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PRE-SERVICE BIOLOGY TEACHERS' REPORTED FEAR AND DISGUST OF ANIMALS AND THEIR WILLINGNESS TO INCORPORATE LIVE ANIMALS INTO THEIR TEACHING THROUGH STUDY YEARS

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Abstract. *In this research, the self-reported fear and disgust toward animals of pre-service biology teachers and their willingness to incorporate live animals into their teaching were assessed with a questionnaire. An entire generation of pre-service biology teachers (N = 128) participated in this research. The results show that students are mostly afraid of animals that are potentially dangerous to humans such as large predators and are disgusted mostly by animals that are small and wet looking, like a slug. The students were less willing to incorporate animals that they reported to be most fearful or disgusting into their teaching. Considering that throughout their study years, there was practically no change in students' levels of fear, disgust and willingness to incorporate live animals into their teaching calls for an improvement of the biology teacher education study programme in order to train teachers that are skilled and willing to use live animals in their teaching. One of the solutions could be offering pre-service teachers as many first-hand experiences with live animals as possible either in a formal learning environment, such as the university or, in case of large animals (predators), in informal learning environments, like a zoo or a national park.*

Keywords: *disgust of animals, students beliefs, fear of animals, pre-service teachers.*

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Introduction

Attitudes toward animals are influenced by human-animal interactions and range from positive to negative. Direct experiences with animals are a positive predictor of the strength of attitudes (Špur, Pokorny, & Šorgo, 2016) and direct contact in general changes people's attitudes (Bjerke, Østdahl, & Kleiven, 2003; Tomažič, 2011b; Wagler, 2010; Wagler & Wagler, 2011). Attitudes are more powerful if they are related to our evolutionary past (Herzog & Burghardt, 1988) as well as by the direct benefits one gets from the economic value of certain animals (Serpell, 2004). However, one must consider that attitudes toward different species of animals that are feared and disliked cannot be easily reversed from negative to positive (Kaltenborn, Bjerke, Nyahongo, & Williams, 2006).

American psychologist Plutchik (1991) defined two groups of emotions: basic and complex. Expressed fear of animals mostly functions as a response to the perceived or immediate threat of physical injury (Davey, McDonald, Hirisave et al., 1998), while disgust toward animals may act as a protective agent against possible contamination (Davey, Cavanagh, & Lamb, 2003; Prokop & Fančovičová, 2013; Prokop, MedinaJerez, Coleman, Fančovičová, Özel, & Fedor, 2016). In some cases, fear may act as a reinforcing mechanism for disgust and disgust may also act as a reinforcing mechanism of fear (Woody & Techman, 2000). For example, in regards to the fear of spiders, disgust is supposed to have a secondary influence to fear, acting as a reinforcing agent (Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002).

Davey et al. (1998) conducted an international research on the fear of animals categorizing animals into three groups: 'fear-relevant' (fierce animals that can cause physical injury and pain - e.g., wolves, lions, bears); 'disgust-relevant' (associated with spread of disease, infection or contamination of food sources, or possessing features that resemble disgust-evoking stimuli - e.g., slimy animals); and 'fear-irrelevant' animals (that generally do not evoke fear reactions - e.g., companion or domesticated animals such as a cat, a hamster, a rabbit, or a cow). Similarly, Tomažič (2011a), conducted a

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research on a Slovenian sample in which he interviewed lower secondary school students (aged 11-12). Students had to rate their level of fear and disgust towards 20 animals. In that research, animals were categorized similarly to the Davey et al. (1998) research on both fear and disgust scales. Three factors that have been extracted on both scales can also be considered as fear-relevant animals, disgust-relevant animals and fear-irrelevant animals or 'pets'.

Education is, according to Kellert (1996), one of the most important factors in forming positive attitudes toward animals. Teachers in schools as well as pre-service teachers of science and biology are encouraged to include live animals in their teaching because it is known that the use of live animals in educational setting (direct experiences) positively affects students' knowledge, attitudes and emotions (Tomažič, 2008; Ballouard, Provost, Barré, & Bonnet, 2012; Randler, Hummel, & Prokop, 2012). Randler et al. (2012) for example, used three unpopular animals (a wood louse, snail and mouse) to research how practical work in biology teaching influences the self-reported fear and disgust of students toward the above-mentioned animals. Their research showed that negative emotions toward animals can be positively influenced by coming into physical contact with them. The same effect of direct contact with animals has also been reported in other studies (Bjerke et al., 2003; Tomažič, 2011c; Wagler & Wagler, 2011). Tomažič (2011c) found that students were more willing to study toads and were less frightened or disgusted by them when they reported having had a direct experience with the above-mentioned animals.

Studies about attitudes toward animals are usually conducted on primary or secondary school students but rarely on biology teachers or pre-service biology teachers (Tomažič, 2011b; Torkar, Kubiatko, & Bajd, 2012; Torkar, 2015; Wagler, 2010; Wagler & Wagler, 2011). Tomažič (2011b) argued that although university students generally possess more knowledge about snakes, it is not a successful precursor for harbouring positive attitudes toward these reptiles. On the other hand, Prokop, Özel, & Uşak (2009) found, that first-year biology majors had the same knowledge about snakes than first-year non-majors, but the latter held more negative attitudes toward snakes than former. The authors concluded that other factors such as interest in biology could also affect students' attitude ratings. Torkar (2015) studied the effect of direct experience on the fear of snakes, conservation attitudes, and the likelihood of incorporating snakes into future science curriculum of pre-service teachers majoring in preschool and primary education. His research confirmed that students are generally afraid of snakes and that the self-reported fear negatively influences their conservation attitudes and decreases the likelihood of incorporating snakes into the future science curriculum. Students who reported having had a direct experience with snakes also reported having less fear of those animals and expressed more willingness to incorporate live snakes into the future science curriculum. Similar results were obtained by Wagler & Wagler (2011) who found that if pre-service teachers had positive attitudes toward Madagascar hissing cockroaches, they were more likely to believe they would use them in their future science curriculum. However, this only applied to Madagascar hissing cockroaches and not any other animals. Present research explores whether similar results can be obtained in a wide range of potentially unpopular animal species with the emphasis on how emotions and willingness incorporate live animals into their teaching change through study years.

Problem of Research

The renewed lower secondary school science curriculum for sixth and seventh grade (students' age 11 – 13) entered into force in the year 2011. In the sixth grade, students learn mainly about plants and in the seventh grade mainly about animals (animals' structure and function). According to mentioned curricula, it is obligatory that teachers assign 40 % of the teaching time to the teaching that is based on practical work. Therefore, when students learn about animals, a viable option is that teachers also offer students direct experiences of live animals, while it is known, that such experiences positively influence students' attitudes and lower negative emotions (fear and disgust) toward them (Randler et al., 2012; Tomažič, 2008, 2011a, 2011c). In order to plan and execute such teaching, teachers themselves must hold positive attitudes toward animals and express low fear and disgust toward them. Little information is accessible about the effectiveness of teacher education programmes on this topic (i.e. Randler, Hummel, & Wüst-Ackermann, 2013; Wagler & Wagler, 2011).

Research Focus

The aim of the present research was to explore the impact that fear and disgust of animals may have on pre-service biology teachers' willingness to incorporate live animals into their teaching. It was predicted that: (1) students would not report any hesitations for working with live animals as teachers, since they had to attend lectures and

laboratory sessions focusing predominantly on animals in the course of their studies, (2) students who have decided to become biology teachers would express little or no fear and disgust of animals and (3) students' emotions toward animals and willingness to incorporate live animals into their future teaching would change through study years.

Methodology of Research

General Background of Research

The research design was quantitative. Fear and disgust of animals of Slovenian pre-service biology teachers and their willingness to incorporate live animals into their teaching was studied by administering a questionnaire. The research was conducted at the University of Ljubljana, Biotechnical Faculty in the 2014/2015 study year.

Sample of Research

The sample of the research consisted of 128 pre-service biology teachers (aged 18-26), studying two streams at the Faculty of Education. They were biology-chemistry and biology-home economics Bachelor degree (BSc) students from the first to the fourth year of study ($N_{First} = 38$; $N_{Second} = 32$; $N_{Third} = 32$; $N_{Fourth} = 26$). In order to become licensed teachers, they must enrol in a one-year master study (MSc) after graduating from their undergraduate study course. There were no statistically significant differences in the distribution of students according to study year and study programme ($\chi^2 = 0.594$, df = 3, $p = 0.898$). Also, there were no statistically significant differences in the distribution of students according to study year and gender ($\chi^2 = 4.020$, df = 3, $p = 0.259$). Number of males attending first, second, third and fourth year were six, seven, four and one, respectively. Because there were only 18 (14%) male students in total studying to become biology teachers, gender was not considered for analysis. The same problem was also noticed in Torkar's (2015) research, in which gender proportions in the sample were affected by the feminization of the teaching profession in Slovenia.

Instrument and Procedures

The participating students completed a questionnaire within the Didactics of Biology courses that are offered to all student teachers throughout their study years. The time used to fill out the questionnaires was between 20 to 25 minutes. A PowerPoint presentation with projected colour images of 19 animals (animal species) onto the screen was used because students were rating animals on the basis of their visual appearance. For each animal, students were asked to rate their level of fear, disgust and their willingness to incorporate a live animal into their teaching (hereafter: WTI) on a 5-point scales. Fear was rated on the following scale: 1 = *I am not afraid of the animal*; 2 = *I am slightly afraid of the animal*; 3 = *I am afraid of the animal*; 4 = *I am very afraid of the animal*; and 5 = *I am terrified of the animal*. This scale was similar to the one used by Davey et al. (1998) and Tomažič (2011a). Items about disgust were rated on the following scale: 1 = *The animal is not disgusting*; 2 = *I have an unpleasant feeling when close to the animal*; 3 = *The animal is disgusting*; 4 = *This animal makes me sick*; and 5 = *This animal makes me vomit*. The same scale was used in Tomažič (2011a) research. Willingness to incorporate live animals into their teaching scale (Wagler, 2010) was modified from 4-point to 5-point scale where the term '*Perhaps'* was added: 1 = *With no problem at all*; 2 = *With no problem*; 3 = *Perhaps*; 4 = *With a problem*; and 5 = *Absolutely not*.

Additionally, the students had to name each animal as precisely as possible, and report basic information about their gender, study programme and study year. The questionnaire included nineteen animals of different taxonomic groups: invertebrates, fish, amphibians, reptiles and mammals (Table 1).

Data Analysis

In statistical analysis, a Principal Component Analysis (PCA) with Varimax rotation for fear, disgust and WTI items was first applied. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy tests and Bartlett's tests for sphericity were used in order to find if the PCA was appropriate for these data sets. Principal components (PCs) with eigenvalues greater than 1.0 were considered for further analysis. In order to test the reliability of extracted principal components, Cronbach's α coefficients were calculated. If Cronbach's α values were below the accepted limit of 0.69 (Leech, 2005), that is noted in the results section.

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Next, means (*M*) and standard deviations (*SD*) were calculated according to study years for individual PCs. Kruskal-Wallis tests were used in order to determine if there were any improvements in lowering students fear and disgust toward animals and in heightening their willingness to incorporate live animals into their teaching throughout study years. Non-parametric tests were chosen because of the non-Gaussian distribution of some data extracted from principal component analyses. If statistically significant differences in students' ratings according to study years were found on the individual principal component, Dunn-Bonferroni pairwise comparisons were used in order to determine which year students differed statistically.

Spearman correlations (ρ) between fear, disgust and willingness to incorporate live animals into their teaching were calculated for individual animals in order to find which emotion, if either, has an effect on students' willingness to incorporate live animals into their teaching.

All the data were analysed using the SPSS for Windows 20.0.0 statistical software.

Results of Research

Results of Principal Component Analysis (PCA) for Fear, Disgust and WTI Items

Principal component analysis (PCA) for fear items

The KMO (Kaiser-Mayer-Olkin) index of the sampling adequacy test (0.861) and Bartlett's test for sphericity ($p < 0.001$) suggested that PCA for fear items was appropriate (Table 1). According to the PCA, five PCs for fear toward animals can be interpreted. Amphibians loaded highest under PC I. Under PC II, animals that can cause physical injury and pain were placed. Under PC III and V only invertebrates were present. These two PCs are the least reliable due to the low Cronbach alphas and should be interpreted with caution. PC III includes 'slimy' invertebrates, while PC V includes two 'non-slimy' invertebrates. Within PC IV some animals considered as 'pests' were placed (mouse, rat and fly). Madagascar hissing cockroach, slug and louse did not load in any of the PCs for fear toward animals. Loadings (above 0.42 are shown) and Cronbach's alphas with the means for individual PCs are presented in Table 1.

Table 1. Principal component analysis with a varimax rotation of items on the fear toward animals scale.

N	Animal	Fear					α^a= 0.87
		Principal component					α
		I	II	III	IV	V	
1	Toad	0.843					
2	Edible frog	0.820					α = 0.86
3	Salamander	0.773					
4	Brown bear		0.772				
5	Shark		0.764				
6	Wolf		0.749				α = 0.82
7	Grass snake		0.604				
8	Scorpion		0.592				
9	Earthworm			0.806			
10	Leech			0.625			α = 0.56
11	Maggot			0.570			
12	Mouse				0.763		
13	Fly				0.756		α = 0.68
14	Rat				0.680		

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N	Animal	Fear					α^a= 0.87
		Principal component					α
		I	II	III	IV	V	
15	Tick					0.750	α = 0.45
16	Spider					0.620	
17	Madagascar hissing cockroach						NC
18	Slug						
19	Louse						
	M	1.4	2.5	1.5	1.5	2.0	
	SD	0.73	0.82	0.63	0.61	0.83	
	95% CI	[1.26, 1.52]	[2.35, 2.63]	[1.37, 1.59]	[1.34, 1.56]	[1.85, 2.14]	

Note: N = numerous; α^a = Cronbach's alpha for 19 scale items; α = Cronbach's alpha for individual PC; NC = not calculated; M = mean; SD = standard deviation; 95% CI = confidence intervals

Principal component analysis (PCA) for disgust

The KMO (Kaiser-Mayer-Olkin) index of the sampling adequacy test (0.796) and Bartlett's test for sphericity ($p < 0.001$) suggested that PCA for disgust items was appropriate (Table 2). According to the PCA six PCs for disgust toward animals can be interpreted. As with the PCA for fear, amphibians loaded highest in PC I. Within this PC, the grass snake was also included. Under PC II, large predators were placed. Under PC III, IV and VI invertebrates are loaded. Rodents are loaded under PC V. Earthworm was not placed under any of the PCs. Loadings (above 0.42 are shown) and Cronbach's alphas with the means for individual PC are presented in Table 2. PCs IV and VI are least reliable.

Table 2. Principal component analysis with a varimax rotation of items on the disgust toward animals scale.

N	Animal	Disgust						α^a= 0.87
		Principal component						α
		I	II	III	IV	V	VI	
1	Edible frog	0.820						α = 0.80
2	Toad	0.752						
3	Salamander	0.742						
4	Grass snake	0.629						
5	Brown bear		0.788					α = 0.74
6	Shark		0.774					
7	Wolf		0.757					
8	Leech			0.783				α = 0.69
9	Slug			0.679				
10	Maggot			0.663				
11	Spider				0.782			α = 0.66
12	Madagascar hissing cockroach				0.672			
13	Scorpion				0.547			

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N	Animal	Disgust						α^{a}= 0.87
		Principal component						α
		I	II	III	IV	V	VI	
14	Mouse					0.835		α = 0.75
15	Rat					0.737		
16	Louse						0.657	α = 0.64
17	Fly						0.651	
18	Tick						0.597	
19	Earthworm							NC
	M	1.6	1.4	2.2	1.9	1.7	1.9	
	SD	0.68	0.57	0.82	0.70	0.69	0.67	
	95% CI	[1.46, 1.69]	[1.24, 1.43]	[2.02, 2.30]	[1.74, 1.99]	[1.59, 1.83]	[1.74, 1.98]	

Note: N = numerous; α^{a} = Cronbach's alpha for 19 scale items; α = Cronbach's alpha for individual PC; NC = not calculated; M = mean; SD = standard deviation; 95% CI = confidence intervals

Principal component analysis (PCA) for willingness to incorporate live animals into their teaching (WTI)

The KMO (Kaiser-Mayer-Olkin) index of the sampling adequacy test (0.832) and Bartlett's test for sphericity ($p < 0.001$) suggested that PCA for their willingness to incorporate live animals into their teaching was appropriate for this data set (Table 3). According to the PCA, five PCs for WTI can be interpreted. Invertebrates loaded highest under PC I. Under PC II, loaded amphibians and earthworm. Under PC III, loaded large predators. Under PC IV loaded rodents and under PC V loaded only one animal (fly). Grass snake, spider and tick did not load on any of the above-mentioned PCs. Loadings (above 0.42 are shown) and Cronbach's alphas with the means for individual PC are presented in Table 3.

Table 3. Principal component analysis with a Varimax rotation of items on the willingness to incorporate live animals into their teaching scale.

N	Animal	WTI					**αα= 0.89**
		Principal component					**α**
		I	II	III	IV	V	
1	Maggot	0.749					α = 0.80
2	Madagascar hissing cockroach	0.692					
3	Leech	0.641					
4	Slug	0.554					
5	Scorpion	0.526					
6	Edible frog		0.795				α = 0.80
7	Toad		0.747				
8	Salamander		0.732				
9	Earthworm		0.507				

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N	Animal	WTI					αα= 0.89
		Principal component					α
		I	II	III	IV	V	
10	Brown bear			0.865			α = 0.85
11	Shark			0.842			
12	Wolf			0.799			
13	Rat				0.859		α = 0.81
14	Mouse				0.827		
15	Fly					0.842	NC
16	Grass snake						NC
17	Spider						
18	Tick						
19	Louse						
	M	2.4	1.8	2.9	2.1	1.4	
	SD	0.94	0.83	1.13	1.13	0.84	
	95% CI	[2.28, 2.61]	[1.62, 1.91]	[2.74, 3.14]	[1.94, 2.34]	[1.24, 1.53]	

Note: N = numerous; α[a] = Cronbach's alpha for 19 scale items; α = Cronbach's alpha for individual PC; NC = not calculated; M = mean; SD = standard deviation; 95% CI = confidence intervals

The Expression of Fear, Disgust and WTI through Study Years

Fear through study years

More than 40% of students expressed slight or strong fear toward ten out of the nineteen animals: shark (90%), brown bear (83%), scorpion (78%), wolf (77%); spider (67%), grass snake (59%), tick (54%), rat (52%), leech (48%), and Madagascar hissing cockroach (43%).

Table 4 illustrates statistically significant differences in students' ratings only on the principal components (PC) about fear. That is, for the Fear I PC, first year students reported the highest level of fear, which was lower in the second year and slightly higher again in the third and fourth study years (Kruskall-Wallis test: $\chi^2 = 8.77$; df = 3; $p = 0.033$). The difference was significant between the ratings of first and second year students (Dunn-Bonferroni: $p = 0.019$). The same trend emerged in regards to the Fear III PC, where the fourth year students' level of fear returned to the same level as that of the first year students (Kruskall-Wallis test: $\chi^2 = 11.35$; df = 3; $p = 0.010$). The greatest differences in ratings were found between first and second year students (Dunn-Bonferroni: $p = 0.037$). The difference between second and fourth year students' ratings was marginal (Dunn-Bonferroni: $p = 0.063$).

Students expressed the most fear of animals that pose a physical threat (Fear II PC; $M = 2.5$; $SD = 0.82$). This means that they were afraid or slightly afraid of harmful animals. They were also slightly afraid of animals that were loaded under the Fear V PC ($M = 2.0$; $SD = 0.83$). For all other fear PCs (I, III and IV) it can be stated that students are generally not afraid of those animals.

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Table 4. Means and standard deviations for individual principal component of fear, disgust and WTI according to study year.

PC	Year 1		Year 2		Year 3		Year 4		KW	
	M	SD	M	SD	M	SD	M	SD	χ^2	p
Fear I - amphibians	1.6	0.98	1.1	0.29	1.4	0.84	1.3	0.37	8.77	0.033
Fear II - harmful	2.4	0.83	2.5	0.82	2.6	0.92	2.5	0.71	1.36	0.715
Fear III - slimy	1.7	0.75	1.2	0.31	1.4	0.52	1.6	0.73	11.35	0.010
Fear IV - pest	1.5	0.65	1.4	0.64	1.5	0.64	1.4	0.47	0.45	0.931
Fear V - non-slimy	2.1	0.86	1.9	0.88	1.8	0.72	2.0	0.86	2.66	0.447
Disgust I - amphibian+	1.7	0.81	1.5	0.61	1.5	0.65	1.6	0.56	3.14	0.371
Disgust II - harmful	1.4	0.57	1.3	0.48	1.4	0.57	1.4	0.68	0.33	0.954
Disgust III - slimy	2.2	0.95	2.0	0.78	2.0	0.72	2.4	0.72	4.70	0.195
Disgust IV - non-slimy	2.1	0.80	1.8	0.70	1.7	0.60	1.9	0.62	4.39	0.222
Disgust V - pest	1.6	0.66	1.7	0.72	1.8	0.77	1.8	0.58	2.96	0.398
Disgust VI - parasite	1.9	0.60	1.9	0.82	1.8	0.63	1.8	0.64	0.89	0.827
WTI I - invertebrates	2.5	0.98	2.3	0.84	2.4	1.00	2.6	0.96	1.51	0.681
WTI II - amphibians+	2.0	1.01	1.5	0.60	1.8	0.80	1.8	0.75	5.72	0.126
WTI III - harmful	2.6	1.06	3.3	1.08	3.0	1.30	2.9	0.98	6.13	0.105
WTI IV - pest	2.1	1.22	1.9	0.94	2.4	1.17	2.3	1.17	4.09	0.252

Note: PC – principal component; M – mean; SD – standard deviation; KW - Kruskal-Wallis test; df = 3

Disgust through the study years

For twelve out of the nineteen animals, more than 40% of students expressed slight or strong disgust: maggot (78%), tick (76%), leech (63%), scorpion (62%); Madagascar hissing cockroach (62%), louse (62%), spider (59%), slug (57%), rat (57%), toad (49%), shark (43%), and edible frog (41%).

The results of students' ratings on disgust PCs (Table 4) showed that they are not disgusted by harmful animals (Disgust II PC: $M = 1.4$; $SD = 0.57$). They feel the most uncomfortable around animals that loaded under the Disgust III PC ($M = 2.2$; $SD = 0.82$), then equally with the Disgust IV PC ($M = 1.9$; $SD = 0.70$) and Disgust VI PC ($M = 1.9$; $SD = 0.67$). They also found mice and rats unpleasant. (Disgust V PC: $M = 1.7$; $SD = 0.69$). Amphibians and grass snake in the Disgust I PC did not score very highly on the disgust scale ($M = 1.6$; $SD = 0.68$).

In Table 4, the results on the disgust PC are presented according to study year. No statistically significant differences in students' ratings according to study year on any principal component were found (all $p > 0.05$).

Willingness to incorporate live animals into their teaching (WTI) through study years

For ten out of the nineteen animals, more than 40% of students expressed that they might or would not use the animals in their teaching: shark (72%), brown bear (68%), scorpion (62%), maggot (55%); wolf (52%), spider (48%), leech (45%), rat (45%), tick (43%), and louse (43 %). Between 25 and 40% would also not use a slug, grass snake, Madagascar hissing cockroach, toad or a mouse. Below 25% of the students would not use an edible frog, salamander, earthworm or a fly in their teaching.

PCA for WTI produced five principal components. The last PC contained only one item (Fly), therefore it is not included in this part of the results. The results of students' ratings on the WTI PCs (Table 4) have shown that they are the least willing to include harmful animals into their teaching (WTI III PC: $M = 2.9$; $SD = 1.13$), followed by willingness to include invertebrates into their teaching (WTI I PC: $M = 2.4$; $SD = 0.94$). They are prepared to include

amphibians (and earthworms), (WTI II PC: $M = 1.8$; $SD = 0.83$) and even rats and mice (WTI IV PC: $M = 2.1$; $SD = 1.13$) into their teaching. No statistically significant differences in students' ratings according to study year on any principal component were found (Table 4; all $p > 0.05$).

Correlations between Fear, Disgust and Willingness to Incorporate Live Animals into their Teaching for an Individual Animal

Spearman correlations between fear (F), disgust (D) and WTI were calculated in order to determine which emotion, if either, has an effect on students' willingness to incorporate live animals into their teaching (Table 5). Positive correlations between fear and disgust mean that the more students are afraid of an individual animal, the more they are disgusted by it. On the other hand, positive correlations between fear/WTI and disgust/WTI can be interpreted as the more they fear an animal or the more an animal disgusts them, the less they are willing to incorporate it into their teaching.

There were generally medium correlations found between disgust and fear ratings for all animals, except for the wolf, where the there was no correlation between fear and disgust ratings ($\rho = 0.17$). The highest correlation between ratings of fear and disgust was found for the rat ($\rho = 0.75$).

Correlations between fear and WTI were high for the following animals: grass snake ($\rho = 0.83$), spider ($\rho = 0.73$), mouse ($\rho = 0.70$), rat ($\rho = 0.70$) and scorpion ($\rho = 0.76$). Correlations between disgust and WTI were high for more than a half of the animals used in the study: leech ($\rho = 0.71$), Madagascar hissing cockroach ($\rho = 0.72$), toad ($\rho = 0.78$), grass snake ($\rho = 0.70$), mouse ($\rho = 0.81$), slug ($\rho = 0.84$), edible frog ($\rho = 0.78$), maggot ($\rho = 0.78$), salamander ($\rho = 0.72$), and earthworm ($\rho = 0.70$).

From Table 5, it can be seen that for some animals F/WTI correlations are larger from D/WTI and vice versa. These differences, if present, show which of the emotions determines the WTI ratings to a greater extent. The differences greater than 0.2 were considered. Disgust is to a greater extent correlated with WTI for animals such as slug, earthworm, edible frog, maggot and fly. And for wolf, scorpion, grass snake, shark and bear, fear predominated disgust when WTI was of concern.

Table 5. Spearman correlations between fear, disgust and willingness to incorporate live animals into their teaching.

N	Animal	Fear - Disgust (ρ)	Fear - WTI (ρ)	Disgust - WTI (ρ)
1	Leech	0.52	0.58	0.71
2	Madagascar hissing cockroach	0.60	0.69	0.72
3	Toad	0.60	0.66	0.78
4	Wolf	0.17**	0.63	0.34
5	Grass snake	0.68	0.83	0.70
6	Spider	0.56	0.73	0.64
7	Mouse	0.61	0.70	0.81
8	Slug	0.34	0.35	0.84
9	Rat	0.75	0.70	0.69
10	Edible frog	0.62	0.56	0.78
11	Louse	0.53	0.55	0.70
12	Scorpion	0.50	0.76	0.58
13	Maggot	0.54	0.58	0.78
14	Shark	0.45	0.57	0.36
15	Brown bear	0.46	0.56	0.36
16	Salamander	0.61	0.57	0.72
17	Earthworm	0.41	0.42	0.70

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N	Animal	Fear - Disgust (ρ)	Fear - WTI (ρ)	Disgust - WTI (ρ)
18	Fly	0.33	0.19*	0.47
19	Tick	0.52	0.60	0.55

*Note: ρ = Spearman's rank correlation coefficient; for value marked with *: $p < 0.031$ and **: $p > 0.05$, for all other values: $p < 0.001$; for values that are shown in bold are considered to have a strong positive correlation.*

Discussion

This research is one of the few that examine the feelings of pre-service biology teachers toward animals that are generally not likable. Although there was a relatively small sample size of students (N = 128) included in present research, this sample represented all the students of the four-year cycle enrolled in the pre-service biology teachers course (the whole population).

The results have shown that students are mostly afraid of animals that can cause physical pain (brown bear, shark, wolf, grass snake and scorpion), (Table 1). For these animals, it can be said that they are predatory animals and, just as researchers Edmunds (1974) and Seligman (1971) found, it can be confirmed that the emotion of fear is associated with predatory animals that are potentially dangerous to humans. In the category of the most disgusting animals, students placed small and slimy-looking animals (maggot, tick, rat, louse, slug, cockroach, leech, spider, toad and edible frog) at the top of their list. These results have shown that the emotion of disgust is primarily associated with avoidance of those animals that bear some resemblance to body products such as mucus, or have been in contact with rotting animal flesh or other human waste (Rozin, Haidt, McCauley, 2008). Research also showed that disgust is an emotion that is adaptive, because it reduces the probability of transmission of infectious diseases (Prokop, Fančovičova, & Fedor, 2010; Prokop, Uşak, & Fančovičová, 2010a; Prokop, Uşak, & Fančovičova, 2010b; Oaten, Stevenson, & Case, 2009; Stevenson, Case, & Oaten, 2009; Curtis, Aunger, & Rabie, 2004; Curtis & Biran, 2001).

It is also not necessarily true that if students fear a certain animal they also feel disgust toward the same animal (Table 5). It can only be speculated that fear increases disgust of certain animals (or vice versa). There were, however, positive relationships between fear and disgust. These data have also shown that for some animals, disgust is a primary emotion, while for others, fear is a primary emotion. As in the Davey et al. (1998) research, some animals in present research can be categorized as fear-relevant and others as disgust-relevant. However, previous research did say that fear, in some cases, can act as a reinforcing mechanism for disgust and vice versa, disgust may act as a reinforcing mechanism for fear (Sawchuk et al., 2002), which can also be speculated from present results (i.e. almost 40% of students expressed some level of disgust toward snakes).

Although a few statistically significant differences were found amongst the fear principal components, they were found on account of the second or third year students (Table 4). No significant differences in ratings were found between first and fourth year students. The same applied for disgust ratings, where no significant differences were found on any principal component (Table 4). It would be expected that the level of fear and disgust of students would be lowered from the first to fourth year of study as a result of biology and biology didactics courses. But that was not the case. Perhaps more relevant results would be gathered if scales for fear and disgust items had not contained such extremes (fear: '*I am terrified of that animal*' or disgust: '*This animal makes me vomit*'), as the primary role of this research was not to find phobic individuals.

The results that relate to willingness to incorporate live animals into their teaching (WTI) have shown that students are not willing to incorporate animals they are mostly afraid of and also animals that disgust them into their teaching (Table 3). From the perspective of animal conservation, a question can arise if these students would be willing to protect animals that are evoking disgust or fear (see Prokop & Fančovičová (2013a). For large predators, it is obvious that pre-service teachers would not include them in their teaching, not only because of their fear, but because there is no possibility to bring a real wolf or a bear to the classroom. Nevertheless, it is not evident from the results of this research if students would organize an out-of-school activity where children for example, would observe large carnivores at the local zoo, or invite a person with a companion dog to school. Teachers can bring or keep in their classrooms almost all other animals that were included in present research. What is worrying is that students are undecided or not willing to incorporate some invertebrates into their teaching although topics about such animals are part of curricular requirements. In addition, a special cause for concern is that there was no change between students' WTI ratings through the study years although lower-secondary school students have been found to be motivated to work with living animals (Wandersee, 1986). Low willingness to incorporate live

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animals into their teaching may be contributed to a lack of working with live animals in university courses. Namely, in an invertebrate and vertebrate biology courses, students are in contact predominantly with preserved specimens, a problem also noted in Randler et al. (2013) research. As Tomažič (2011 a, c) found for primary school students, reported direct experiences with animals produce lower fear and disgust ratings toward almost all animals, which was also found in the research conducted by Randler et al. (2012).

WTI ratings can also be affected by students' knowledge. It is expected that the knowledge through the study years increases, but WTI is influenced also by other factors, both external and personality factors. Teachers usually state many reasons why they would not use animals in their teaching. They for example, list some external factors such as views of the principal, inappropriate infrastructure, time-consuming activities, inadequate technical support, cost of the animals and animal care (Adkins & Lock, 1994). They rarely think about or neglect to mention intrapersonal obstacles they themselves face when working (or for not working) with live animals which is also the case for schoolchildren (Bixler & Floyd, 1999). In Torkar's (2015) research, the pre-service teachers who had more knowledge about snakes supported their conservation and those who planned to include snakes into the future science curriculum had the most positive attitudes toward snakes. Similar to Torkar's (2015) research Wagler's (2010) research showed that students' attitudes toward animals affect their ratings on the WTI items. Studies on the WTI topic should therefore also include both the assessment of participants' knowledge and attitudes.

Conclusions

In addition to building pre-service teachers' knowledge, one of the main goals of their training should also be the development of positive attitudes toward living organisms and nature. Therefore, future biology teachers should meet and work with as many live animals as possible in the course of their studies (biology and biology didactics courses) in order to prepare them for using these animals in their teaching. It should be stressed, that live animals are not intended for the use in experimentation or dissection, but rather for external anatomy and behaviour observations, and for allowing students to experience immediate contact with animals. While not all animals mentioned in present research can be a source of direct experiences per se (teachers cannot bring large predators to the classroom), students can gain some experience of such animals at the local zoos, for example.

Previous research found that for animals, such as snakes, pre-service biology teachers are more willing to study them and have more knowledge about them than lower secondary school pupils. However, their negative view of snakes and willingness to protect animals is the same as in lower secondary school students. Pre-service teachers in the present research went through the same study programme. Therefore, it can be presumed that the acquired knowledge through study years did not affect their view of animals. Their knowledge is largely based on learning with the use of preserved specimens and lectures and not so much on experiencing live animals. Consequently, that way of learning did not produce a positive effect on their expression of fear and disgust toward animals through study years, as well as on their willingness to incorporate live animals into their teaching.

The results of the present research give an insight for possible improvements within mentioned study programme. The findings call for incorporation of live animals into science and biology teacher education programmes, not just into elective subjects but also within the compulsory part of the programmes. Through direct experience of animals, pre-service teachers would beside learning about animals also lower their fear and disgust toward animals and consequently be more willing to incorporate live animals into their teaching. Furthermore, they would gain skills how to handle and take care for the animals and would be able to recognize and manage potential cruelty to which live animals might be exposed to in the classroom. All of the above mentioned prepositions should be evaluated in the future research.

Limitations of the Research

Although present research encompassed all pre-service biology teachers from first to fourth year of the study in a reported school year, the results should not be generalized to in-service biology teachers practice. Additional research should be conducted in order to determine how in-service teachers report their emotions regarding selected animals and which or how many live animals do they actually incorporate into their teaching or chose not to because of their own negative feelings toward them.

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