad Nacional Experimental "Francisco de Miranda" | | |
| | Universidad del Zulia | 23 | |
| | Universidad Centrooccidental "Lisandro Alvarado" | 24 | |

was recorded for 20 HEIs, and the most common year was 2015 (Table 2).

Most of the 24 analyzed documents ($n = 19$, 79%) were exclusively focused on Veterinary Immunology ($p \leq 0.05$); the remaining five (21%) shared subjects with virology ($n = 4$) or general microbiology ($n = 1$). Thirteen of the Veterinary Immunology courses (57%) are chronologically taught after microbiology courses.

According to the location in curricular trees, Veterinary Immunology courses in 22 universities were located mainly between the third and fifth semester.

Veterinary Immunology content

Each document was carefully analyzed to determine the frequency of specific content related to Veterinary Immunology. Sixty-three issues were identified in the 24 HEIs and were numerically codified to facilitate graphic representation (Appendix 2).

Figure 1 shows the overall frequencies for each topic. The highlighted area covers more than 6 HEIs (75% of the sample size). Some topics were checked just for one HEI

(issues 5, 26, 33, 47, 52, and 61), but in several institutions (e.g., HEIs: 8, 17, 18, and 23) there are many more topics; finally, the most common themes (≥ 20 HEIs) were identified as 6, 9, 11, 12, 15–17, 23, 25, 29, 30, 45, and 54.

Table 2 presents the individual record of each institution according to the overall 63 subjects registered (Appendix 2). None of the HEIs covered all the listed topics, but 54.2% ($n = 13$) included ≥ 32 issues (half of the total issues recorded in Appendix 2) in their documents. At least one university per country fulfilled this condition; Argentines were at the top, as they were the most numerous and reached the highest percentage of issues covered, with the exception of institution number 3.

Seventeen (70.8%) of 24 Veterinary Immunology courses were confirmed as theoretical-practical (HEI numbers 1, 7–14 and 16–23), and seven (29.2%) were documented as strictly theoretical ($p \leq 0.05$); however, only 8 of the 17 practical courses presented details of the contents of laboratory activities. Some of these HEIs with theoretical-practical courses ($n = 7$) also belonged to those that covered more than the 32 topics in Immunology courses (Table 2).

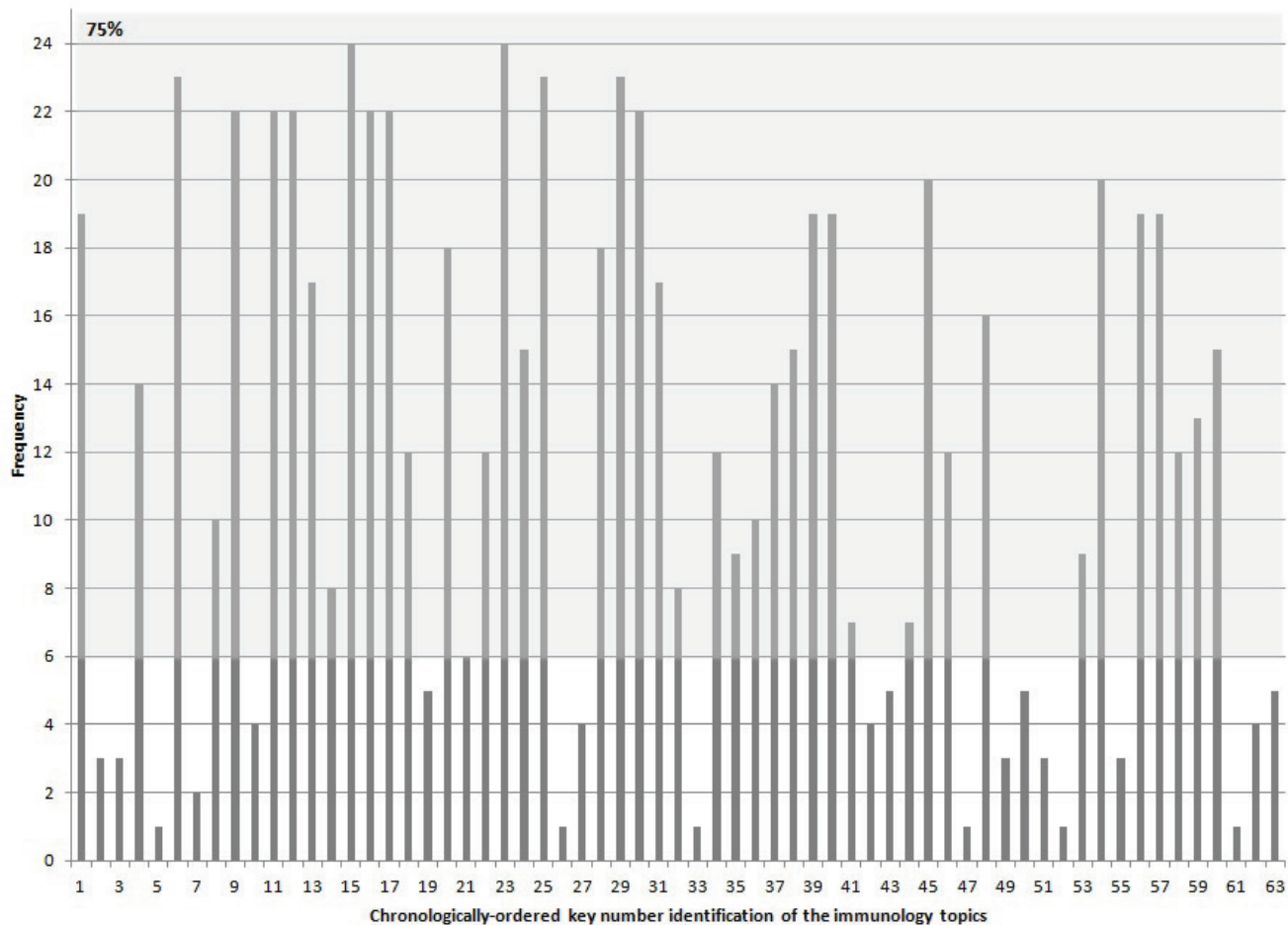


FIGURE 1. Frequency of different issues in Veterinary Immunology (1 to 63) (see Appendix 2) found on the analyzed documents. Gray area corresponds to the topics present in 75% of the universities.

TABLE 2.

The frequency of different variables pertaining to Veterinary Immunology courses in higher education institutions in Latin America.

| Key Number Identification of the Institution | YP | EC | TVIIC (% ^a) | WTH | WPH | TWH | TTH | TPH | CTH |
|--|--------|-----|-------------------------|-----|-----|-----|-------|-------|-------|
| 1 | 2015 | 4 | 33 (52.4) | | | 4 | | | 64 |
| 2 | 2013 | | 28 (44.4) | 2 | | 2 | | | |
| 3 | | 2 | 15 (23.8) | | | | | | |
| 4 ^b | | | 25 (39.7) | | | | | | 64 |
| 5 | | 2 | 32 (50.8) | | | | | | 36 |
| 6 | 2015 | 2 | 31 (49.2) | 3 | | 3 | | | 54 |
| 7 | 2012 | 2 | 27 (42.9) | 3 | 3 | 6 | 48 | 48 | 96 |
| 8 | 2013 | 10 | 41 (65.1) | 4 | 2 | 6 | 64 | 32 | 96 |
| 9 | 2013 | 10 | 26 (41.3) | 4 | 2 | 6 | 64 | 32 | 96 |
| 10 | 2004 | 7 | 38 (60.3) | 3 | 1 | 4 | 48 | 16 | 64 |
| 11 | 2012 | 7 | 28 (44.4) | 5 | 2 | 7 | 80 | 32 | 112 |
| 12 | 2012 | 5 | 30 (47.6) | 3 | 2 | 5 | 48 | 32 | 80 |
| 13 | 2015 | | 32 (50.8) | | | | | | 80 |
| 14 ^b | | | 35 (55.6) | | | | | | |
| 15 | 2004 | | 36 (57.1) | | | | | | 70 |
| 16 | 2009 | | 37 (58.7) | 2 | 1 | 3 | 46 | 14 | 60 |
| 17 | 2013 | 5 | 40 (63.5) | 3 | 2 | 5 | 48 | 10 | 58 |
| 18 | 2011 | | 45 (71.4) | 1,5 | 2,5 | 4 | 30 | 50 | 80 |
| 19 ^b | 2014 | | 11 (17.5) | | | 4 | | | 60 |
| 20 ^b | 2015 | 7 | 23 (36.5) | 7 | | 7 | 49 | 20 | 69 |
| 21 | 2015 | 6 | 35 (55.6) | 6 | | | 38 | 22 | 60 |
| 22 ^c | 2007 | 4 | 27 (42.9) | 3 | 2 | 5 | 9 | 2 | 11 |
| 23 | 2005 | 4 | 39 (61.9) | 2 | 2 | 4 | | | 64 |
| 24 | 2008 | 1 | 35 (55.6) | 1 | | 1 | 16 | | 16 |
| Mean±SD | 2011±4 | 5±3 | 31±8 | 3±2 | 2±1 | 4±2 | 45±19 | 26±15 | 66±25 |
| Mode | 2015 | 2 | 35 | 3 | 2 | 4 | 48 | 32 | 64 |
| Median | 2012 | 5 | 32 | 3 | 2 | 4 | 48 | 27 | 64 |

YP = year of publication; EC = educational credits; TVIIC = total veterinary immunology issues covered (according to Appendix 1); WTH = weekly theoretical hours; WPH = weekly practical hours; TWH = total weekly hours; TTH = total theoretical hours; TPH = total practical hours; CTH = total hours of the course.

^a Percentage of the total 63 issues listed in Appendix 1.

^b HEI with course that includes immunology and virology subjects.

^c HEI with course that includes immunology and microbiology subjects.

Credit units in a Latin American context

The Immunology courses had an average of 5 ± 3 EC and a mode of 2 (Table 2). It is remarkable that only two Argentinean HEIs use the EC system, but none stated that they had implemented it according to Competencies (this kind of affirmation is usual on documents related to this approach).

The face-to-face contact hours dedicated to the Veterinary Immunology courses were evaluated, presenting high standard deviations (SD) (Table 2). The documents did not detail the time dedicated to each issue listed in Appendix 2,

but correlations were detected among EC values (according to European definitions) (39) and weekly theoretical hours, with a Spearman's correlation coefficient = 0.73, and total weekly hours with a Spearman's correlation coefficient = 0.65 ($p \leq 0.05$) (Table 2).

Common elements among Latin American Veterinary Immunology courses

According to the overall numerical records for each course (quantity of issues detailed on Table 2), a dendrogram was constructed to identify grouping tendencies among

eight HEIs (which fulfilled all the studied continuous variables; Appendix 3). A similar exercise was developed with a preliminary classification according to country of origin, detecting similarities among courses from four countries (Appendix 4), those from Mexico and Argentina being the closest ones.

Considering the constraints imposed by the limited numerical records of various Immunology courses (Table 2), clustering tests were then developed with the total Veterinary Immunology issues for each HEI (Fig. 2), and this variable plus the total hours of the courses (registered to 21 HEIs) (Fig. 3). No clustering patterns according to country of origin in either exercise were detected.

DISCUSSION

Differences and similarities among Veterinary Immunology courses from Latin American HEIs

As stated in the previous section, the most recent syllabi ($n = 7$, the eighth was the oldest one) fit the standard model of Competencies, confirming that this educational approach has been recently introduced in many Latin American academies (6, 15, 17, 40–42), and Mexican HEIs were the first (5). The adoption of the Competencies approach in this part of the continent arises through the recommendations of academic and international organisms

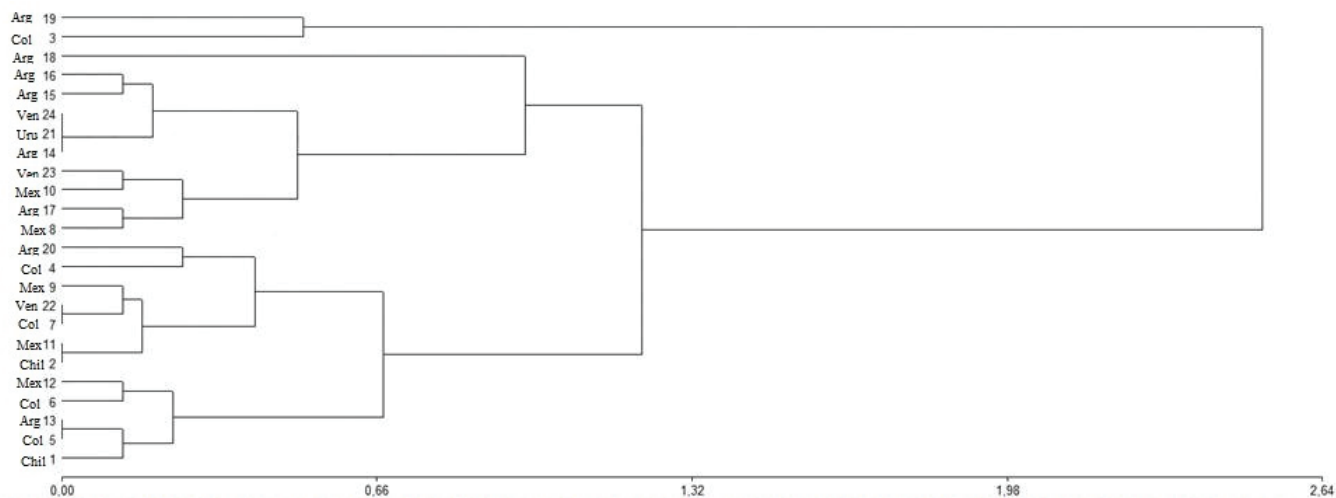


FIGURE 2. Dendrogram of the 24 HEIs surveyed according to the total Veterinary Immunology issues studied (Table 2 and Appendix 2). Cophenetic correlation index = 0.892, cluster analysis by average linkage algorithm or UPGMA, distances calculated with Manhattan or Euclidean models are invariable. Arg = Argentina; Col = Colombia; Ven = Venezuela; Uru = Uruguay; Mex = Mexico; Chil = Chile; HEI = higher-education institution; UPGMA = unweighted pair-group method using an arithmetic average.

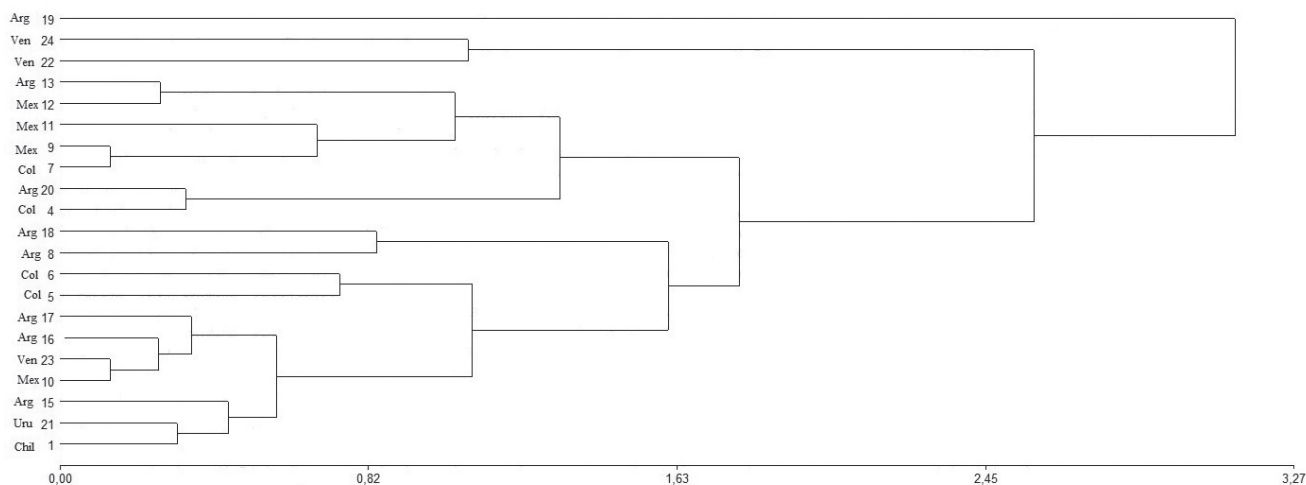


FIGURE 3. Dendrogram of Veterinary Immunology courses from some Latin American HEIs, considering two variables (TVIIC and CTH, see Table 2). Cophenetic correlation index = 0.811, cluster analysis by average linkage algorithm of UPGMA, distances calculated with Euclidean model. HEI = higher-education institution; TVIIC = total veterinary immunology issues covered; CTH = total hours of the course; UPGMA = unweighted pair-group method using an arithmetic average.

(2, 3, 7, 8, 10, 12, 36) that want to promote the benefits of this educational approach.

Most of the HEIs dedicated an exclusive curricular space to Veterinary Immunology contents, showing the importance that veterinary learning programs traditionally confer on Biomedical sciences; a similar phenomenon is described in Mexican and Spanish universities (15).

The frequency of each Veterinary Immunology issue listed in Appendix 2 (Fig. 1), and the total records of such items for every HEI (Table 2), should be considered with caution. They reflect the gold standard to be accomplished by the courses, so overestimation or underscores may take place in Latin American classrooms. In this regard, institutions from Venezuela apply instruments to register the real number of issues accomplished in a quantitative way, but these records are usually available only to local authorities. Analysis of quality control measures is beyond the scope of this research.

Two of the less frequently recorded issues in Fig. 1 (5: Immunology on Veterinary Medicine, Zootechnics and Public Health, and 33: tumoral diseases on domestic animals, according to Appendix 2) are related to contents that veterinarians recommend studying in undergraduate courses. Academicians consider that the remaining less frequent subjects ($n = 4$) should be included in postgraduate programs or more advanced courses, where students are under intensive and deeper academic training (29).

The results about the type and number of topics studied in Veterinary Immunology courses clearly show quantitative heterogeneity among Latin American HEIs (Figs. 1–3). Just over half of the institutions ($n = 13$) have a wide syllabus in terms of the number of topics, but the others ($n = 11$) have shorter programs covering fewer than 32 of the issues listed. Nevertheless, it is important to remember the previous statement that these are theoretical registers, and the teaching-learning process is a dynamic activity which depends on several variables, so students could acquire more topics than those stated in the documents of their respective HEIs.

The data about practical activities reveal its frequent implementation in Latin American HEIs, especially in Argentinean and Mexican institutions, considering that this kind of task reinforces the teaching-learning process, according to traditional constructive and cognitive educative theories. Research about the impact of these activities on professional life would help determine their benefits, and this information would be valuable to those institutions that largely depend on government support, as they usually have difficulty implementing laboratory activities due to scarce budgets.

Considering this scenario, the laboratory activities should be focused on mandatory competencies for undergraduate programs (5), e.g., basic training of veterinarians should include primary techniques (immunofluorescence, ELISA, and variants) and secondary tests (immunodiffusion, precipitation, agglutination, complement fixing). Immune cell response assessment assays and the remaining immunodiagnostic

techniques should be considered in postgraduate programs (optional and additional competencies) (29).

Quantitative and qualitative heterogeneity was detected among HEIs analyzed for immunology issues and other curricular variables, so it was not possible to establish a geographic clustering pattern (Figs. 2 and 3; Appendices 3 and 4), even in universities from the same country, perhaps due to a lack of numerical variable data (Table 2).

Toward a consistent syllabus of Veterinary Immunology: the pending task for educational credits

Variations among Veterinary Immunology courses will probably not negatively impact the performance of the learners of each HEI, but such variations could complicate inter-institutional actions that require consistency, like student or academican exchange programs and degree equivalencies, and these conflicts could happen within the same country.

The data summarized in Figure 1 and Table 2 could be helpful in preparing a regional syllabus leaning toward similar degrees, but to fully accomplish Competencies precepts, it is desirable to consider the recommendations from veterinarians in clinical settings and other users of veterinary services from different geographical areas (3). In relation to this issue, reports have been presented to veterinary programs in the Latin American context (40, 43), and one investigation specific to the immunology field was developed in Venezuela, with many of the topics cited here corroborated as important to the clinical setting (29).

High variability was recorded for EC and other variables (Table 2). Consensus regarding the value of EC to academic courses in Latin America has been an issue of heated debate, chiefly in educational projects under the Competencies approach (44); this circumstance could explain missing data in most of the universities, especially in Argentina. In Europe, this system facilitates student and professional mobility (39).

The adoption of the EC scheme in the Latin American context would require matching the concepts, considering the additional hours that learners would need to accomplish the assignments, while accounting for individual variation and other variables, which could affect the time required to acquire and reinforce competencies. Specialists recommend a redefinition of EC as "...the measurement unit to assess academic activity, which harmonically combines theoretical and practical instructions with other academic tasks, and the quantity of work that students must do to master the subjects" (González and Wagenaar, 2006, cited in 39).

According to Villarroel (39), institutions from Europe estimate 25 to 30 hours (average of 27.5 ± 2.5) to acquire one EC. The acceptability of this parameter in a Latin American context should consider the resources available to the students. Furthermore, it was demonstrated that personal abilities (cognitive and non-cognitive) influence the ability to gain knowledge, which can modify the time required to acquire and consolidate desired competencies (45, 46). The

concept of an equitable and realistic measurement unit could be considered as an unattainable utopia, but this ambitious project must not be forsaken, trying to harmonize and optimize conditions among learners, and some HEIs have devoted considerable effort to this matter (47).

This situation presents a hypothetical scenario, where Latin American undergraduate students could spend more time than those from developed countries to accomplish competencies, so that the EC value would vary by the differences (accessibility to resources and information), justifying the annotated discussions (44). A definitive solution could be solidified with more research, which would determine the time a learner would need to accomplish a competence in the Latin American context, including the time required for the autonomous apprenticeship, so that an updated measuring unit could be established. To date, the scenario is conjectural and requires exhaustive verification.

A standard EC value is necessary to facilitate “equivalencies,” remembering the positive aspects of this action; nevertheless, experts warn “to avoid a common and unified curriculum planning project or an international curriculum, otherwise, they recommend a curriculum design that understands and recognizes diversity” (8, 13), so that the relationship with statements from Complex Thinking theory (variety and plurality) is maintained (5). Therefore, during curriculum planning, space must be given to consider factors derived from society and geographical particularities, which could permeate teaching-learning processes (48).

A third way: the “regional” syllabus sponsored by international organizations

Another alternative is to choose between the “homologated degrees by [as a consequence of] globalization” and “to respond to environment requests by particularization according to Complex Thinking theory” (5). This way seeks to strengthen regional and solidarity cooperation networks, e.g., implemented by the European Community (39), the Latin American Tuning project, and the MERCOSUR (Mercado Común del Sur, a special market area in South America which comprised several countries [Brazil, Uruguay, Paraguay, Argentina, Bolivia, and Venezuela]) projects (ARCU-SUR [college careers accreditation system] and MARCA [a program sponsored by MERCOSUR that promotes undergraduate academic exchanges among ARCU-SUR accredited universities] systems). These networks try to respect national sovereignty, harmonizing quality standards through the proposal of a regional model created by academic experts (49, 50). Broadly, these initiatives tend to stimulate exchanges (academic and student) and cooperative research, improve internal practices, information and experience swaps, and to confirm the relevance of local and global visions (8, 9) as UNESCO states (12).

In this regard, it would be valuable to investigate the amount of time spent on independent work required by a learner to acquire or reinforce a competency. This

information could be collected through a question in a formal test where students specify the hours employed in that task. In this way, a data bank would be available for future calculations and would be adjusted to the conditions presented throughout the teaching-learning process, reinforcing the institutional and regional particularities in an indirect way. Then, more numerical data can be obtained, and more trustworthy statistical approximations can be set. The information from the previous proposal, along with records of face-to-face activities, is going to be the input to calculate more accurate EC values, remembering that available standards were established according to European educational systems (39).

CONCLUSION

The pivotal role of biosciences in training healthcare practitioners, particularly in immunology, was corroborated in this research. Although several information gaps and important differences in curricular variables were recorded, the data analyzed will be valuable in providing at a glance how biosciences are taught in Latin American HEIs; furthermore, the information can help to construct regional and consistent veterinary programs, which would accomplish the Competencies statement about harmonized programs.

SUPPLEMENTAL MATERIALS

- Appendix 1: Methodology employed in this research
- Appendix 2: Key numbers according to veterinary immunology topics applied in this research
- Appendix 3: Veterinary immunology courses dendrogram from some Latin American HEIs, considering all variables registered on Table 2
- Appendix 4: Dendrogram from 8 veterinary immunology courses (HEI key identification number in parentheses) from 4 countries that fulfilled all studied variables according to Fig. 1 and Appendix 2

ACKNOWLEDGMENTS

The author is grateful to the academic personnel listed in Table 1, who generously provided many of the syllabi analyzed, and Dr. Catalina Rey, who helpfully guided the corrections of this manuscript using her broad experience teaching Veterinary Immunology. The author declares that there are no conflicts of interest.

REFERENCES

1. United Nations. 1948. Universal declaration of human rights, p 71–79. [Online] United Nations [http://www.un.org/es/comun/docs/index.asp?symbol=A/RES/217\(III\)&referer=http://www.un.org/es/universal-declaration-human-rights/&Lang=E](http://www.un.org/es/comun/docs/index.asp?symbol=A/RES/217(III)&referer=http://www.un.org/es/universal-declaration-human-rights/&Lang=E)

2. Villarroel C. 2007. La acreditación: diversas connotaciones, p 1–12. *In* Villarroel C (ed), La acreditación universitaria: una ilusión de la calidad. CNU-OPSU, Caracas.
3. UNESCO, UNICEF, World Bank, UNFPA, UNDP, UN Women, UNHCR. 17 Nov 2016, posting date. Education 2030, Incheon Declaration and Framework for Action towards inclusive and equitable quality education and lifelong learning for all. [Online] UNESCO-Education http://uis.unesco.org/sites/default/files/documents/education-2030-incheon-framework-for-action-implementation-of-sdg4-2016-en_2.pdf
4. Albornoz O. 2005. What type of university does a society need?, p 645–670. *In* Albornoz O (ed), Academic populism: higher education policies under state control. Facultad de Ciencias Económicas y Sociales de la Universidad Central de Venezuela-Biotechnology, C.A., Caracas.
5. Tobón S. 2005. Formación basada en competencias, pensamiento complejo, diseño curricular y didáctica, 2nd ed. 266 p. Ecoe Ediciones, Bogotá.
6. Universidad de Deusto, Universidad de Groningen. 2007. Competencias Genéricas, p 33–70. *In* Beneitone P, Esquetini C, González J, Maletá MM, Siufi G, Wagenaar R (ed), Reflexiones y perspectivas de la educación superior en América Latina informe final-proyecto Tuning-América Latina 2004–2007. Publicaciones de la Universidad de Deusto, Bilbao.
7. UNESCO–Instituto internacional para la educación superior en América Latina y el Caribe. 2016, posting date. Vinculación de las Universidades con su entorno para el desarrollo social y económico sostenible. [Online] UNESCO–IESALC http://www.iesalc.unesco.org.ve/index.php?option=com_content&view=article&id=3516:vinculaentorno&catid=62:articulos6&Itemid=716&lang=en.
8. Universidad de Deusto, Universidad de Groningen. 2007. Contextualización, p 23–31. *In* Beneitone P, Esquetini C, González J, Maletá MM, Siufi G, Wagenaar R (ed), Reflexiones y perspectivas de la educación superior en América Latina informe final-proyecto Tuning-América Latina 2004–2007. Publicaciones de la Universidad de Deusto, Bilbao.
9. Villarroel C. 2007. La acreditación: origen y evolución, p 63–86. *In* Villarroel C (ed), La acreditación universitaria: una ilusión de la calidad. CNU-OPSU, Caracas.
10. OIE International Office of Epizootics. 2013. Final recommendations, OIE global conference on veterinary education and the role of the veterinary statutory body. OIE Global Conferences on Veterinary Education, Foz do Iguazu (Brazil). [Online] http://www.oie.int/eng/A_EDUVSB2013/recommendations/A_Recommendations_Brazil_Final.pdf
11. UNESCO – Instituto Internacional para la Educación Superior en América Latina y el Caribe. 2016, posting date. INFOACES, Integrated information system for higher education institutions in Latin America for the common higher education area with Europe. [Online] UNESCO-IESALC. http://www.iesalc.unesco.org.ve/index.php?option=com_content&view=article&id=2649:infoaces&catid=62:proyectos&Itemid=716.
12. UNESCO-Instituto Internacional para la Educación Superior en América Latina y el Caribe. 2016, posting date. Recognition. [Online] UNESCO-IESALC http://www.iesalc.unesco.org.ve/index.php?option=com_content&view=article&id=3428&Itemid=1439&lang=en
13. Díaz-Barriga Arceo F. 31 May 2012, posting date. Reformas curriculares y cambio sistémico: una articulación ausente pero necesaria para la innovación. RIES, III:23–40 [Online] <https://www.ries.universia.unam.mx/index.php/ries/article/view/63/249>
14. Universidad Autónoma de Baja California. 2003, posting date. Plan de estudios de veterinaria. [Online] Instituto de Investigaciones en Ciencias Veterinarias. <http://iicv.mx/abc.mx/index.php/mnuprogramaeducativos/mnuvetlicenciatura/mnuvetinforme-de-actividades-5>
15. Climent J. 2014. Tipología de las competencias en educación veterinaria. *Rev Inv Vet Perú* 25:293–316.
16. Nassar-Montoya F. 2012. *¿Están preparadas las ciencias veterinarias y zootécnicas para el futuro?: una visión desde Colombia*. *Rev MVZ Córdoba* 17:2928–2935.
17. Climent J. 2014. Un acercamiento a las competencias de la educación veterinaria en México y España. *Rev Mexicana Agronegocios XVIII*:761–772.
18. Jacobs C. 2006. Career opportunities in public health: one veterinarian's experience. *J Vet Med Educ* 33:558–560.
19. Taffarel AC. 2015. Aspectos do papel do médico veterinário na saúde pública, o ensino curricular e o conceito de ONE HEALTH: revisão de literatura e considerações. Bachelor thesis. Universidade Federal do Rio Grande do Sul. Faculdade de Veterinária. Curso de Medicina Veterinária, Rio Grande do Sul. [Online] <http://www.lume.ufrgs.br/bitstream/handle/10183/127673/000974429.pdf?sequence=1>
20. Miller R, Hardin L, Cowart L, Ellersieck M. 2004. Practitioner-defined competencies required of new veterinary graduates in food animal practice. *J Vet Med Educ* 31:347–365.
21. Posey D, Hoffsis G, Cullor J, Naylor J, Chaddock M, Ames T. 2012. Preparing students for careers in food-supply veterinary medicine: a review of educational programs in the United States. *J Vet Med Educ* 39:257–262.
22. Maccabe AT, Matchett KE, Hueston WD. 2008. The need for public-health veterinarians as seen by future employers. *J Vet Med Educ* 35:269–274.
23. Schurig G, Osburn B. 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.
24. North American Veterinary Medical Education Consortium. 2011, posting date. Roadmap for veterinary medical education in the 21st century: responsive, collaborative, flexible. [Online] Association of American Veterinary Colleges. http://www.aavmc.org/data/files/navmec/navmec_roadmapreport_web_booklet.pdf
25. Atlas R, Maloy S. February 2014, posting date. The future of ONE HEALTH. *Microbiol Spectr* 2(1): doi:10.1128/microbiolspec.OH-0018-2012.

26. Clímént J. 2014, posting date. Supuestos básicos del enfoque de competencias en educación superior. La educación veterinaria como marco de análisis. REDIE 16:71–90 [Online] <http://redie.uabc.mx/redie/article/view/710/921>
27. Blanco M, Cutuli MT, Doménech A, Domínguez G, Gibello A, **Gómez-Lucía E.** 2010. Inmunotrivial: un juego de autoevaluación para el aprendizaje de la inmunología, p 75–80. *In V Jornadas Campus Virtual UCM: buenas prácticas e indicios de calidad.* Universidad Complutense de Madrid, Madrid [Online] <http://eprints.ucm.es/10595/1/Blanco.pdf>
28. Doucet M, Vrins A. 2009. The importance of knowledge, skills, and attitude attributes for veterinarians in clinical and non-clinical fields of practice: a survey of licensed veterinarians in Quebec, Canada. *J Vet Med Educ* 36:331–342.
29. Carrero L. 2018. Necesidades educativas en el área de inmunología para la formación de médicos veterinarios en Venezuela. *Rev Med Vet (B Aires)* 99:5–13.
30. Rosol T, Moore R, Saville W, Oglesbee M, Rush L, Mathes L, Lairmore M. 2009. The need for veterinarians in biomedical research. *J Vet Med Educ* 36:70–75.
31. Arias F. 2006. La investigación científica, p 21–36. *In Arias F (ed), El proyecto de investigación, introducción a la metodología científica.* Episteme, Caracas.
32. Peacock J, Peacock P. 2011. Cross-sectional studies, p 32–33. *In Peacock J, Peacock P (ed), Oxford handbook of medical statistics.* Oxford University Press, Oxford.
33. Peacock J, Peacock P. 2011. Sampling strategies, p 54–55. *In Peacock J, Peacock P (ed), Oxford handbook of medical statistics.* Oxford University Press, Oxford.
34. Díaz NC. 2011. Comparación de proporciones. *Rev Soc Esp Enferm Nefrol* 2011:149–164.
35. Balzarini M, Gonzalez L, Tablada M, Casanoves F, Di Rienzo J, Robledo C. 2018. Análisis multivariado, p 167–232. *In Balzarini M, Gonzalez L, Tablada M, Casanoves F, Di Rienzo J, Robledo C (ed), InfoStat Manual del Usuario.* Brujas, Córdoba.
36. Castañón N. 2009. Didáctica en educación superior, p 13–23. *In Castañón N (ed), Pedagogía de la educación superior.* Universidad Metropolitana, Caracas.
37. Benítez M. 2010. El modelo de diseño instruccional ASSURE aplicado a la educación a distancia. *Tlatemoani* 1:1–12.
38. Luzardo M. 2004. Herramientas nuevas para los ajustes virtuales de la educación. análisis de los modelos de diseño instruccional. PhD thesis. Tecana American University, Miami, FL.
39. Villarroel C. 2007. Evaluación y acreditación europeas, p 103–132. *In Villarroel C (ed), La acreditación universitaria: una ilusión de la calidad.* CNU-OPUSU, Caracas.
40. Taylor J, Parra H, de Cervantes R. 2012, posting date. Competencias profesionales del recién egresado de la carrera de medicina veterinaria en Latinoamérica, p 147–152. *In Taylor J (ed), Competencias profesionales en medicina veterinaria.* [Online] FAO (Food and Agriculture Organization of the United Nations). http://www.panvet.org/wp-content/uploads/2014/10/Competencias-MV_2012.pdf
41. Díaz-Barriga Á. 30 September 2011, posting date. Competencias en educación. Corrientes de pensamiento e implicaciones para el currículo y el trabajo en el aula. RIES. 11:3–24 [Online] <https://www.ries.universia.unam.mx/index.php/ries/article/view/44/173>
42. Nassar-Montoya F. 2012. Políticas educativas y educación profesional: análisis colombiano desde la veterinaria. RCCP 25:151–159. [Online] http://www.panvet.org/wp-content/uploads/2014/10/Competencias-MV_2012.pdf
43. Frago F. 2012, posting date. Competencias del médico veterinario desde la perspectiva de la OIE, p 53–66. *In Taylor J (ed), Competencias profesionales en medicina veterinaria.* [Online] FAO (Food and Agriculture Organization of the United Nations). http://www.panvet.org/wp-content/uploads/2014/10/Competencias-MV_2012.pdf
44. Universidad de Deusto, Universidad de Groningen. 2007. Reflexiones sobre las unidades de medida de trabajo del estudiante para el aprendizaje en América Latina, p 291–302. *In Beneitone P, Esquetini C, González J, Maletá MM, Siufi G, Wagenaar R. (ed), Reflexiones y perspectivas de la educación superior en América Latina informe final-proyecto Tuning-América Latina 2004–2007.* Publicaciones de la Universidad de Deusto, Bilbao.
45. Cadoche L, Prendes M. 3 March 2010, posting date. Competencias sociales requeridas y observadas en alumnos de medicina veterinaria: la visión de los docentes. REDVET, 11:1695–7504. [Online] www.veterinaria.org/revistas/redvet/n030310/031003.pdf
46. Barth M, Godemann J, Rieckmann M, Stoltenberg U. 2007. Developing key competencies for sustainable development in higher education. *IJSHE* 8:416–430.
47. Universidad Nacional Experimental “Francisco de Miranda.” 2015, posting date. Plan Estratégico Institucional 2016–2020 [Online] Universidad Nacional Experimental “Francisco de Miranda.” http://unefm.edu.ve/avisos/planversionplus_final.pdf
48. Bello ME. 2009. Sistema modular: propuesta para el diseño de programas de asignaturas, p 123–153. *In Castañón N (ed), Pedagogía de la educación superior.* Universidad Metropolitana, Caracas.
49. Botto M. 2015, posting date. La transnacionalización de la educación superior: ¿qué papel juegan los nuevos regionalismos en la difusión de estas ideas? El caso del MERCOSUR (1992–2012) en perspectiva comparada. RIES. 16:90–109 [Online] <https://www.ries.universia.unam.mx/index.php/ries/article/view/153/606>
50. Solanas F. 31 January 2014, posting date. Intercambio cooperativo versus mercantilización competitiva: las políticas de movilidad académica en el MERCOSUR y la Unión Europea. RIES. 15:3–22 [Online] <https://www.ries.universia.unam.mx/index.php/ries/article/view/107/422>