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**Abstract:** Veterinary undergraduates, after completion of five academic years, need to have developed a set of skills to be able to work as practitioners, for that reason it is necessary to train highly qualified veterinary pathologists.

Sheep as an educational model in animal pathology offers veterinary students the opportunity to study with an easy-to-handle animal that has a wide and varied pathology, offering an excellent training method for veterinary undergraduates.

In the present educational model, sheep are treated as individual patients; a thorough individual examination is made with all laboratory tests that are considered necessary. Undergraduates can study main sheep pathologies but also individual pathologies as it is normally done in small animals. Their final diagnosis is confirmed by necropsy, so they can check if there is a substantial agreement or disagreement between clinical and pathologic diagnoses.

The last relevant point is the feedback to the productive sector. The information gained is directly transferred to the farmers and this has obvious benefits in terms of flock health planning or disease surveillance.

The opinion of students was obtained from a questionnaire and it provided an encouraging and valuable information and feedback.

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**A NOVEL TEACHING SYSTEM: SHEEP AS AN  
EDUCATIONAL MODEL IN ANIMAL PATHOLOGY**

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19 **Abstract**

20 Veterinary undergraduates, after completion of five academic years, need to  
21 have developed a set of skills to be able to work as practitioners, for that reason it is  
22 necessary to train highly qualified veterinary pathologists.

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24 opportunity to study with an easy-to-handle animal that has a wide and varied  
25 pathology, offering an excellent training method for veterinary undergraduates.

26 In the present educational model, sheep are treated as individual patients; a  
27 thorough individual examination is made with all laboratory tests that are considered  
28 necessary. Undergraduates can study main sheep pathologies but also individual  
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30 by necropsy, so they can check if there is a substantial agreement or disagreement  
31 between clinical and pathologic diagnoses.

32 The last relevant point is the feedback to the productive sector. The information  
33 gained is directly transferred to the farmers and this has obvious benefits in terms of  
34 flock health planning or disease surveillance.

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36 encouraging and valuable information and feedback.

37

38 **Keywords**

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40

41 **Introduction**

42 The European Space for Higher Education (ESHE) was promoted in Europe  
43 after the Bologna Declaration and should have been implemented in 2010. It is for that  
44 reason that all Spanish Universities are undergoing important changes to adopt a

45 common framework of comparable degrees, also in Veterinary Medicine. Furthermore,  
46 educational changes are promoted from ESHE, particularly focused on specific  
47 professional competences for veterinary students. Veterinary undergraduates have to  
48 develop a set of skills that include technical competencies, effective communication,  
49 decision making and professionalism (Baillie, Pierce et al. 2010).

50 Students get a Veterinary degree after completion of five academic years and are  
51 supposed to have been trained to work as clinicians. Recent reports project a deficiency  
52 of veterinary pathologists, indicating a need to train highly qualified veterinary  
53 pathologists, particularly in academic veterinary medicine (Lairmore et al. 2007).  
54 Veterinary students claim more clinical learning during their last years at university. It  
55 was a historic demand by 3<sup>rd</sup> year students to be able to compare healthy animals with  
56 sick animals when they were learning clinical exploration.

57 Faced with the request made by students about increasing the number of clinical  
58 practices, it has been designed a novel teaching system, using sheep as an educational  
59 model, not only for ruminants but also for general clinical training. There are multiple  
60 reasons to use sheep as clinical educational model that will be developed throughout the  
61 text.

62 This system has been used since the academic year 2004-2005 with very  
63 encouraging results. In this paper we will explain the implementation and operation of  
64 this teaching system and feedback from students.

65

## 66 **Material and Methods**

67 In a geographical area with more than 2 million sheep, the use of these animals  
68 in the veterinary clinical training is a claim for the students and a reality for lectures.  
69 Sheep is an animal easy to handle by students, with a varied range of pathologies, not  
70 difficult to get in the area and cheap. Undergraduates can perform clinical exploration;

71 tests and treatments without the pressure of the owner and they can follow all the  
72 process, concluding at the post mortem room with necropsy.

73 During these years we have received the support of the University of Zaragoza  
74 with the projects of Teaching Innovation that it grants. The first was gained in the  
75 academic year 2004-2005; afterwards, we got other innovation projects in 2008-2009,  
76 2009-2010 and 2010-2011.

77 Teaching planning and operation is supported by the following steps:

78 1. Animals. Sheep are admitted at the Faculty in two different ways:

79 a. At the beginning of each academic semester, one of the involved teachers  
80 visits the collaborating farms to choose sheep that are considered  
81 interesting for our practices. A good selection allowed us to have a high  
82 mixed casuistry. Each sheep usually have different pathologies. The  
83 price of the animals is very low because animal selected usually have  
84 some pathological or productive problems.

85 b. External consultancy: farmers and clinicians bring sick animals to the  
86 Faculty to be diagnosed. Examination and treatment is performed by  
87 students with the help of teachers in the established practices during the  
88 5<sup>th</sup> year.

89 2. Animal Transport. At the beginning of the process, it was a problem to take the  
90 animals to the Faculty because animal transport has an important cost and it  
91 takes many bureaucratic procedures. From the Ruminant Service an agreement  
92 with the local government was promoted to reduce the bureaucracy and another  
93 one with a local cooperative to lower the price of the transport.

94 3. Animal feeding and housing: animals are housed at the facilities of the Service  
95 Support of the Veterinary Faculty. Sheep stay there for no longer than 6 months  
96 and they are treated to improve their general health status. At the end of the

97 period, most of the animals are euthanized and examined at the post mortem  
98 room.

99 4. Transfer to livestock sector. The collaboration of the farmer is essential for the  
100 system to work properly. Information needs to be transferred to producers in  
101 order to ensure a good operation of the procedure.

102 The selected animals are used during the academic year in different subjects. In all  
103 cases strictly according to the recommendations of the Ethics Committee on Animal  
104 Use in Veterinary Practice.

105 Clinical Propaedeutic, Medical Pathology, Farm Animals Nutritional Pathology and  
106 Clinical Rotation are the subjects in which these sheep are used. Students from 3<sup>rd</sup> year  
107 learn to develop clinical exploration and management; students from 4<sup>th</sup> year learn  
108 clinical pathology and anatomic pathology and 5<sup>th</sup> year undergraduates develop  
109 prevention and treatment of the animals coming from external consultancy.

110 Over these years, a survey of the main casuistry found in our sheep has been  
111 conducted. A clinical record is filled in any clinical exploration of the animals and all  
112 these data are entered into a database with the laboratory tests that have been performed  
113 and with the anatomopathological findings from the necropsy. With all this data a  
114 statistical study is carried out to find out the main casuistry. The statistical program  
115 SPSS 12.0 was used to perform the tests.

116 Furthermore, the educational model has been evaluated by students through a  
117 questionnaire. They were asked to complete it anonymously and immediately after the  
118 practices. This assessment was performed in the Small Ruminant Clinical Rotation  
119 practice and after the Medical Pathology small ruminant practices, during the academic  
120 year 2010-2011 to gather complete feedback.

121 The questionnaire was designed in two parts:

- 122 • First part: Three quantitative questions (1-5) aiming to assess the importance  
123 given to these practices within their general clinical training (1<sup>st</sup> question) and  
124 within their particular ruminant training (2<sup>nd</sup> question). The third question  
125 assesses the general satisfaction obtained in these practices.
- 126 • Second part: This part evaluates the ruminant practices undertaken during all the  
127 university years. The first question of the second part asks if the ruminant  
128 practices developed during the course have been sufficient, insufficient or  
129 excessive for them. The second is a Y/N question about whether they want to  
130 work with ruminants in their professional life or not. And the third question asks  
131 students to mark from 1 to 6 their preferences for the future: horses, pets,  
132 exotics, ruminants, swine or veterinarian without animal contact.

133

## 134 **Results**

### 135 *Casuistry*

136 The number of animals has increased progressively in the last five years. In the  
137 academic year 2006-2007 the number of sheep was 46 ewes and 7 lambs and in the  
138 present academic year 2010-2011 we have managed 121 adult sheep and 12 lambs. In  
139 the last five years, the total number of animals used at the practices has been 365 adults  
140 and 56 lambs (Figure 1).

141 In this small group it has been possible to diagnose a wide and varied pathology.  
142 Frequently, it is possible to observe several pathologies in the same animal, usually one  
143 severe illness, which caused the confiscation, and one or more other different secondary  
144 diseases that, nevertheless, have a high academic interest (Table 1).

145 At this casuistry it is important to differentiate between:

- 146 • Relevant diseases for the sheep clinical activity, as respiratory, mammary and  
147 digestive diseases.

148 • Individual diseases that are not very relevant in the daily sheep veterinarian  
149 activity but with a high teaching interest. For example, ear, eyes or  
150 cardiovascular conditions are not very relevant for sheep industry, but they have  
151 a big interest for general clinical training of veterinary undergraduates.

152 Clinical and pathological study is performed to most of the animals. In this way it is  
153 possible to go deeper into more pathological information obtained from our sheep. By  
154 way of example: with the data obtained from clinical examination and necropsy of 139  
155 animals with respiratory diseases, it was possible to diagnose the following conditions:

- 156 • Nostrils conditions: rhinitis and tumours: 19
  - 157 ○ Oestrosis: 11
  - 158 ○ Enzootic intranasal tumour: 3
  - 159 ○ *Salmonella diarizonae* upper respiratory tract infection: 5
- 160 • Tracheal conditions: stenosis and deformation: 67
- 161 • Mediastinal lymph nodes abscesses: 25
- 162 • Lung disturbance: pneumonia, oedema, pleurisy, abscesses...: 58
  - 163 ○ Gangrenous pneumonia: 16
  - 164 ○ Verminous pneumonia: 6
  - 165 ○ Pulmonary Maedi: 19
  - 166 ○ Adenomatosis: 5
  - 167 ○ Other conditions: 12

168

### 169 *Subjects involved*

170 Several subjects are involved thank to the enormous casuistry and the high  
171 number of animals. Furthermore, graphic material used for teaching has been obtained  
172 from these animals during these years and, besides, some case reports have been  
173 published from the clinical cases that have been diagnosed. This is just anecdotal



174 because the main point is that students have the opportunity to explore, diagnose and  
175 treat a wide variety of pathologies in live animals.

176 A great advantage of the model is demonstrated by the large number of subjects  
177 and lectures involved. Moreover the number of students taking advantage of the model  
178 is very important. When animals are admitted at the Service Support facilities, they are  
179 distributed according to the pathology and needs of the involved subjects. These are:

180 • Clinical Propaedeutic (3<sup>rd</sup> year, four-month long core subject-180 students).

181 Students learn clinical exploration of these animals for 10 hours. They have a  
182 great opportunity to explore varied pathology which is very useful to learn the  
183 differences between what is normal and what is not. Until 2005, third year  
184 student explored healthy animals and it was a historic request by them to be  
185 able to compare healthy animals to sick animals.

186 • Medical Pathology: (4<sup>th</sup> year, annual core subject-180 students). Each student  
187 spends 15 hours in these practices with sheep. They perform the clinical  
188 examination, diagnosing major diseases with the help of the teacher and  
189 recommending the necessary laboratory tests. To guide the exploration they  
190 have a clinical record that must be filled in.

191 • Anatomic Pathology (4<sup>th</sup> year, annual core subject-180 students). All sheep are  
192 sent to the post mortem room and students perform necropsies and interpret  
193 pathological findings with the help of their teacher. During the 4<sup>th</sup> year they can  
194 go through all the clinical findings until confirmation is made by means of the  
195 necropsy results. This fact improves clinical teaching to a reasonable extent.

196 • Farm Animal Nutritional Pathology (5<sup>th</sup> year, four-month long elective subject-  
197 40 students). Each student spends 15 hours in nutritional practices and farm  
198 control.

199       • Clinical Rotation: (5<sup>th</sup> year, annual core subject-180 students). Each student  
200           spends 6 hours working with sheep. Animals referred to the Ruminant External  
201           Consultancy from other clinicians or farmers are explored, diagnosed and  
202           treated by these students.

203

#### 204 *Students' assessment*

205           Feedback was gathered from students during the academic year 2010-2011 by  
206           means of a questionnaire, which was returned by 154 students out of 180 (85.55%  
207           response rate) in Medical Pathology (4<sup>th</sup> year) and 138 students out of 180 (76.66%  
208           response rate) in Small Ruminant Clinical Rotation (5<sup>th</sup> year).

209           In the first part of the questionnaire we tried to gain students' consideration about  
210           the sheep practices in three quantitative questions from 1-5. First question asked them  
211           about the importance of the practices in their general clinical training, second was about  
212           the importance within their particular ruminant training and the third question assessed  
213           the general satisfaction obtained in these practices. The questionnaire was offered in  
214           two subjects: Medical Pathology and Small Ruminants Clinical Rotation and the results  
215           were as follows:

- 216       • Medical Pathology (n=154). The average was 4.17, 4.51 and 3.93, in the first,  
217           second and third question, respectively (Figure 2).
- 218       • Small Ruminant Clinical Rotation (n=138). The average was 4.28, 4.63 and  
219           4.31, in the first, second and third question, respectively (Figure 3).

220           Furthermore, we studied the relationship between their opinion and their  
221           professional preference (Figure 2 and 3). There were no significant differences, from  
222           which we can draw that, generally speaking, undergraduates consider these practices  
223           very important for their general clinical training.

224 The second part of the questionnaire consisted of three questions: The first one  
225 evaluated the opinion of undergraduates about the number of hours they spent on  
226 ruminants during the university years (Figure 4). These results show the different  
227 opinion of students depending on their professional interest. And it is possible to draw  
228 that in the 5<sup>th</sup> year, students have a more global point of view.

229 The other two questions of this part referred to occupational preferences.  
230 Nowadays, there has been a decline in the number of graduates entering food supply  
231 Veterinary Medicine careers and most of the undergraduates asked show their  
232 preference for working with pets. In our survey we have obtained the same results;  
233 approximately half of the students chose as first option small animals as their  
234 professional vocation. The second were ruminants, with 16% and 20% in 4<sup>th</sup> and 5<sup>th</sup>  
235 year respectively, but we have to take into account that the questionnaire was offered to  
236 students at the end of the ruminant practices, so it was probably a partially biased  
237 opinion. The species for which students exhibited less interest were swine and poultry  
238 (4%).

239

## 240 **Discussion**

241 Teaching and learning clinical skills is increasingly challenging mainly due to  
242 heightened awareness of animal welfare, increased number of students and reduced  
243 working hours. In this context, novel educational methods have to be implemented  
244 (Baillie, Pierce et al. 2010).

245 Sheep as an educational model in animal pathology offers veterinary  
246 undergraduates the opportunity to study with an easy-handle animal that has a wide and  
247 varied pathology, offering an excellent training method for veterinary undergraduates.  
248 Furthermore, the educational use of this species has low economic cost, mainly in  
249 comparison with other species. Besides, as is made a deep individual examination with

250 all laboratory tests that are considered necessary, undergraduates can study main sheep  
251 pathologies but also individual pathologies, as it is normally done in dogs and cats. The  
252 study of most of the pathologies (except digestive pathologies) can be extrapolated from  
253 one species to another.

254 Students can learn how to handle sheep successfully, which allows them to  
255 become increasingly confident in their abilities. Professional bodies require veterinary  
256 graduates to demonstrate the ability to handle and restrain animals safely and humanely.  
257 Furthermore, students who are confident with one species are often ready to learn easily  
258 from another (Austin et al., 2007).

259 Undergraduates have the opportunity to work directly with the animal as if they  
260 were already clinicians, playing a vet-role, highly valued by students. With this method  
261 students incorporate many skills, including technical competencies, effective  
262 communication and decision making (Baillie, Pierce et al. 2010). Students have to step  
263 up to veterinarian status, need to apply and combine a variety of skills and have to take  
264 on the responsibilities associated with their future position. In other species, as pets or  
265 horses, with the owner present, students have, unfortunately, their activity reduced.

266 Clinical examination is the basic foundation upon which the practitioner must  
267 build an investigation of disease or sub-optimal performance. Veterinary students must  
268 acquire the skills to interpret the range of clinical signs displayed by animals. This can  
269 only be obtained through practice. And although gathering of a detailed history and  
270 examination of both the environment and the flock is very important, the detailed  
271 physical examination of the individual is essential and highly relevant (Lovatt, 2010).  
272 Undergraduates develop all the monitoring and clinical exploration of each clinical case  
273 and 5th year students also carry on an anamnesis in those animals that are referred to the  
274 Small Ruminant External Consultancy.

275 Most animals died or were euthanized, so necropsy was performed in all of them  
276 by students, during the Anatomic Pathology practices (4<sup>th</sup> year). Besides, all  
277 undergraduates can go to the post mortem room to follow the cases. That is a very  
278 interesting point because students can confirm their diagnosis and see if there was a  
279 substantial agreement or disagreement between clinical and pathologic diagnoses. In  
280 studies comparing ante-mortem and post-mortem findings in dogs, which either had  
281 died or were euthanized, there was a total disagreement between the clinical and  
282 pathologic diagnoses in approximately a third of the cases (Kent, Lucroy et al. 2004;  
283 Vos, Borst et al. 2005). Necropsies are essential for the confirmation of the diagnosis  
284 and it is a challenge for undergraduates to follow all the process to confirm their  
285 diagnoses.

286 In addition, pathology training is heavily dependent on images, for this reason in  
287 many Veterinary faculties simulators, videos or other methodologies related to images  
288 have been developed (Pospischil, Djamei et al. 2007). In our educational method, with  
289 1501 different pathologies it has been possible to obtain many graphic materials to be  
290 used in lectures, as well as some international journal articles used by students as  
291 bibliography. Furthermore, an open website with a database of images has been created,  
292 where students can find images of different breeds, pathologies and clinical cases:  
293 <http://www.fotovet.es>.

294 The last relevant point is the feed back to the farmer. The information obtained  
295 from monitoring, clinical examination and necropsy of the animals is directly  
296 transferred to the farmers and this has obvious benefits in terms of flock health planning  
297 or disease surveillance. Moreover, it represents an important issue at university because  
298 it creates a link between the university research and the productive sector. With this  
299 educational model farmers get all the information about their animal diseases and how  
300 to prevent them. Farmers show us their gratitude and awareness of the system.

301 Teacher satisfaction is a personal feeling which is difficult to quantify but  
302 feedback from students and watching them as they improve their skills encouraged the  
303 staff involved in these practices to keep on working in the future. Additionally, the  
304 obtained material has permitted us to publish some case reports (Lacasta,D. 2009;  
305 Ferrer,L.M. 2011; Lacasta,D. 2011) and has improved the transfer to the productive  
306 sector.

307 The opinion of students obtained from questionnaires provided valuable  
308 information and feedback, but it would be useful to conduct further studies with more  
309 objective measures of skill development in the future.

310

## 311 **References**

312

- 313 Austin, H. E.; Hyams, J. H.; Abbott, K. A. (2007). "Animal Handling: A Critical  
314 Component of Veterinary Education." *Journal of Veterinary Medical  
315 Education*,34(5): 566-575.  
316
- 317 Baillie, S., Pierce, S. E. et al. (2010). "Fostering integrated learning and clinical  
318 professionalism using contextualized simulation in a small-group role-play".  
319 *Journal of Veterinary Medical Education*, 37(3): 248-253.  
320
- 321 Ferrer,L.M.; Lacasta,D.; Ramos,J.J.; García,del Jal; Ruiz,de Arcaute; Conde,T. (2011)  
322 "Squamous cell carcinoma of the vagina and cervix in sheep - case report" *Acta  
323 Vet Hung* 59 (1) 123-127  
324
- 325 Kent, M. S., Lucroy ,M. D. et al. (2004). "Concurrence between clinical and pathologic  
326 diagnoses in a veterinary medical teaching hospital: 623 cases (1989 and 1999)".  
327 *Journal of the American Veterinary Medical Association*, 224(3): 403-406.  
328
- 329 Lacasta, D.; Ruíz, S.; Ramos, J.J.; Ferrer, L.M.; Fernández, A. (2011) "Tetralogy of  
330 Fallot in a three-month old lamb: Clinical, Ultrasonographic and Laboratory  
331 Findings" *Vet Rec* 169, xx cite as doi:10.1136/vr.d2609  
332
- 333 Lacasta,D.; Ferrer,L.M.; Ramos,J.J.; Ortín, A.; Vela,A.I.; Latre,M.V.(2009) "Unilateral  
334 scrotal pyocele in ram caused by *Staphylococcus capitis*". *Aus Vet J* 87(12) 484-  
335 486  
336
- 337 Lairmore, M. D.; Oglesbee, M.; Weisbrode, S. E.; Wellman, M.; Rosol, T.; Stromberg,  
338 P. (2007) " Developing and fostering a dynamic program for training in veterinary

339 pathology and clinical pathology: veterinary students to post-graduate education."  
340 Journal of Veterinary Medical Education 2007 Vol. 34 No. 4 pp. 464-472

341

342 Lovatt, F. M. (2010). "Clinical examination of sheep". Small Ruminant Research,  
343 92(1/3): 72-77.

344

345 Pospischil, A., Djamei, V. et al. (2007). "Introduction to the Swiss way of teaching  
346 veterinary pathology in the twenty-first century: application of e-learning  
347 modules". Journal of Veterinary Medical Education, 34(4): 445-449.

348

349 Vos, J. H., Borst, G. H. A. et al. (2005). "Comparison of clinical and pathological  
350 diagnoses in dogs". Veterinary Quarterly, 27(1): 2-10.

351

352

Table 1: It shows the diseases diagnosed in 365 adult sheep during these years.

353

<b>Pathology</b>	<b>Number of affected animals</b>	<b>Percentage</b>
General disease	301	82.5%
Mucous, skin and wool conditions	284	77%
Mouth, teeth and jaw conditions	277	75.8%
Respiratory diseases	139	38.0%
Digestive and abdominal diseases	30	8.2%
Mastitis	161	44.1%
Limbs diseases	170	46.6%
Eye diseases	65	17.8%
Ear diseases	7	1.9%
Genitourinary conditions	45	12.2%
Primary lymphadenitis	8	2.12%
Cardiovascular disease	7	2%
Behavioural and nervous conditions	7	2.0%
<b>Total</b>	<b>1501</b>	

354

355

356 Figure 1. Total number of animals used at clinical practices from 2006 to 2011.

357 Figure 2. Average rating given by Medical Pathology students grouped by occupational  
358 preferences (n=154).

359 Figure 3. Average rating given by Small Ruminant Clinical Rotation students grouped  
360 by occupational preferences (n=138).

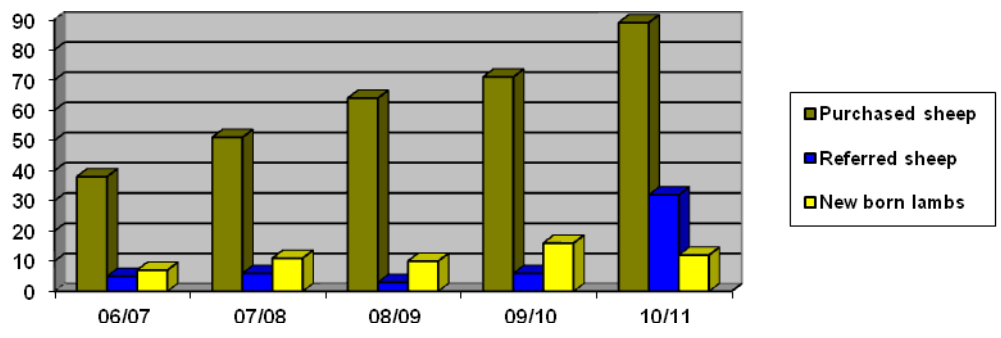
361 Figure 4: Medical Pathology students' opinion about the number of hours spent on  
362 ruminants during the university years (n=154).

363 Figure 5: Small Ruminant Clinical Rotation students' opinion about the number of  
364 hours spent on ruminants during the university years (n=138).

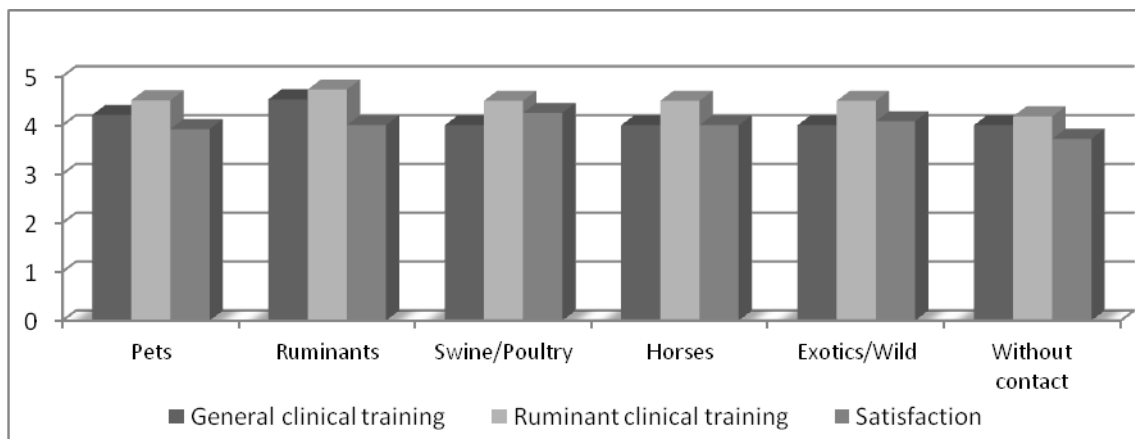
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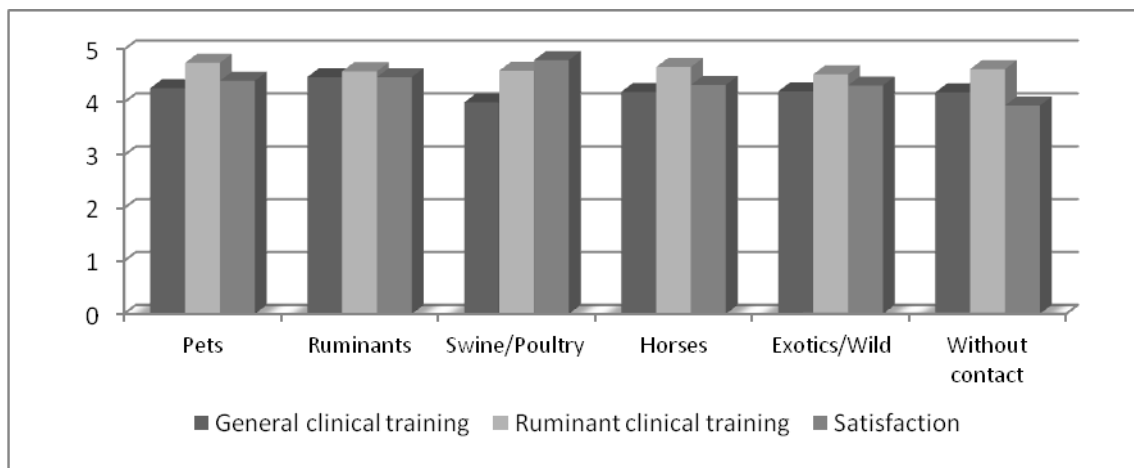
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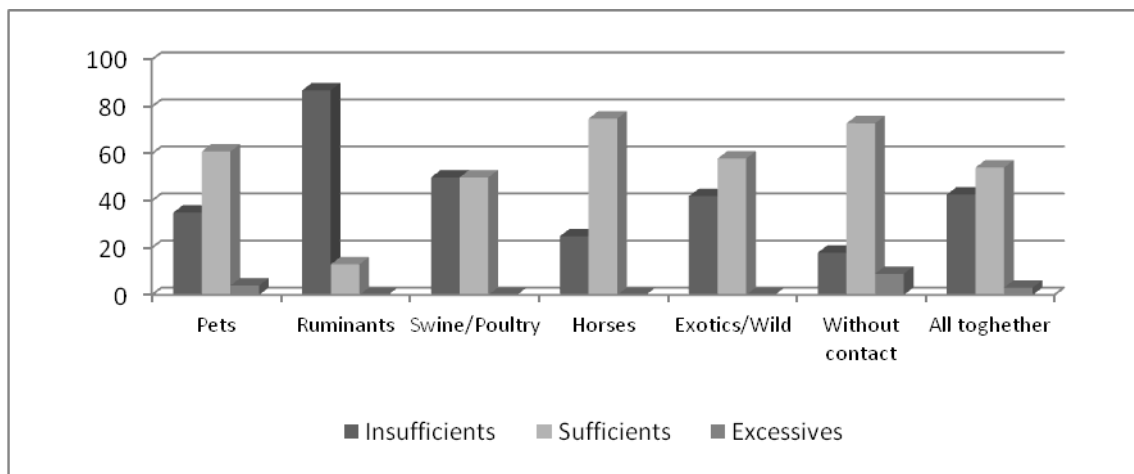
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