

The effectiveness of blended learning continuing education program on toxoplasmosis for basic education teachers

A eficácia do programa de educação continuada de aprendizagem combinada em toxoplasmose para professores da educação básica

La efectividad del programa de educación continua de aprendizaje mixto sobre toxoplasmosis para maestros de educación básica

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Tercilia de Oliveira Rodrigues

ORCID: <https://orcid.org/0000-0001-7101-7270>
Universidade Estadual Paulista Julio de Mesquita Filho, Brazil
E-mail: tercilia2003@gmail.com

Italmar Teodorico Navarro

ORCID: <https://orcid.org/0000-0001-9518-1083>
Universidade Estadual de Londrina, Brazil
E-mail: italmar@uel.br

Jancarlo Ferreira Gomes

ORCID: <https://orcid.org/0000-0002-2466-7315>
Universidade Estadual de Campinas, Brazil
E-mail: jgomes@ic.unicamp.br

Luzia Helena Queiroz

ORCID: <https://orcid.org/0000-0002-5472-5029>
Universidade Estadual Paulista Julio de Mesquita Filho, Brazil
E-mail: luzia.h.queiroz@unesp.br

Sílvia Helena Venturoli Perri

ORCID: <https://orcid.org/0000-0001-5083-5557>
Universidade Estadual Paulista Julio de Mesquita Filho, Brazil
E-mail: shvperri@fmva.unesp.br

Mariele Fernanda da Cruz Panegossi

ORCID: <https://orcid.org/0000-0003-3388-7456>
Universidade Estadual Paulista Julio de Mesquita Filho, Brazil
E-mail: marielepanegossi@gmail.com

Thaís Rabelo dos Santos-Doni

ORCID: <https://orcid.org/0000-0002-8300-0473>
Universidade Federal dos Vales do Jequitinhonha e Mucuri, Brazil
E-mail: rabelo.vet@hotmail.com

Katia Denise Saraiva Bresciani

ORCID: <https://orcid.org/0000-0002-8767-8855>
Universidade Estadual Paulista Julio de Mesquita Filho, Brazil
E-mail: katia.bresciani@unesp.br

Abstract

Toxoplasmosis is a zoonosis of great importance for public health since it is referenced as causing changes in human fetuses and animals. This research aims at comparing the knowledge of 165 basic education professionals before and after a blended learning online course (180-hour) on toxoplasmosis. A health education course on major urban zoonoses was offered once a year between 2009 and 2013 on the Virtual Learning Environment TelEduc platform. An open question questionnaire on Toxoplasmosis was applied before and after the specific module, and the responses were categorized according to the literature review theme. The initial and final evaluations addressed issues such as toxoplasmosis etiologic agent, clinical signs in animals and humans, and form of transmission and prevention. Toxoplasmosis general knowledge increased significantly ($p < 0.0001$) after the course. The results showed that the continuing education of teachers through Distance Learning and Blended Learning Course contributed to the acquisition of knowledge.

Keywords: Toxoplasmosis; Health education; Teaching; Public health.

Resumo

A toxoplasmose é uma zoonose de grande importância para a saúde pública por ser referenciada como causadora de alterações em fetos humanos e animais. Esta pesquisa tem como objetivo comparar os conhecimentos de 165 profissionais da educação básica antes e depois de um curso online de blended learning (180 horas) sobre

toxoplasmose. Um curso de educação em saúde sobre as principais zoonoses urbanas foi oferecido uma vez por ano entre 2009 e 2013 na plataforma do Ambiente Virtual de Aprendizagem TelEduc. Um questionário de perguntas abertas sobre Toxoplasmose foi aplicado antes e após o módulo específico, e as respostas foram categorizadas de acordo com o tema da revisão da literatura. As avaliações iniciais e finais abordaram questões como agente etiológico da toxoplasmose, sinais clínicos em animais e humanos e forma de transmissão e prevenção. O conhecimento geral sobre toxoplasmose aumentou significativamente ($p < 0,0001$) após o curso. Os resultados evidenciaram que a formação continuada de professores por meio dos cursos EAD e Blended Learning contribuiu para a aquisição de conhecimentos.

Palavras-chave: Toxoplasmose; Educação em saúde; Ensino; Saúde pública.

Resumen

La toxoplasmosis es una zoonosis de gran importancia para la salud pública ya que se la menciona como causante de cambios en fetos humanos y animales. Esta investigación tiene como objetivo comparar los conocimientos de 165 profesionales de la educación básica antes y después de un curso en línea de aprendizaje mixto (180 horas) sobre toxoplasmosis. Una vez al año, entre 2009 y 2013, se ofreció un curso de educación sanitaria sobre las principales zoonosis urbanas en la plataforma TelEduc del entorno de aprendizaje virtual. Se aplicó un cuestionario de cuestionario abierto sobre Toxoplasmosis antes y después del módulo específico, y las respuestas se categorizaron según el tema de revisión de la literatura. Las evaluaciones inicial y final abordaron temas como el agente etiológico de la toxoplasmosis, los signos clínicos en animales y humanos, y la forma de transmisión y prevención. El conocimiento general de la toxoplasmosis aumentó significativamente ($p < 0,0001$) después del curso. Los resultados mostraron que la formación continua de los docentes a través de la Educación a Distancia y el Curso de Aprendizaje Combinado contribuyó a la adquisición de conocimientos.

Palabras clave: Toxoplasmosis; Educación en salud; Enseñanza; Salud pública.

1. Introduction

Toxoplasmosis is caused by the coccidia *Toxoplasma gondii*, an obligate intracellular parasite with a complex life cycle, whose definitive hosts are the felines, including household cats. It affects almost all warm-blooded animal species, including birds, mammals, and humans (Tong, et al., 2021).

Toxoplasmosis is a zoonosis of great importance for public health since it causes reproductive alterations in human foetuses (Bittencourt, et al., 2012) and animals (dos Santos, et al., 2016). This parasitic disease is an opportunistic infection that may re-emerge in immunosuppressed patients with human immunodeficiency virus (HIV), or transplants, reactivating the disease in the lungs and nervous system. It has been reported that 25% of patients co-infected with HIV developed severe encephalitis (Tarekgn, et al., 2020). This coccidia reduces the quality of life of infected individuals (Flegr & Horacek, 2017) causing, according to some studies, behavioral changes such as schizophrenia, alzheimer and parkinson's diseases attention deficit, and obsessive-compulsive disorder (Bichuette, et al., 2017; El Mouhawess, et al., 2020).

Reducing the environmental contamination by *T. gondii* requires investing to change people behavior (dos Santos et al., 2010) by spreading information, offering training and testing situations that lead people to reflect on the problems of their community, and decision-making regarding possible solutions (Brasileiro, et al., 2019). These preventive measures can be experienced by promoting health education in the school environment (Rodrigues, et al., 2011). Furthermore, health education programs advising on toxoplasmosis preventive measures help to reduce not only the damage to animal production but also the costs of treating humans affected by clinical toxoplasmosis and its consequences (Rahmanian, et al., 2020).

However, science teachers feel insecure and have difficulties especially concerning zoonoses due to the lack of specific knowledge (Leonello & L'Abbate, 2006) and information on these diseases as well as the important role of the child as disseminator of best practices for disease control (Rodrigues, et al., 2011).

These educators lack the time for classroom training aiming at updating and improving their knowledge and, therefore, are pressured to seek new educational approaches. In this context, distance learning (DL) stands out as an effective teaching method capable of overcoming the lack of time and geography, enabling the formation of target groups, which, by their characteristics, would hardly have the opportunity to attend a classroom course (Santos & Mercado, 2010).

The School of Veterinary Medicine of Araçatuba (FMVA), São Paulo State University (UNESP), designed a continuing education program directed to educators and students from the municipal basic education schools in Araçatuba, SP. The program offers a blended learning course aimed at promoting Education in Public Health by training information multipliers. An early conceptual phase addresses vector-borne diseases and major zoonoses, food hygiene, responsible pet ownership and health education, and a subsequent practical phase regarding the development and implementation of educational projects (Rodrigues, et al., 2011). This research aims at comparing the cognitive skills of 165 basic education professionals, before and after taking the blended learning online course, concerning the module of on toxoplasmosis.

2. Methodology

The research was directed to 165 basic education professionals that work in public schools in the peripheral and central areas of Araçatuba, São Paulo. All coordinators, directors, and teachers had a full Education degree while 85% had at least a specialization degree in education, 98.7% were women and 63% were over 40 years old.

The online blended learning training called "Application of basic concepts of responsible pet ownership and major urban zoonoses for health education" was available on the VLE (Virtual Learning Environment) TelEduc platform and it was offered once a year between 2009 and 2013. The 180-hour course was hosted by the servers of the Distance Education Center of Proex-Unesp and characterized as University Extension Course.

The course began by defining the necessary documents for the creation of distance learning courses, designed by the research author (Instructional Designer for online distance education), such as development model of Instructional Designer with detailed course plan, Matrix Instructional Designer (Activity Detailing Virtual Dynamics) and Activity Boards. Then, applications and virtual training were held in schools in ATPC (Collective Pedagogical Work Class) on the principles of Distance Learning (DL) and the VLE TelEduc. At that moment, each participant was asked about previous experience with DL and specific knowledge on zoonosis, particularly, toxoplasmosis.

The toxoplasmosis module was structured to facilitate the building of knowledge by the student. The theme was addressed through dynamic activities, such as forums, exercises, readings, videos, preparing dissertation texts and educational materials to work with students in the classroom.

In addition to online activities, four in-person meetings were held at the FMVA/UNESP, for diagnostic evaluations (before the course), classroom sessions, presentation of seminars and in-school activities for teachers as well as the final evaluation at the end of the course.

The complexity of using open questions in applied questionnaires before and after the course required the responses to be categorized according to the theme of the literature review. Thus, diagnostic and final evaluations addressed issues such as toxoplasmosis etiologic agent, clinical signs in animals and humans, as well as form of transmission and prevention.

Microsoft Excel® 2010 software was used to determine the knowledge level of the answers to each question following the criteria: adequate (> 50% of correct items cited in the response), satisfactory (≤ 50% correct items cited in response), and unsatisfactory (blank answers or no correct data). The data on toxoplasmosis knowledge for each question were submitted to Wilcoxon statistical test at 5% using Statistical Analysis Software (SAS) (2004).

The research audience signed a free and informed consent and received all information on the research objectives. The research was approved by the Ethics in Research Committee of the School of Dentistry and School of Veterinary Medicine of Araçatuba-SP, UNESP - Process FOA-1123/09.

3. Results and Discussion

At the beginning of the course, the initial evaluation indicated that only 4.8% of the respondents had information on how to tackle zoonoses during their formal graduation course. In addition, only 27.3% had previous experiences with DL and blended learning courses, having taken at least one course before.

Data on the changing level of general knowledge on toxoplasmosis are shown in Table 1. Table 2 showed the knowledge of the participants before and after the course, regarding the main characteristic clinical signs of toxoplasmosis in humans and animals, the most common forms of transmission, and prevention methods.

Table 1. Frequency (n) and percentage (%) of responses to the questions about toxoplasmosis, according to the knowledge level before and after the blended learning course. Araçatuba, 2014.

Question	Before (n = 165)						After (n = 165)						P ⁽¹⁾
	Unsatisfactory		Satisfactory		Adequate		Unsatisfactory		Satisfactory		Adequate		
	n	%	n	%	n	%	n	%	n	%	n	%	
Etiology	160	97.0	3	1.8	2	1.2	13	7.9	82	49.7	70	42.4	< 0.0001
Clinical signs(human)	95	57.6	66	40.0	4	2.4	5	3.0	58	35.2	102	61.9	< 0.0001
Clinical signs(animal)	120	72.7	39	23.6	6	3.7	46	27.9	67	40.6	52	31.5	< 0.0001
Transmission	110	66.7	44	26.7	11	6.6	15	9.1	91	55.2	59	35.8	< 0.0001
Prevention	118	71.5	46	27.9	1	0.6	14	8.5	82	49.7	69	41.8	< 0.0001

⁽¹⁾ Teste de Wilcoxon. Source: Authors.

The VLE TelEduc is a collaborative learning environment that uses tools for enabling interaction and monitoring of the learning process between students and tutors.

During the course, participants interacted with tutors and colleagues and accessed texts for studies, activities, and assessments of their contents. Synchronous and asynchronous communication tools were used for clarifying doubts and interacting, as many activities were collaborative. The activities were designed to provide meaningful learning, which happens when the student has the opportunity to build and rebuild their own knowledge and is able to form concrete concepts about the world, allowing thinking, reflecting, describing and reacting to reality (Gonzalez & Martins, 2017).

Usually, due to the lack of knowledge on the specific topic and its context, Pedagogy students and science teachers in basic education are insecure and sometimes even unable to teach this matter (Martínez-Bello, et al, 2021).

A study conducted with Pedagogy students (Leonello & L'Abbate, 2006) concluded that 65% had no information on working with health issues and zoonoses in particular. Of the educators participating in a research on intervention and action of a blended learning continuing education course (Rodrigues, et al., 2011), 97.5% claimed lack of information regarding zoonoses and working issues in the classroom, hygiene and public health during the graduation.

The level of general knowledge on toxoplasmosis increased significantly ($p < 0.0001$) after the course compared to the initial data (Table 1). Similar results were obtained in a study that evaluated the results of educational activities on dengue vector control, leishmaniasis, and yellow fever after the first edition of the blended learning course was offered to 40 teachers at municipal elementary school in Araçatuba-SP (Rodrigues, et al., 2011).

The level of knowledge on the clinical signs of human disease increased significantly ($p < 0.0001$) while abortion and/or congenital problems were the best-known and assimilated symptoms by the course participants. Despite the relevance of this zoonosis and health education activities, population knowledge generally is limited and restricted to clinical signs related

to congenital toxoplasmosis, since the pathogen, and other symptoms can cause abortion or reproductive changes in their intermediate hosts (Nayeri, et al., 2021).

Studies indicate that 10% to 20% of human *T. gondii* infections occur in adults with symptomatic evolution. The most common clinical manifestation in the acute phase of this zoonosis is lymphadenopathy. There may also be fever, malaise, night sweats, myalgia, maculopapular rash, and lymphocytosis (Kolören & Dubey, 2020). Table 2 shows that after the course, participants assimilated and kept this concept.

Table 2. Percentage of clinical signs characteristic of human toxoplasmosis, clinical signs characteristic of animal toxoplasmosis, forms of toxoplasmosis transmission, forms of toxoplasmosis prevention cited by the participants, before and after the blended learning course. Araçatuba, 2014.

Question	Blended learning course (n = 165)			
	Before, n (%)		After, n (%)	
Clinical signs of human toxoplasmosis				
abortion, congenital problems	8	(4.8)	99	(60.0)
asymptomatic	2	(1.2)	10	(6.1)
tiredness	0	(0)	11	(6.7)
headache	0	(0)	29	(17.6)
body and muscle pain	1	(0.6)	56	(33.9)
fever	0	(0)	87	(52.7)
retinal lesions. eye problems	29	(17.6)	80	(48.5)
lymphadenopathy. swollen lymph nodes	1	(0.6)	89	(53.9)
body spots	3	(1.8)	38	(23.0)
heart problems	0	(0)	40	(24.2)
Clinical signs of animal toxoplasmosis				
Depletion. prostration	0	(0)	31	(18.8)
Abortion	0	(0)	44	(26.7)
Anorexia	2	(1.2)	31	(18.8)
Sometimes asymptomatic	1	(0.6)	33	(20.0)
Diarrhea	0	(0)	30	(18.2)
fever	4	(2.4)	48	(29.1)
lymphadenopathy	0	(0)	27	(16.4)
neurological and muscular manifestation	0	(0)	36	(21.8)
newborn mortality	0	(0)	41	(24.8)
Transmission				
Infected cats feces containing oocysts	20	(12.1)	85	(51.5)
Eating raw or undercooked meat	3	(1.8)	62	(37.6)
Ingestion of vegetables. water or fruits contaminated by oocysts	5	(3.0)	60	(36.4)
Ingestion of raw milk containing tachyzoites	0	(0)	2	(1.2)
From mother to cub via placenta	0	(0)	38	(23.0)
Blood transfusion or organ transplantation	0	(0)	5	(3.0)
Prevention				
Avoid contact with animal feces	12	(7.3)	70	(42.4)
Avoid eating undercooked meat or always eat cooked meat	3	(1.8)	96	(58.2)
washing hands after handling raw meats	0	(0)	29	(17.6)
washing well vegetables and fruits	4	(2.4)	85	(51.5)
wash hands/hygiene	1	(0.6)	48	(29.1)
wash hands thoroughly after handling with soil that may be	0	(0)	35	(21.2)

contaminated with feces				
Clean and protect environments to prevent dog and cat feces	1	(0.6)	25	(15.2)
Pregnant women should avoid cleaning boxes of cat dropping and materials potentially with cat feces	0	(0)	29	(17.6)

Source: Authors.

Another important concept assimilated is that toxoplasmosis can go unnoticed at birth, but it can, however, manifest months or years later in children born with this parasitosis. In such cases, the most common manifestations are retinochoroiditis, cerebral calcifications, neuropathies, and microcephaly. In more severe cases of congenital infection, the infant may have modified cranial volume, intracerebral calcifications and/or convulsions (Pagliuca, et al., 2017). Therefore, early diagnosis and treatment of disease during pregnancy are essential for the reduction of congenital toxoplasmosis and its sequels (Capobianco et al., 2014).

The knowledge on the clinical manifestations in the animal progressed from the unsatisfactory to satisfactory level. The most frequently cited signs were fever (29.1%) and abortion (26.7%) (Table 2). The responses of the course participants (clinical signs of animal toxoplasmosis) are in agreement with previously reported pathological changes in female dogs (Bresciani, et al., 2009) and cats (Sakamoto et al., 2009) experimentally infected with evolving forms of *T. gondii*.

The level of knowledge of course participants on the transmission of toxoplasmosis to humans increased significantly ($p < 0.0001$), especially with regard to the satisfactory level. The contact with feces of infected cats containing oocysts was the transmission most cited by course participants, followed by eating raw or undercooked meat, ingestion of vegetables, water or fruits contaminated by oocysts, from mother to cub via placenta, blood transfusion or organ transplantation and ingestion of raw milk containing tachyzoites.

This especially important information should be transmitted to children and their families since there is a small possibility that humans may become infected by directly touching or caressing infected cats (dos Santos, et al., 2010). *T. gondii* oocysts are eliminated by these definitive hosts but need to remain in the environment for at least a day, under certain temperature and humidity conditions, to sporulate and become infective (dos Santos, et al., 2010). There is important evidence that adopting hygienic measures can help prevent infection, therefore, hand washing remains recommended, especially after direct contact with cats. In a study held in Araçatuba, SP, 85 teachers of elementary schools were interviewed on toxoplasmosis and indicated that 92.94% and 80% of cats and dogs were transmitters, respectively, while only 4.71% cited the intake of meat products (Bresciani, et al., 2013).

The course participants cited water as an important means of transmission. However, it is noteworthy that only complete water treatment systems are effective against transmission since the *T. gondii* oocysts are retained during the coagulation, sedimentation, and filtration processes while chlorination of water is not able to inactivate the oocysts (Almeida, et al., 2011).

Before the course, most participants had no idea on how to reduce environmental contamination by *T. gondii*. Similar lack of knowledge has been reported among doctors and nurses of the Basic Unit of Health and Hospitals in Juiz de Fora, Minas Gerais (da Silva, et al., 2011), as well as in the elderly population (Lima, et al., 2008) and most recently in dog owners (Viol, et al., 2014) in Araçatuba, SP.

The prevention measures most frequently cited after the course were to avoid eating raw and undercooked meat (58.2%) and contact with animal feces (51.5%). Although widely disseminated most of the population still do not know that humans and animals should not consume raw or undercooked meat, unpasteurized dairy products, or boiled water without being treated, as well as unwashed fruits and vegetables (Belluco, et al., 2018). This is important information that needs to be passed on regularly to the children and their families.

Interestingly, the very important information regarding the contact with animal feces is that the newly disposed feces of felids are not infectious, and they must remain in the environment for at least a day for sporulation to occur and become infectious. Thus, the population needs to be aware that feces must be removed daily, considering that *T. gondii* oocysts are highly resistant to the conditions of the external environment (Pineda, et al., 2020).

The lack of other continuing distant learning courses directed to basic education teachers to improve knowledge on zoonoses, in particular, toxoplasmosis, proves that more investments in this field are necessary so other editions of the course can be offered since they may become important training program multipliers regarding Animal Health and Public Health.

One Health is an approach that involves multiple disciplines and sectors aiming to improve health for people, animals, and the environment, with promising impacts in responding to Global Health challenges, such as preventing future pandemics. The integration of different disciplines is still a challenge for Global Health (Destoumieux-Garzón, et al., 2018). Therefore, capacity building among students in this direction should be promoted (Rabinowitz, et al., 2017). Training in One Health can facilitate behavioral change of professionals, who will be more prepared to share, exchange, collaborate, and learn from each other (Vicente, et al., 2021).

However, the support of other professionals and institutions, whether in the school environment or in the social context, to continue the teacher's effort is essential for future success and for the realization of true health education for all.

4. Conclusion

We observe a significant contribution of continuing education of teachers through Distance Learning and Blended Learning Course for acquiring knowledge on toxoplasmosis. Then, this work offered education professionals the necessary training tools to transmit this knowledge, promoting not only better educational quality for students, but also the generation of societies with basic understanding. in One Health.

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