

E-learning course in laboratory animal science: participants' characteristics and points of view

Siavash Ahmadi-Noorbakhsh (✉ s.noorb@gmail.com)

Tehran University of Medical Sciences <https://orcid.org/0000-0001-6293-670X>

Jila Sadighi

Institute for Health Sciences Research, ACECR

Ehsan Shamsi Gooshki

Tehran University of Medical Sciences

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Abstract

Proper education in laboratory animal (LAN) science is a legal requirement and necessity of good scientific practice. The education could be delivered via traditional face-to-face methods or modern e-learning modalities. E-learning has the advantages of continuous availability (24/7), no geographical restriction, requiring no commuting to/from a venue, less cost, unlimited number of attendees, and less burden on lecturers. A successful e-learning course (e-course) should be relevant to the characteristics, needs, and interests of its audience. To define these qualities, we developed a 22.5 hours e-course and enrolled attendees for a year. We then developed an online researcher-made questionnaire to investigate the sociodemography, animal use experience, interaction with animals, course enrolment factors, and course completion factors among the participants. We found that the majority of participants were female paramedical Ph.D. students in their thirties who needed to use animals (mostly rats) for their theses. Most of them had 0–2 years of work experience with LAN and had a very positive relationship with animals. The most important topics selected by the participants included ethics, guidelines, anesthesia/analgesia, pain recognition and methods of animal use. Participants were very concerned with the ethical implications of animal studies and the effect of the study on animal welfare. Practical training was the most sought-after topic for further education. Having long-term access to the course content was the most wanted feature. In conclusion, for developing a successful e-course one should consider the characteristics, needs, and interests of the majority of attendees as discussed above.

Introduction

Scientific use of animals requires a fair amount of knowledge and a proper attitude¹. This is not only a legal requirement^{2–6}, but is a necessity for preserving animal welfare and scientific integrity of research^{2,7,8}. In fact, the lack of training leads to poor performance that costs too much for researchers, animal care personnel, research institutions, and even the whole structure of biomedical research in a country⁹. However, studies show that there are unmet educational needs among a large number of LAN researchers¹⁰.

Traditional methods of education are mainly based on face-to-face sessions. These have certain advantages such as enhancing learning by quick feedback between the lecturer and learners and fostering social interaction¹¹. However, they have several important disadvantages. For attending a face-to-face session, learners are required to be geographically close to the venue, they should be available on certain dates and times¹¹, they require to spend time and money to commute to/from the session venue, they should pay for the costs of holding a physical lecture, and only a small number of students could be taught in a single session. On the other hand, frequent holding of face-to-face sessions is a demanding task for lecturers, which may inadvertently lead to a reduction in the quality of teaching. E-learning technologies resolve these disadvantages. In addition, the Covid-19 pandemic has necessitated the use of e-learning “to keep [LAN] courses alive”¹².

E-learning in LAN science has been delivered in various formats such as ⁹: 1) Information exchange websites (e.g., CompMed); 2) Webinars; 3) Learning management system (LMS); and 4) Online courses (electronic classrooms) where specific topics in LAN science are taught using audio-visual means.

It is shown that a well-structured “online course” in LAN science could be a valuable source of knowledge for LAN veterinarians ¹³ and even undergraduate students ¹⁴.

For developing an effective e-learning online course (e-course), the characteristics, needs, and interests of its main target audience should be identified ¹⁵. The e-course content should then be tailored “relevant” to the needs and interests of these audiences ^{15–18}. This “principle of relevancy” is known as the core principle of making an effective e-course ¹⁹. The more you know about your audience’s needs, the better you will be able to meet them ²⁰.

Therefore, the question “Who is my audience?” is a fundamental question that needs to be answered early in the e-course creation. This question can be subdivided into three other main questions about participants: who are they? what they think? and what they need? We designed the current study to investigate the answers to these questions by the participants of a LAN science e-course.

Materials And Methods

This study had two parts: 1) developing the e-course; and 2) performing a survey on the participants of the e-course.

Developing the e-course

The e-course entitled “Principles of Working with Laboratory Animals” consisted of talking head and slide presentations. For developing the e-course we used a proposed framework described elsewhere ²¹. It was recorded in the Persian language from November 2019 to January 2020. The film recordings were edited and were made available online from July 2020 on the Aved Medical Education Institute website (www.aveedme.com/Courses/Details/2317). The topics, sub-topics, and duration of each part of the e-course are presented in Supplement 1 to this paper.

The e-course was accredited by the Deputy of Research and Technology in the Ministry of Health and Medical Education in July 2020. The vice chancellor for research and technology formally announced the course to related universities and research institutions (<https://bit.ly/e-courseletter>). In this announcement, the course was recommended as one of the prerequisites for receiving permission to work with animals, according to Iranian national guideline for the care and use of laboratory animals ⁵.

The e-course is open to everyone interested in the subject matter. Participants have three opportunities to take the final exam within six months after enrolling in the e-course. The final exam of the e-course

consists of 44 questions and should be completed within 44 min. The minimum passing score for the exam is 75%.

Survey

Ethical approval for this part of the study was obtained from National Institute for Medical Research Development (IR.NIMAD.REC.1400.015). This research did not involve the use of animals.

A researcher-made questionnaire was used to collect five types of information: 1) sociodemography; 2) animal use; 3) interaction with animals; 4) course enrolment factors; and 5) course completion factors. This questionnaire was provided as an online form to participants. The content of the questionnaire is presented in Supplement 2 to this paper.

We contacted those who had attended the e-course from July 2020 to August 2021 by mobile text message invitations sent by the Aved institute. To gain access to the questionnaire, each attendee was required to enter the phone number he/she had used for attending the e-course. Non-responding attendees received another text message reminder after 10 days.

Due to the extent of this study, we need to report various aspects of it in separate publications. Here, we provide the descriptive statistics to answer the questions of the current research. In this regard, Statistical Package for the Social Sciences version 18 (SPSS 18) was used for analyses. The statistical analyses were conducted using descriptive statistics function.

Results

The produced e-course has a length of 22.5 hours. From July 2020 to August 2021, 1449 people attended the e-course and were contacted to participate in this study. Of those, 234 people participated (16.2% participation).

Who are they?

Sample characterization

The mean age of the study participants was 33.1 ± 8.2 (N = 231), with a minimum of 20 and a maximum of 58 years old. The majority of participants were female with education in paramedical sciences (Table 1). There were equal numbers of people with veterinary and medical backgrounds. Science, medical specialties, and dentistry had relatively similar numbers of participants that were almost half the number of veterinary or medical (GP) participants. Interestingly, the numbers of the participants were in order of their educational level, with PhDs being the majority of the participants, and Master's, MD/DVM/DDS/PharmD, bachelor, and associate degrees were in descending order. Most of the participants were students of medical universities. The majority of staff was also affiliated with medical universities and mainly had a ranking of assistant professor or instructor.

Table 1
Socio-demography of the study participants.

Parameter	Frequency	Percentage
Gender (N = 231)		
Female	156	67.5
Male	75	32.5
Major (N = 231)		
Paramedical sciences	122	52.8
Biology	38	16.5
Pharmacology	19	8.2
Veterinary medicine	15	6.5
Medicine (GP)	15	6.5
Science	8	3.5
Medical specialties	7	3.0
Dentistry	6	2.6
Engineering	1	0.4
The current educational level (N = 231)		
PhD	114	49.4
Master's	71	30.7
MD/DVM/DDS/PahrmD	33	14.3
Bachelor	12	5.2
Associate degree	1	0.4
Educational status (N = 231)		
Students	133	57.6
Graduates	98	42.4
Place of education (N = 231)		
Medical sciences universities	117	50.6
Science, research and technology universities	61	26.4
Azad universities	47	20.3
Payam Noor (distant education)	2	0.9

Parameter	Frequency	Percentage
Research institutions	2	0.9
Overseas Universities	2	0.9
Place of work (N = 105)		
Medical sciences universities	56	53.3
Research institutions	23	21.9
Azad university	9	8.6
Science, research and technology universities	9	8.6
Ministry of Education	5	4.8
Medical personnel	3	2.9
Academic ranking (N = 62)		
32	51.6	
Instructor	21	33.9
Associate Professor	7	11.3
Professor	2	3.2

Animal use experience

The majority of participants (47.2%) had no previous experience with LAN, and 22.5% had up to one year of experience. The maximum experience was 25 years. More than half of the participants used animals for their theses (Table 2). More than half of the remaining participants used animals for non-thesis research. A small fraction of participants used animals for educational purposes. One in 10 participants had no experience of animal use at all. The rat was the most common species used by the participants. Nearly half of the participants had used mice in their projects. Dogs were used three times more than cats. Nonhuman primates were the least used species. Four in 100 participants had used other species of animals including sheep, goat, poultry, cattle, and salamander.

Table 2
Laboratory animal work experience (N = 231).

Parameter	Frequency	Percentage
For what purpose do you use laboratory animals?		
Thesis	122	52.8
Non-thesis research project	72	31.2
No animal use	24	10.4
Other purposes	7	3
Education	6	2.6
Which animal species do you use for scientific purposes?		
Rats	148	64.1
Mice	115	49.8
Rabbits	28	12.1
Guinea pigs	12	5.2
Hamsters	11	4.8
Dogs	10	4.3
Other animals	10	4.3
Marines	7	3
Insects	4	1.7
Cats	3	1.3
Nonhuman primates	2	0.9

LAN science experience

We investigated the prior exposure of participants to topics in LAN science. Approximately one-third of the participants (76 people; 32.9%) had previously attended other LAN courses. More than half of the participants (129 people; 55.8%) had no peer-reviewed articles regarding LAN. Twenty-six participants (11.3%) had one article; 19 and 13 people had two and three articles, respectively. Two of the participants had published books regarding LAN. A majority of participants (212 people; 91.8%) had no previous experience in teaching LAN courses; 18 participants had taught in 1–5 courses, and one participant had taught in 30 courses.

What they think?

Interaction with animals

A quarter of the participants (25.5%) were against animal use in science. More than half of the participants (55.9%) were in favor of animal use for scientific purposes (Table 3). If we also consider those having no idea in this regard (18.6%), we can say that three-quarters of participants did not oppose animal use for scientific purposes. Interestingly, also three-quarters of participants were very interested or interested in animals. Almost the same proportion was very interested or interested in the LAN they use. In comparison between the interest of people in general animals or LAN, we can see that the total interest is slightly higher for LAN (78.4% vs. 75.7% very interested or interested). However, interest in LAN is less intense than in general animals (39.9% vs. 45.0% very interested).

Approximately one-fifth of the participants (43 people; 18.6%) were members of animal protection groups. There were 131 participants (56.7%) who had voluntarily helped in treating sick stray animals. An amazing 88.7% of participants (205 people) used to feed or water stray animals. Approximately one-third of participants (75 participants; 32.5%) had companion animals. The companion animals included cat, squirrel, duck, bird, dog, guinea pig, rabbit, fish, chicken, cockerel, turtle, quail, adopted laboratory mouse, and rodents.

Table 3
Interaction with animals

Parameter	Frequency	Percentage
How much do you agree with the use of animals for scientific purposes? (N = 231)		
Agree	105	45.5
Disagree	47	20.3
No idea	43	18.6
Very much agree	24	10.4
Very much disagree	12	5.2
Do you generally like animals? (N = 231)		
Very interested	104	45.0
Interested	71	30.7
Intermediate	47	20.3
Not interested	8	3.5
Hate	1	0.4
Do you like the laboratory animals that you use? (N = 208)		
I Very much like them	83	39.9
I like them	80	38.5
Moderate	35	16.8
I don't like them	9	4.3
I hate them	1	0.5

Course enrollment

The advertisement had a minor role in attracting our participants. This is in accordance with the fact that the online platform (Aveed) had never had an advertising campaign for the e-course. For them, "recommendation" was the main channel for customers of the e-course. In fact, 86.5% of the participants had been recommended either by the university/research institution or their colleagues/friends to attend the e-course (Supplement 3). Other methods of knowing about the e-course were Instagram posts or the National Ethics Committee website. The participants who had voluntarily attended the e-course constituted 62.8% of the participants (145 people).

The main aims of the participants to attend the e-course were learning (77.9%) and receiving certificate (64.9%). Other aims for attending the e-course included using the experience of the course lecturer,

receiving ethics code for research projects, learning to teach the topics to other students, more confident working with animals, gaining a better feeling in working with LAN, and gaining self-assurance.

According to Supplement 3, more than 80% of participants thought the cost of the course was average to low, in comparison to the information it provided. The e-course's cost for non-students was 1.000.000 Rials (~ 4% of the minimum salary in 2020 in Iran). By applying student concession, the e-course's cost was reduced to one-fourth.

Course completion

The e-course did not affect the interest of a third of the participants in doing further research on animals (Table 4). The number of participants who became less interested in animal research due to ethical concerns was twice the number of participants who felt more interested to do animal research. A large number of participants (95.4%) were satisfied or very satisfied with the e-course. The majority of participants (77.6%) believed the e-course had very much or much effect in changing their attitude toward working with LAN. In comparison, 57.5% believed the e-course improved their technical knowledge to a much or very much extent. Also, 68.4% declared that the e-course had much or very much effect in improving the quality of their research and articles.

Most people (92.5%) were willing to recommend the e-course to others. A majority (80.5%) thought that the e-course should be delivered as a university unit and a relatively similar proportion of participants liked the e-course to be continued by a practical module. Two people (1.1%) had used the certificate of the e-course for applying for permission to use animals in foreign countries (Türkiye), of which both applications were granted.

Table 4
Course attendance experience (N = 174).

Parameter	Frequency	Percentage
The effect of the e-course on the interest of participants to do animal research.		
Less interested due to ethical concerns	78	44.8
No effect	60	34.5
More interested	36	20.7
How much are you satisfied with the content of the e-course?		
Satisfied	87	50.0
Very satisfied	79	45.4
Neither satisfied nor dissatisfied	4	2.3
Dissatisfied	3	1.7
Very Dissatisfied	1	0.6
To what extent your attitude toward working with laboratory animals has changed after attending the e-course?		
Very much	72	41.4
Much	63	36.2
Moderate	37	21.3
Very few	1	0.6
Few	1	0.6
To what extent your technical knowledge in working with laboratory animals have changed after attending the e-course?		
Moderate	63	36.2
Much	56	32.2
Very much	44	25.3
Few	10	5.7
Very few	1	0.6
To what extent attending the e-course has increased the quality of your research or your articles?		
Much	72	41.4
Very much	47	27.0

Parameter	Frequency	Percentage
Moderate	41	23.6
No effect	10	5.7
Few	4	2.3
Do you recommend attending the e-course to your friends and colleagues?		
Yes	161	92.5
No idea	11	6.3
No	2	1.1
Do you agree that the content of the e-course to be delivered as a university study unit?		
Yes	140	80.5
No	19	10.9
No idea	15	8.6
If we provide a new course to cover practical techniques in working with laboratory animals, do you attend that course?		
Yes	138	79.3
No	22	12.6
No idea	14	8

What they need?

The most important topics

To know what the participants needed from the e-course, we asked them which topics they found the most important. We also asked which topics were the least important topics for them. The results of these questions are provided in Supplement 4 to this paper. Then we ranked the topics according to their overall importance for the study population by calculating the “pure importance”. For calculating pure importance, we subtracted the number of people voting a topic as the least important, from the number of people voting that topic as the most important. The pure importance is shown in Table 5.

Table 5
Pure importance of the topics according to the participant' votes

Parameter	Frequency*	Percentage*
Ethics in laboratory animal research	49	28.2
The guideline for the care and use of laboratory animals in Iran	13	7.5
Principles of anesthesia and algesia in laboratory animals	9	5.2
Recognition of pain and distress in laboratory animals	8	4.6
Designing the method of animal use in research	8	4.6
Replacements to laboratory animals	6	3.4
Principles of substance administration to laboratory animals	5	2.9
Basic biology of common laboratory animal species	4	2.3
Humane endpoints and euthanasia of laboratory animals	4	2.3
Principles of sampling	2	1.1
Sample size calculation in animal studies	0	0.0
Selecting an animal model	-2	-1.1
Safety in laboratory animal facilities	-2	-1.1
Principles of experimental surgery	-3	-1.7
Animal care and basic standards of animal Facilities	-4	-2.3
Reporting the results of laboratory animal studies	-5	-2.9
Principles of designing interventional studies	-6	-3.4
Selecting a research topic and accessing relevant scientific resources	-12	-6.9
Principles of laboratory animal transportation	-13	-7.5
Completion of the ethics application form for laboratory animal studies	-13	-7.5
No idea	-48	-27.6
*Positive numbers represent people considering a topic as the most important; negative numbers represent people considering the topic as the least important.		

Ethics was by far the most important topic selected by the participants (Table 5). Then comes the guideline for the care and use of laboratory animals. Therefore, it seems the ethical and legal aspects of animal research were the most important topics for more than a third of the participants (35.7%). Three other topics had relatively similar popularities including anesthesia and analgesia, recognition of pain,

and methods of using animals in research. Hence, it seems pain prevention and proper use of animals were at the next level of importance for the participants.

The majority of respondents had “no idea” about the least important topics of the e-course (Supplement 4). In other words, they could not choose a topic as the least important topic. How to fill out the application form, principles of LAN transportation, and selecting a research topic were the next least important topics voted by the participants. Sample size calculation was ranked as a neutral topic, not being least important and not very important.

Interest in receiving further information

In response to the open-ended optional question “In which subject(s) regarding working with laboratory animals you like to receive more information?”, 96 participants declared 117 topics. The most sought-after topics are presented in Table 6. A quarter of participants were interested to receive further information about substance administration and sampling methods. Practical training in general was the next topic of interest. A relatively similar number of participants requested further information on surgery and anesthesia.

Only two participants (1.7%) requested further information on each of the alternatives to LAN, animal handling, and pain recognition. Other topics had only one person (0.9%) requesting further information, including: animal biology, less-common laboratory species (insects and *C. elegans*), LAN diseases, large animals, research design, safety, sample size calculation, and stem cell extraction.

Table 6
Requested topics by the participants.

Topic	Frequency	Percentage
Substance administration and sampling	30	25.6
Practical training	22	18.8
Surgery	18	15.4
Anesthesia and analgesia	14	12.0
Disease modelling	8	6.8
Animal husbandry	5	4.3
Ethics	3	2.6
Euthanasia	3	2.6

Comments/suggestions/feedback

In response to the open-ended question regarding participants’ Comments/suggestions/feedback, 105 answers were collected. Of those, 62.9% were compliments, 10.5% were keen to have long-term access to the e-course content, for example by downloading the video materials, and 9.5% requested a practical

session to be run either as an online course or in person. Other comments were: requesting a specialty course for each animal species or disease model (4.8%), declaring the exam was difficult (4.8%), requesting topics to be classified according to the requirements of participants (1.9%), and requesting to be in contact with the course lecturer during attending in the course (1%).

Discussion

Although we had a mixed population of participants, we could identify a general pattern for the majority of them. The participants were mainly female Ph.D. students in their thirties, which used animals (mainly rats) for their theses. They were mainly from the paramedical background, with none to little work experience with LAN. The majority of them had a friendly relationship with animals but did not oppose animal use in science. Two in 10 participants were members of animal protection groups. A large number of participants were concerned with the consequences of their animal research, either for themselves or for their animals. This was evident by the most important topics of the e-course they rated.

“Recommendation” was the most important route for new enrolments. Overall, the e-course was very successful in improving the attitude and knowledge of the participants. It also developed a state of moral sensitization among many of them.

One of the most important features of LAN courses is the great diversity in participants’ characteristics such as age, gender, university majors, attitude to animal use, etc. This is also documented in previous studies^{9,22}. However, looking closely, a general trend could be identified among various courses. In fact, the general characteristics of participants in our e-course were relatively similar to previous studies investigating an introductory e-learning course in LAN science²³ and also LAN courses in Switzerland²². The majority of participants in all these courses were female Ph.D. students aging 26–33 years old. In comparison, the maximum age of our participants was 17 years higher than one previous study²³ and 4 years less than the other study²². Similar to another study²³ the majority of our participants had no prior experience with LAN.

Rats were the most used species of animals among our study participants. This is in contrast to the worldwide trend of using mice as the most common animal species. We think easier instrumentation of rats could be a reason for its more popularity among our novice population of animal researchers. Practical training was the most sought-after topic following the completion of the e-course. This was in close agreement with the views of the attendants of previous studies^{22,24} that rated practical training as the most useful topic of the workshops.

The good interaction between researchers and animals (positive relationship) is shown to benefit animals, researchers, research, and the general public^{25,26}. The good interaction reduces the animals’ fear and distress²⁵, and this consequently facilitates procedures on animals. Reduced distress also lowers confounding factors and improves the scientific validity of the studies²⁶. LAN workers with a good relationship with animals are more satisfied with their jobs, have higher morale, and improved self-

worth ²⁵⁻²⁸. Good human-animal interaction in laboratories, can also address the ethical concerns of society regarding animal use in science ^{25,26}. Some methods of fostering good human-animal interaction are described elsewhere ²⁵. It is also suggested that childhood relationships with animals (even in form of images) could contribute to the development of a person's cognition about animals ^{29,30}. This cognition consequently leads to positive youth development ²⁹.

However, having good interaction with LAN may have a tradeoff ²⁵. Some people may develop a strong bond with the animals they use, such that euthanizing the animal for scientific or ethical reasons may become very stressful to them ²⁶. On the other hand, taking care of sick animals or performing procedures on favorite animals could lead to compassion fatigue in these people ³¹. There are controversies among various studies about the prevalence of this condition: some show a low prevalence of the condition ³², and some report a high prevalence ³³.

Overall, having good interaction with animals is an ideal state ²⁵ and its benefits outweigh the costs. However, it is imperative to properly address its negative consequences. In this regard, strategies are proposed to reduce morale conflicts ³⁴ and compassion fatigue ³¹ among LAN caretakers and users.

In terms of the participants' attitude to using animals in research, our results were in close agreement with a largescale previous study surveying this attitude among faculty members in a university in the US ³⁵. In both studies, the majority of participants did not oppose the use of animals in science (74.5% in our study vs. 79.2%). However, surveying undergraduate students in the same study ³⁵ showed a larger number of students opposing animal research than our study participants (35.0% vs. 25.5%).

However, when it comes to the use of animals by the e-course participants themselves, the condition changes. In fact, 44.8% of those who had completed the e-course (N = 174) declared they are less interested in performing animal research due to ethical concerns. We think that this is an informed choice that might be resulted from moral sensitization and should be respected. It is also shown in a previous study ²² that 2–6 years following compulsory LAN courses, 19% of participants had not performed any animal research, and 5% were no longer used animals. In reality, we have seen many students with little or no prior experience with LAN, who eagerly select a LAN thesis. However, when the experiments begins and they need to run procedures on animals, they suddenly lose interest but feel obliged to continue. This not only causes moral distress for the person but also endangers the scientific integrity of the research. It is also shown in a previous study ³⁶ that students of biology and medicine possessed limited knowledge of LAN experiments. Therefore, in agreement with that study ³⁶, we think appropriate information about the nature of LAN research should be provided to students in their early stages of undergraduate studies. It should then be left to them to decide whether they want to continue in this field or not.

We acknowledge that there are certain limitations to our study. Firstly, the e-course was sponsored and promoted by the Ministry of Health and Medical Education. Therefore, the large number of participants with paramedical backgrounds or medical affiliations in our study may be related to this issue. Secondly,

we had a participation rate of 16.2%, which raised the concern that our results may have been obtained from part of the population with extreme views to animal research ³⁵. This is an inherent limitation of many questionnaire-based studies, in which participants are no longer bonded with the topic in question. Nevertheless, we have shown several instances of agreement between our findings and similar findings in other larger scale studies.

Our study suggests that an inclusive e-learning course should provide materials and examples relevant to a wide range of audience characteristics. However, it seems Ph.D. students in paramedicine are the majority of the audience and should receive relatively higher attention. The course content and delivery should be mainly adjusted for adult education ³⁷ in their thirties. Since many participants attended the e-course for preparing for their theses, we suggest future courses to have a specific attention to thesis-related matters, such as need-based thesis ideation, proposal development, and designing LAN studies within budget constraints.

Our results also suggest that although many participants are not against animal studies, they very much care about animals' wellbeing. Therefore, we strongly recommend that a LAN course lecturer carefully consider this caring attitude. A genuine successful lecturer should develop a role model for animal care that may even exceed the expectations of the participants.

To reach a larger population of audiences, we suggest investing in the enrolled attendees. These people could be the best advertisers for the course on their free will. To satisfy these people, we recommend special attention to developing a caring attitude toward animals among them while building on their knowledge. In terms of knowledge delivery, a successful course should cover a range of topics relevant to attendees' functions. However, we recommend more attention to be paid to teaching ethics and regulations of animal use, anesthesia and analgesia, and pain recognition. Making the videos downloadable for the participants may add to their overall satisfaction with the course. If possible, we recommend in-person practical training to be provided to attendees that successfully complete the e-learning course.

Declarations

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References

1. Carlsson, H.-E., Hagelin, J., Höglund, A. U. & Hau, J. Undergraduate and postgraduate students' responses to mandatory courses (FELASA category C) in laboratory animal science. *Lab Anim* **35**, 188–193 (2001).
2. Zutphen, B. van. Education and Training for the Care and Use of Laboratory Animals: An Overview of Current Practices. *ILAR Journal* **48**, 72–74 (2007).
3. National Research Council (US) Institute for Laboratory Animal Research. *Guide for the Care and Use of Laboratory Animals*. (National Academies Press (US), 1996).
4. Duffee, N., Nevalainen, T. & Hau, J. Education and Training. in *Handbook of Laboratory Animal Science* (CRC Press, 2021).
5. Ahmadi-Noorbakhsh, S. *et al.* Guideline for the Care and Use of Laboratory Animals in Iran. *Lab Animal* **50**, 303–305 (2021).
6. Anonymous. Directive 2010/63/EU of the European parliament and of the council of 22 September 2010 on the protection of animals used for scientific purposes. *Official Journal of the European Union L* **276/33**, 33–79 (2010).
7. Gaafar, K. & Fahmy, S. R. Effects of Laboratory Animal Science Training on Scientists' Attitudes and Practice in Egypt. *Journal of the American Association for Laboratory Animal Science* **57**, 712–714 (2018).
8. Smith, D. Aiding mutual recognition of laboratory animal science courses through the ETPLAS initiative, the Education & Training Platform for Laboratory Animal Science. *Lab Anim* **50**, 223–224 (2016).
9. Kennedy, B. W. & Froeschl, K. *Education and Training. Management of Animal Care and Use Programs in Research, Education, and Testing. 2nd edition* (CRC Press/Taylor & Francis, 2018). doi:10.1201/9781315152189-12.
10. Herrmann, K. & Flecknell, P. Retrospective review of anesthetic and analgesic regimens used in animal research proposals. *ALTEX* **36**, 65–80 (2019).
11. Ketelhut, D. J. & Niemi, S. M. Emerging Technologies in Education and Training: Applications for the Laboratory Animal Science Community. *ILAR Journal* **48**, 163–169 (2007).
12. Gyger, M. Impact of the coronavirus disease 2019 pandemic on education and training: A FELASA first experience. *Lab Anim* **54**, 397–398 (2020).
13. Patricia T. V. Distance Education as a Tool for Training Veterinarians in Laboratory Animal Medicine. *Chinese Journal of Comparative Medicine* 1–4 (2012).
14. Bing, J., Pratt-Phillips, S. & Farin, C. E. Effect of Supplemental Online Resources on Undergraduate Animal Science Laboratory Instruction. *NACTA Journal* **56**, 67–72 (2012).
15. Fahnert, B. Be prepared – Learning for the future. *FEMS Microbiology Letters* **366**, fnz200 (2019).
16. Azimi, H. M. & Rahmani, R. Importance of Needs Assessment for Implementation of E-learning in Colleges of Education. 6.

17. Brown, A. R. & Voltz, B. D. Elements of Effective e-Learning Design. *The International Review of Research in Open and Distributed Learning* **6**, (2005).
18. Ananga, P. Pedagogical Considerations of E-Learning in Education for Development in the Face of COVID-19. *International Journal of Technology in Education and Science* **4**, 310–321 (2020).
19. Teo, C. B., Chang, S. C. & Gay, K. L. Pedagogy considerations for E-learning. *Int. J. Instructional Technology Distance Learning* **3**, 3–26 (2006).
20. Pincus, A. *Presenting*. (Dorling Kindersley Limited, 2015).
21. Ahmadi-Noorbakhsh, S., Sadighi, J., Hatami, Z. & Shamsi Gooshki, E. A proposed framework for holding intensive 3Rs workshops in laboratory animal science. *Laboratory Animal Research* **38**, 10 (2022).
22. Crettaz von Roten, F. Laboratory animal science course in Switzerland: participants' points of view and implications for organizers. *Lab Anim* **52**, 69–78 (2018).
23. Costa, A., Costa, A. & Olsson, I. A. S. Students' acceptance of e-learning approaches in Laboratory Animal Science Training. *Lab Anim* **54**, 487–497 (2020).
24. Pratap, K. & Singh, V. P. A training course on laboratory animal science: an initiative to implement the Three Rs of animal research in India. *Altern Lab Anim* **44**, 21–41 (2016).
25. Bayne, K. Development of the Human-Research Animal Bond and Its Impact on Animal Well-being. *ILAR Journal* **43**, 4–9 (2002).
26. Serpell, J. A. Companion animals. in *Anthrozoology* (Oxford University Press, 2018). doi:10.1093/oso/9780198753629.003.0002.
27. Hubrecht, R. C. A comparison of social and environmental enrichment methods for laboratory housed dogs. *Applied Animal Behaviour Science* **37**, 345–361 (1993).
28. Adams, K. M., Navarro, A. M., Hutchinson, E. K. & Weed, J. L. A canine socialization and training program at the National Institutes of Health. *Lab Anim (NY)* **33**, 32–36 (2004).
29. Mueller, M. K. Human-Animal Interaction as a Context for Positive Youth Development: A Relational Developmental Systems Approach to Constructing Human-Animal Interaction Theory and Research. *HDE* **57**, 5–25 (2014).
30. Hurley, K. B. Development and Human-Animal Interaction: Commentary on Mueller. *Human Development* **57**, 30–34 (2014).
31. *Cost of Caring: Human emotions in the care of laboratory animals*. (American Association for Laboratory Animal Science, 2010).
32. Schlanser, T. V., Rabinowitz, P. M. & Thompson-Iritani, S. Compassion Fatigue and Satisfaction in US Army Laboratory Animal Medicine Personnel. *Journal of the American Association for Laboratory Animal Science* **60**, 422–430 (2021).
33. Thurston, S. E. *et al.* Compassion Fatigue in Laboratory Animal Personnel during the COVID-19 Pandemic. *Journal of the American Association for Laboratory Animal Science* **60**, 646–654 (2021).

34. Herzog, H. Ethical Aspects of Relationships Between Humans and Research Animals. *ILAR Journal* **43**, 27–32 (2002).
35. Sandgren, E. P., Streiffer, R., Dykema, J., Assad, N. & Moberg, J. Attitudes toward animals, and how species and purpose affect animal research justifiability, among undergraduate students and faculty. *PLoS One* **15**, e0233204 (2020).
36. Kanzler, S., Krabbe, J., Forkmann, T., Tolba, R. H. & Steitz, J. Animal experiments in biomedical research: Knowledge, self-evaluation and attitudes of biology and medical students. *Lab Anim* 002367722210808 (2022) doi:10.1177/00236772221080833.
37. Whitcomb, T. L. & Taylor, E. W. Teaching Laboratory Rodent Research Techniques under the Tenets of Situated Learning Improves Student Confidence and Promotes Collaboration. *Journal of the American Association for Laboratory Animal Science* **53**, 368–375 (2014).

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