

The video as a tool to change perceptions and knowledge about snakes in adults with a high academic level in Costa Rica

Sergio Gabriel Quesada-Acuña¹  & Gabriela Pérez-Gómez² 

1. Universidad Estatal a Distancia, Vicerrectoría de Investigación, Laboratorio de Ecología Urbana, 2050 Sabanilla, San José, Costa Rica; sgbiotropic@gmail.com
2. Universidad Estatal a Distancia, Vicerrectoría de Investigación, Laboratorio de Vida Silvestre y Salud, 2050 Sabanilla, San José, Costa Rica; gabytta1985@gmail.com

Recibido 7-VI-2020 • Corregido 9-IX-2020 • Aceptado 29-IX-2020

DOI: <https://doi.org/10.22458/urj.v12i2.3033>

ABSTRACT. Introduction: Snakes suffer persecution by humans for misperception, misinformation, and fear. In addition, snakes are threatened by habitat decline, which leads them to seek new territories, favoring human-snake encounters. In Costa Rica these threats also exist in the inhabitants of the city, even in those with a high academic level. To favor the conservation of snakes, it is necessary to implement environmental education strategies aimed at a specific target audience. One possible tool is the creation and dissemination of educational videos, which increase knowledge and improve decision-making for their conservation. **Objective:** Evaluate the effectiveness of an educational video as a tool to change the perception and knowledge about snakes in adults of high educational level in Costa Rica. **Methods:** We worked with 340 officials from the UNED headquarters, to whom we had applied an initial diagnosis in 2019. We separated the same participants into two groups: 240 officials received an educational video on snakes from the Greater Metropolitan Area (GAM) that we generated for them and 100 officials received a journalistic video as a control group. Finally, we evaluate their responses in a comparative way with respect to the previous diagnosis. **Results:** After observing the respective video, 75% of the officials maintain their perception of snakes and 68% would act in the same way in case of an encounter. However, 51,5% showed improvement in their general knowledge about snakes, showing dependence on the video observed. **Conclusions:** The educational video improved the general knowledge about snakes, but the environmental education effort has to face a high percentage of disinterest on the part of the population, which is a challenge for the conservation of snakes.

Keywords: Environmental education, Human-Snake conflict, Snakes from Costa Rica, Urban ecology, Video.

RESUMEN. “El video como herramienta para cambiar percepciones y conocimientos sobre serpientes en adultos con alto nivel académico en Costa Rica” **Introducción:** Las serpientes experimentan persecución de los humanos por la mala percepción, la desinformación y el temor. Además, son amenazadas por la disminución del hábitat, que las conduce a la búsqueda de nuevos territorios, favoreciendo los encuentros humano-serpiente. En Costa Rica existen estas amenazas en los habitantes de la ciudad, incluso en aquellos con alto nivel académico. Para favorecer la conservación de las serpientes, es necesario implementar estrategias de educación ambiental dirigidas a un público meta específico. Una posible herramienta es la creación y divulgación de videos educativos. **Objetivo:** Evaluar la efectividad de un video educativo como herramienta para cambiar la percepción y el conocimiento sobre serpientes en adultos de alto nivel educativo en Costa Rica. **Métodos:** Trabajamos con 340 funcionarios de la UNED sede central, a los que les habíamos aplicado un diagnóstico inicial en el 2019. Separamos a los mismos participantes en dos grupos: 240 funcionarios recibieron un video educativo sobre serpientes de la Gran Área Metropolitana (GAM) que generamos para ellos y 100 funcionarios recibieron un video periodístico como grupo control. Finalmente evaluamos sus respuestas de forma comparativa respecto al diagnóstico previo. **Resultados:** Luego de observar el video respectivo, el 75% de los funcionarios mantiene su percepción hacia las serpientes y el 68% actuaría de la misma forma en caso de un encuentro. Sin embargo, 51,5% mostró mejoría en su conocimiento general sobre serpientes, mostrando dependencia con respecto al video observado. **Conclusiones:** El video educativo mejoró el conocimiento general sobre serpientes, pero el esfuerzo de educación ambiental debe enfrentarse a un alto porcentaje de desinterés por parte de la población, lo que resulta un reto para la conservación de las serpientes.

Palabras clave: Conflicto humano-serpiente, Ecología urbana, Educación ambiental, Serpientes de Costa Rica, Video.



Snakes experience the most persecution by humans, so the protection of their populations it is very difficult since there is a lot of misperception, poor information and widespread fear in people (Prokop, Özel, & Uşak, 2009; LoBue, Rakison, & DeLoache, 2010; Alemán, DeClerck, Finegan, Casanoves, & García, 2011; Alves et al., 2014; Nonga & Haruna, 2015; Torkar, 2015; Aguilar-López, 2016; Pinheiro, Mota, & Borges-Nojosa, 2016; Landová et al., 2018). In addition, snakes face other threats such as the decline of their natural prey and decrease and fragmentation of their habitat, generating that they search for new territories, food and refuge in house gardens, recreational green areas and even urban habitats or cities, where they increase their encounters with humans and many snakes die for no reason (Alemán et al., 2011; Alves et al., 2014; Nonga & Haruna, 2015; Torkar, 2015; Aguilar-López, 2016; Quesada-Acuña, 2018; Zipkin, DiRenzo, Ray, Rossman, & Lips, 2020). In Costa Rica the same negative perception and ignorance about snakes has been found in the city's inhabitants, even in those with the highest academic level (Solórzano, 2004; Quesada-Acuña, 2019). A negative perception can directly influence people's behavior and decision-making towards this type of reptile, hindering conservation efforts (Alea-García, 2006).

In order to promote the conservation of snakes, it is necessary to implement environmental education strategies aimed at a specific target audience, considering the immediate environment of individuals and the learning opportunities they may have; using techniques such as: face-to-face talks with experts, direct interaction with animals or distance environmental education (Alea-García, 2006; Prokop et al., 2009). A possible tool for doing distance environmental education, aimed at urban adults with university education, is the creation and dissemination of short educational videos, taking advantage of the fact that said target public has easy access to information on the internet and social networks (Ceríaco, 2012; Pinheiro et al., 2016; Sánchez-Paniagua, González-Villalobos, & Abarca, 2018; Estévez-Haro & Proaño-Morales, 2019).

Distance environmental education using videos has advantages such as: accessibility, ease of use and dissemination, helps in understanding the message, simultaneously involves sound and visual messages, can be designed cross-culturally, is compatible with the use of printed material, allows the user to apply it in their own context, among others (Gruber, Benayas, & Gutiérrez, 2001; Cabero & Llorente, 2005; Alea-García, 2006; Galindo-González, 2015). However, there are few educational videos on snakes and their effectiveness in environmental education in adults has never been estimated. The objective of this research is to evaluate the effectiveness of an educational video as a tool to change the perception and knowledge about snakes in adults with a high educational level in Costa Rica.

MATERIALS AND METHODS

Study Site: Universidad Estatal a Distancia (UNED), headquarters, San José, Costa Rica. We analyzed the perception and knowledge about snakes in 340 officials for a previous work (between March and April 2019), which served as a previous diagnosis (Quesada-Acuña, 2019).

Data collection: We generate an educational video on snakes from the Greater Metropolitan Area of Costa Rica and select a free-access journalistic report as a control (Appendix 1). We separated the 340 participants from the previous diagnosis into two random groups and sent them a link to the YouTube video by email, with instructions to observe it freely during September and October 2019. A total of 240 officials received the educational video and 100 officials received the journalistic video, as a control group. We send a reminder to all participants just in the middle of the period. Finally, during December 2019 we repeated the diagnostic survey to 200 participants at random, always individually and face-to-face to avoid plagiarism or search for answers in digital media.



Analysis of data: We compared the participants' new responses with respect to their own previous response, according to three categories: best (a positive point), worst (a negative point) or equal (zero). We consider an answer to be "better", if the person provides more examples or improves accuracy over the true value. From the original survey we only analyzed two questions about perception (without assigning a score) and six questions about knowledge (Appendix 2). Finally, we evaluated the change in general knowledge according to the sum of points: better (+1 to +6), worse (-1 to -6) or equality (0), for example: A person who gets +2, means that in general terms his knowledge improved in two questions. We analyzed the data with descriptive statistics, frequency analysis and independence tests (Pearson or chi square of contingency or goodness of fit), using XLStatistics (Carr, 2017). Full data set available here: <https://doi.org/10.5281/zenodo.4085506>

RESULTS

Sociodemographic characteristics and visualization of the educational video: We surveyed 200 participants (125 women and 75 men), between the ages of 22 and 64 (mean= 40,62; SD= 9,88; $p < 0,05$). 95% have university-level studies ($\chi^2 = 162$; DF= 1; $p < 0,05$) and 95% live in urban districts of the Greater Metropolitan Area ($\chi^2 = 162$; DF= 1; $p < 0,05$).

Only 33,5% acknowledged having observed the video they received ($\chi^2 = 21,78$; DF= 1; $p < 0,05$). The decision to watch the video was independent of the participant's gender (χ^2 Pearson= 0,93; DF= 1; $p > 0,05$), to his feeling for snakes (χ^2 Pearson= 4,50; DF= 4; $p > 0,05$) and even at his age (χ^2 Pearson= 0,74; DF= 2; $p > 0,05$).

Perception towards snakes: 75% of the participants maintained their feeling for snakes ($\chi^2 = 157,34$; DF= 2; $p < 0,05$) and 68% maintained their behavior when encountering a snake at home ($\chi^2 = 111,17$; DF= 2; $p < 0,05$). Both traits are independent of the participant's gender and the video observed (Table 1).

TABLE 1

Change in perception towards snakes in highly educated adults in Costa Rica.

Questions about perception	Participants (%)	Statistical difference (χ^2)	Variable dependency
Change in feelings towards snakes:			
Better	9,50	$\chi^2 = 157,34$ DF= 2; $p < 0,05$	Versus "observed video"
Equal	75,00		(χ^2 Pearson= 9,04; DF= 4; $p > 0,05$)
Worse	15,50		Versus "gender"
Change in reaction when finding a snake:			
Better	21,00	$\chi^2 = 111,17$ DF= 2; $p < 0,05$	(χ^2 Pearson= 4,53; DF= 2; $p > 0,05$)
Equal	68,00		Versus "observed video"
Worse	11,00		(χ^2 Pearson= 5,61; DF= 4; $p > 0,05$)
			Versus "gender"
			(χ^2 Pearson= 0,44; DF= 2; $p > 0,05$)

Knowledge about snakes: 46% made a better estimate of the number of Costa Rican snake species ($\chi^2 = 24,16$; DF= 2; $p < 0,05$), although the improvement in estimating the poisonous species was not significant ($\chi^2 = 4,81$; DF= 2; $p > 0,05$). An improvement of 43% was also observed when estimating the maximum size of a snake in Costa Rica ($\chi^2 = 12,04$; DF= 2; $p < 0,05$) (Table 2).

No improvement was found when consulting about the possible prey of the snakes ($\chi^2 = 4,27$; DF= 2; $p > 0,05$); 67.5% maintained their previous knowledge to correctly identify venomous snakes from non-venomous ($\chi^2 = 107,87$; DF= 2; $p < 0,05$) and 44% remembered the same number of



common snake names that they mentioned in the diagnosis ($\chi^2= 10,72$; $DF= 2$; $p< 0,05$). All the knowledge features were independent of the participant's gender and the video observed (Table 2).

TABLE 2
Change in knowledge about snakes in highly educated adults in Costa Rica.

Questions about knowledge	Participants (%)	Statistical difference (χ^2)	Variable dependency
Number of Costa Rican snakes species:			Versus "observed video"
Better	46,00	$\chi^2= 24,16$;	(χ^2 Pearson= 8,68; $DF= 2$; $p> 0,05$)
Equal	36,00	$DF= 2$; $p< 0,05$	Versus "gender"
Worse	18,00		(χ^2 Pearson= 1,28; $DF= 2$; $p> 0,05$)
Number of venomous snake species:			Versus "observed video"
Better	39,00	$\chi^2= 4,81$;	(χ^2 Pearson= 2,72; $DF= 4$; $p> 0,05$)
Equal	34,50	$DF= 2$; $p> 0,05$	Versus "gender"
Worse	26,50		(χ^2 Pearson= 1,11; $DF= 2$; $p> 0,05$)
Estimation of the maximum size of a snake:			Versus "observed video"
Better	43,00	$\chi^2= 12,04$;	(χ^2 Pearson= 2,02; $DF= 4$; $p> 0,05$)
Equal	34,00	$DF= 2$; $p< 0,05$	Versus "gender"
Worse	23,00		(χ^2 Pearson= 0,55; $DF= 2$; $p> 0,05$)
Recognize possible prey of a snake:			Versus "observed video"
Better	36,00	$\chi^2= 4,27$;	(χ^2 Pearson= 9,33; $DF= 4$; $p> 0,05$)
Equal	37,50	$DF= 2$; $p> 0,05$	Versus "gender"
Worse	26,50		(χ^2 Pearson= 0,97; $DF= 2$; $p> 0,05$)
How you identify venomous snakes:			Versus "observed video"
Better	21,00	$\chi^2= 107,87$;	(χ^2 Pearson= 5,56; $DF= 4$; $p> 0,05$)
Equal	67,50	$DF= 2$; $p< 0,05$	Versus "gender"
Worse	11,50		(χ^2 Pearson= 0,24; $DF= 2$; $p> 0,05$)
Mention common names of snakes:			Versus "observed video"
Better	30,00	$\chi^2= 10,72$;	(χ^2 Pearson= 7,08; $DF= 4$; $p> 0,05$)
Equal	44,00	$DF= 2$; $p< 0,05$	Versus "gender"
Worse	26,00		(χ^2 Pearson= 0,03; $DF= 2$; $p> 0,05$)

In general terms, knowledge about snakes improved in 51,5%, 26% worsened and 22,5% remained the same ($\chi^2= 30,07$; $DF= 2$; $p< 0,05$). These criteria changes were dependent on the observed video (χ^2 Pearson= 17,36; $DF= 4$; $p< 0,05$) (Figure 1), and independent of gender (χ^2 Pearson= 1,55; $DF= 2$; $p> 0,05$), to the feeling for snakes (χ^2 Pearson= 9,35; $DF= 8$; $p> 0,05$) and to age (χ^2 Pearson= 0,92; $DF= 2$; $p> 0,05$).

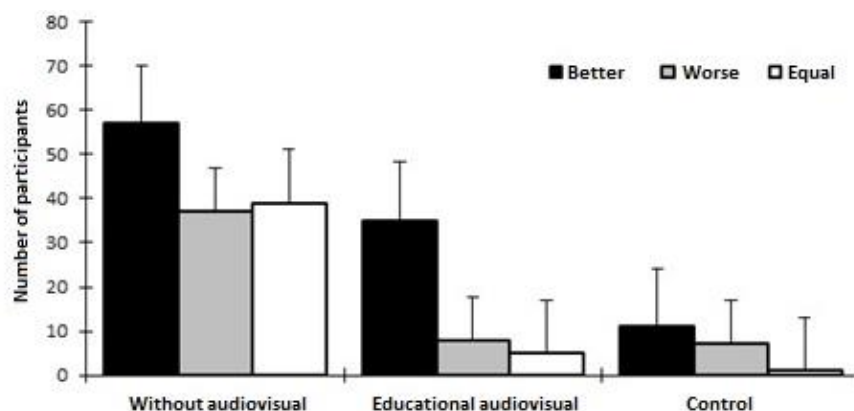


Fig. 1. Change in the general knowledge about snakes, detected in highly educated adults in Costa Rica in relation to the video observed.

DISCUSSION

Costa Rica is internationally recognized for its biodiversity conservation model, although some environmental problems, such as the human-snake conflict, remain active in the population and must be mitigated with specific environmental education, designed in accordance with the target audience (Ceríaco, 2012; Pandey, Pandey, Devkota, & Goode, 2016; Estévez-Haro & Proaño-Morales, 2019; Prosser-Bravo & Romo-Medina, 2019).

We designed this research so that the population sector with the highest academic level and better access to information technologies, had free and unlimited access for more than two months, to the possibility of observing an educational video on snakes; so that the methodology allowed us to visualize an additional obstacle that all massive environmental education efforts must face and that most research fails to detect: public disinterest (Pandey et al.; 2016; Pinheiro et al, 2016; Reynolds, Salamander, & Wilson, 2018).

Usually, when carrying out environmental education to people who voluntarily attend a certain place or who even pay an entry for it, such as zoos, museums or herpetarians; a bias is generated because people express a pre-existing interest in exposing themselves to being educated environmentally (Pinheiro et al., 2016; Calderón-Arrieta, 2017; Reynolds et al., 2018). The same happens when the participants agree to volunteer for a certain study, since those who did not agree to participate are excluded from the sample and their interest in the subject was perhaps not sufficient to participate (Pandey et al., 2016; Pinheiro et al., 2016; Reynolds et al., 2018).

On the contrary, in this research we analyze the responses of both groups: the disinterested majority and the minority who observed the video knowing the general subject but not its specific content; this allowed us to detect that the decision to watch or not watch the video does not depend on gender, age or their feelings towards snakes (which they had confessed in the previous diagnosis) and, therefore, it is a technological tool with great educational potential, mainly for urban populations (Gruber et al., 2001).

Perception towards snakes: Changing negative to positive perceptions has been documented to be difficult, and efforts in that direction tend to be more successful when working with young children (Kellert, 1984; Torkar, 2015; Souchet & Aubret, 2016; Pandey Chaudhary, Pandey, Piya, & Devkota, 2020).

In this research, most of the participants maintained their feeling towards snakes and also their way of acting in the event of a possible encounter with them, regardless of their gender and the video observed. However, a significant percentage improved in their possible reaction to finding a snake, suggesting that their participation in the research somehow enabled them to revalue the danger they associated with snakes (Prokop et al., 2009; Torkar, 2015; Aguilar-López, 2016; Pinheiro et al., 2016; Reynolds et al., 2018).

In the previous diagnosis (Quesada-Acuña, 2019), the participants had the opportunity to interact face-to-face and individually with a biologist specialized in snakes, which generated an atmosphere of trust to evacuate doubts, tell anecdotes and receive guidance on the subject. This socialization space represents another type of environmental education that was not evaluated and that could also have a positive impact on the perception of snakes (Torkar, 2015; Aguilar-López, 2016; Pinheiro et al., 2016).

Finally, it is also possible that the change observed in a small percentage of the population shows in some way the need for knowledge and the advantages of directing environmental education towards an urban population with a higher educational level and possibly with less adherence to myths and beliefs (Fita, Costa-Neto, & Schiavetti, 2010; Ceríaco, 2012; Gómez-Martínez, Gutiérrez-Montes, & DeClerck, 2014; Pinheiro et al., 2016; Estévez-Haro & Proaño-



Morales, 2019; Ríos-Orjuela, Falcón-Espitia, Arias-Escobar, Espejo-Uribe, & Chamorro-Vargas, 2020). This, eventually, could generate positive impacts on the environmental education received by the child population related to the participants who showed such improvement in their perception towards the snakes.

Knowledge about snakes: Participants showed improvement in half of the knowledge-oriented questions, including: number of Costa Rican snake species, number of poisonous species, and maximum size of a snake in Costa Rica; although none evidenced dependence with respect to the observed video. It is important to note that all the improvements are related to numbers that could be easier to memorize and it is also possible that this improvement responds to an interaction of positive effects, between watching the video and interacting with a specialist, although this could not be evaluated (Alea-García, 2006). Direct interaction has been described as an excellent environmental education strategy (Torkar, 2015; Pinheiro et al., 2016), but it has disadvantages compared to educational video, mainly in terms of economic investment, reproduction and scope (Cabero & Llorente, 2005). In fact, the creation of educational videos has recently gained in importance due to the pandemic and its adaptability could be key in environmental education.

Regarding the remaining questions, the participants maintained the same level of knowledge about: snake prey, characteristics to identify venomous snakes and common names of snakes; regardless of the video observed. These results could have a negative impact on the conservation of snake populations, because they suggest that people still believe that snakes are more dangerous than they actually are (Fita et al., 2010; Aguilar-López, 2016).

Since venomous snakes in Costa Rica represent an easily distinguishable minority (Savage, 2002; Solórzano, 2004; Quesada-Acuña, 2018; Sánchez-Paniagua et al., 2018; Sasa, Bonilla, & Chaves, 2019), reinforces the importance of designing environmental education on snakes highlighting the characteristics to differentiate venomous from non-venomous snakes, which favors the conservation of populations of this group (Fita et al., 2010; Gómez-Martínez et al., 2014; García-López, Villegas, Pacheco-Coronel, & Gómez-Álvarez, 2017; Quesada-Acuña, 2018; Sánchez-Paniagua et al., 2018).

Finally, when analyzing the general knowledge by summation of scores, a considerable improvement was evident in favor of those participants who observed the educational video, which suggests that it is an effective tool and that it generates in the population a different effect than journalistic reports (usually negative), possibly because it allows the viewer to build their own knowledge in its immediate context, without the information received generating unwarranted prejudice or fear (Perales & García-Granada, 1999; Cabero & Llorente, 2005; Alea-García, 2006; Santiago-Rivera, 2008; Galindo-González, 2015).

In addition, it is important to consider that we designed the research seeking a time distance of at least 45 days between the observation of the video and the evaluative survey, so that the changes reflect a memorization or learning that was maintained in the participants for a considerable time, which could have a positive effect on people's behavioral patterns towards snakes, promoting their conservation (Cabero & Llorente, 2005; Alea-García, 2006; Lavilla-Cerdán, 2011). In this regard, many investigations omit this temporal spacing and do not give participants the opportunity to show the effect of time, real interest, or knowledge acquired during the intervention in their responses (Alves et al., 2014; Pinheiro et al., 2016; Souchet & Aubret, 2016; Landová et al., 2018). We believe that by doing so we obtained a response closer to reality, since all the participants had time to “forget” (Lavilla-Cerdán, 2011).

Our research suggests that educational video can be an efficient distance environmental education tool in changing perceptions and disseminating knowledge, not only in children's populations where environmental education efforts are more frequently focused (Prosser-Bravo &



Romo-Medina, 2019), but also in young people and adults who can positively influence child populations for the conservation of biodiversity.

ACKNOWLEDGEMENTS

To Erick Rojas, Ricardo Osorno and Saúl Fernández of the Scientific Divulcation Unit (UNED) for design the educational video. To Gabriela Jones, Carolina Seas, Wendy Ramírez and Zaidett Barrientos, for their support of the project and their suggestions to improve the article.

ETHICAL, CONFLICT OF INTEREST AND FINANCIAL STATEMENTS

The authors declare that they have fully complied with all pertinent ethical and legal requirements, both during the study and in the production of the manuscript; that there are no conflicts of interest of any kind; that all financial sources are fully and clearly stated in the acknowledgments section; and that they fully agree with the final edited version of the article. A signed document has been filed in the journal archives.

The manuscript was planned, developed, analyzed and written by the two authors with equal percentages of contribution.

REFERENCIAS

- Aguilar-López, J. L. (2016). Las serpientes no son como las pintan. *Revista Ciencia*, 67(2), 6-13.
- Alea-García, A. (2006). Diagnóstico y potenciación de la educación ambiental en jóvenes universitarios. *Odiseo, Revista Electrónica de Pedagogía*, 3(6), 1-29.
- Alemán, B., DeClerck, F., Finegan, B., Casanoves, F., & García, J. (2011). Caracterización de reptiles y percepción local hacia las serpientes en la subcuenca de río Copán, Honduras. *Agroforestería de las Américas*, 48(1), 103-117.
- Alves, R., Silva, V., Trovao, D., Oliveira, J., Mourao, J., Dias, T., Alves, A., Lucena, R., Barboza, R., Montenegro, P., Vieira, W., & Souto, W. (2014). Students attitudes toward and knowledge about snakes in the semiarid region of Northeastern Brazil. *Journal of Ethnobiology and Ethnomedicine*, 10(30), 1-8. DOI: 10.1186/1746-4269-10-30.
- Cabero, J., & Llorente, M. (2005). Las TIC y la Educación Ambiental. *Revista Latinoamericana de Tecnología Educativa*, 4(2), 9-26.
- Calderón-Arrieta, D. (2017). *Evaluating Current Attitudes towards Snakes in the Nicholas School of the Environment's (NSOE) Environmental Master's Student Community*. (tesis inédita de maestría). Universidad de Duke, Nicholas School of the Environment, Estados Unidos. Recuperado de: <https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/14150/Evaluating%20Current%20Attitudes%20towards%20Snakes%20at%20NSOE.pdf?sequence=1&isAllowed=y>
- Carr, R. (2017). *XLStatistics: Excel workbooks for statistical analysis. Versión 17-02-16*. Recuperado de <https://www.deakin.edu.au/individuals-sites/?request=~rodneyc/XLStatistics>.
- Ceríaco, L. (2012). Human attitudes towards herpetofauna: The influence of folklore and negative values on the conservation of amphibians and reptiles in Portugal. *Journal of Ethnobiology and Ethnomedicine*, 8(8). DOI: 10.1186/1746-4269-8-8
- Estévez-Haro, M. A., & Proaño-Morales, A. S. (2019). Percepción y conocimiento de serpientes en una zona rural y urbana del Ecuador. *Ethnoscintia*, 4(1), 1-10. DOI: 10.22276/ethnoscintia.v4i1.153.
- Fita, D. S., Costa-Neto, E. M., & Schiavetti, A. (2010). "Offensive" snakes: cultural beliefs and practices related to snakebites in a Brazilian rural settlement. *Journal of Ethnobiology and Ethnomedicine*, 6(13). DOI: 10.1186/1746-4269-6-13.



- Galindo-González, L. (2015). La educación ambiental en la virtualidad: un acercamiento al estado del arte. *Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, 5(10), 1-42.
- García-López, R., Villegas, A., Pacheco-Coronel, N., & Gómez-Álvarez, G. (2017). Traditional use and perception of snakes by the Nahuas from Cuetzalan del Progreso, Puebla, México. *Journal of Ethnobiology and Ethnomedicine*, 13(6). DOI: 10.1186/s13002-016-0134-7.
- Gómez-Martínez, M.J., Gutiérrez-Montes, I., & DeClerck, F. (2014). Percepción local acerca de la calidad del agua y la herpetofauna en fincas ganaderas del municipio de Matiguás, Nicaragua. *Revista Luna Azul*, 38, 30-57.
- Gruber, G., Benayas, J., & Gutiérrez, J. (2001). Evaluación de la calidad de medios audiovisuales como recurso para la educación ambiental. *Tópicos en Educación Ambiental*, 3(8), 85-100.
- Kellert, S. R. (1984). Attitudes toward animals: age-related development among children. In Fox, M. W., & Mickley, L. D. (Eds.), *Advances in animal welfare science 1984/1985*, (pp. 43-60). Washington, DC: The Humane Society of the United States.
- Landová, E., Bakhshaliyeva, N., Janovcová, M., Pelésková, S., Suleymanova, M., Polák, J., Guliev, A., & Frynta, D. (2018). Association between fear and beauty evaluation of snakes: cross-cultural findings. *Frontiers in Psychology*, 9(333). DOI: 10.3389/fpsyg.2018.00333.
- Lavilla-Cerdán, L. (2011). La memoria en el proceso de enseñanza/aprendizaje. *Pedagogía Magna*, 11, 311-319.
- LoBue, V., Rakison, D. H., & DeLoache, J. S. (2010). Threat perception across the life span: evidence for multiple converging pathways. *Current Directions in Psychological Science*, 19(6), 375-379. DOI: 10.1177/0963-7214-1038-8801.
- Nonga, H. E., & Haruna, A. (2015). Assessment of human-snake interaction and its outcomes in Monduli District, northern Tanzania. *Tanzania Journal of Health Research*, 17(1), 1-12. DOI: 10.4314/thrb.v17i1.9.
- Pandey, D. P., Pandey, G. S., Devkota, K., & Goode, M. (2016). Public perceptions of snakes and snakebite management: Implications for conservation and human health in southern Nepal. *Journal of Ethnobiology and Ethnomedicine*, 12(22). DOI: 10.1186/s13002-016-0092-0.
- Pandey, D. P., Chaudhary, B., Pandey, G. S., Piya, R. C., & Devkota, N. R. (2020). School Students' Perceptions on Snakes, their Uses, and Snakebite in Nepal: Implications for Snake Conservation and Snakebite Prevention. *Advances in Clinical Toxicology*, 5(1). DOI: 10.23880/act-16000180.
- Perales, F. J., & García-Granada, N. (1999). Educación ambiental y medios de comunicación. *Comunicar*, 12, 149-155.
- Pinheiro, L. T., Mota, J. F., & Borges-Nojosa, D. M. (2016). Formal education, previous interaction and perception influence the attitudes of people toward the conservation of snakes in a large urban center of northeastern Brazil. *Journal of Ethnobiology and Ethnomedicine*, 12(25). DOI: 10.1186/s13002-016-0096-9.
- Prokop, P., Özel, M., & Uşak, M. (2009). Cross-cultural comparison of student's attitudes toward snakes. *Society and Animals*, 17(3), 224-240. DOI: 10.1163/156853-009-X-445398.
- Prosser-Bravo, G., & Romo-Medina, I. (2019). Investigación en educación ambiental con menores en Iberoamérica: Una revisión bibliométrica de 1999 a 2019. *Revista mexicana de investigación educativa*, 24(83), 1027-1053.
- Quesada-Acuña, S. G. (2018). Serpientes de la Gran Área Metropolitana (GAM) de Costa Rica. *UNED Research Journal*, 10(1), 81-90. DOI: 10.22458/urj.v10i1.2044
- Quesada-Acuña, S. G. (2019). Percepción y conocimiento sobre serpientes en funcionarios de una universidad pública costarricense. *UNED Research Journal*, 11(3), 369-377. DOI: 10.22458/urj.v11.i3.2654.
- Reynolds, B. R., Salamander, T., & Wilson, T. P. (2018). A walk in the woods: changing student attitudes toward amphibians and reptiles. *Creative Education*, 9, 182-191. DOI: 10.4236/ce.2018.92014.



- Ríos-Orjuela, J. C., Falcón-Espitia, N., Arias-Escobar, A., Espejo-Urbe, M. J., & Chamorro-Vargas, C. T. (2020). Knowledge and interactions of the local community with the herpetofauna in the forest reserve of Quiníní (Tibacuy-Cundinamarca, Colombia). *Journal of Ethnobiology and Ethnomedicine*, 16(17). DOI: 10.1186/s13002-020-00370-8.
- Sánchez-Paniagua, K., González-Villalobos, K., & Abarca, J. G. (2018). Percepción social y encuentros con serpientes en Costa Rica: un análisis a través de la red social Facebook. *Revista de Ciencias Ambientales*, 52(1), 190-208. DOI: 10.15359/rca.52-1.11.
- Santiago-Rivera, J. A. (2008). La problemática del ambiente, la educación ambiental y el uso didáctico de los medios de comunicación social. *Investigación y Postgrado*, 23(2), 241-270.
- Sasa, M., Bonilla, F., & Chaves, F. (2019). *Serpientes venenosas de Costa Rica: Biología básica*. San José, Costa Rica: Universidad de Costa Rica, Instituto Clodomiro Picado.
- Savage, J. M. (2002). *Amphibians and reptiles of Costa Rica: A herpetofauna between two continents, between two seas*. Chicago, Estados Unidos: University of Chicago Press.
- Solórzano, A. (2004). *Serpientes de Costa Rica: Distribución, taxonomía e historia natural*. Heredia, Costa Rica: Instituto Nacional de Biodiversidad (INBio).
- Souchet, J., & Aubret, F. (2016). Revisiting the fear of snakes in children: the role of aposematic signaling. *Scientific Reports*, 6(37619). DOI: 10.1038/srep37619.
- Torkar, G. (2015). Pre-service teachers' fear of snakes, conservation attitudes, and likelihood of incorporating animals into the future science curriculum. *Journal of Baltic Science Education*, 14(3), 401-410.
- Zipkin, E. F., DiRenzo, G. V., Ray, J. M., Rossman, S., & Lips, K. R. (2020). Tropical snake diversity collapses after widespread amphibian loss. *Science*, 367, 814-816. DOI: 10.1126/science.aay5733

