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Animal dissections are essential parts of anatomy/zoology courses, but their effectiveness is influenced by student attitudes and emotions. Here we examined attitudes toward dissections in 397 prospective biology teachers enrolling two Slovak universities. Perceived disgust of dissections negatively correlated with other attitudes toward dissections domains and previous experiences with dissections correlated positively with attitudes toward dissections. Reported experiences with real and virtual dissections in Slovak elementary and high schools were rare. Students who owned animal(s) at home had less positive attitudes toward dissections than non-animal owners. Our research support an idea that prior experiences with dissections and low perceived disgust correlate with positive attitudes toward dissections. Special attention should be dedicated to females and to animal owners, because positive attitudes toward animals may be in conflict with supportive attitudes towards dissections.

Keywords: animals, attitudes, dissection, gender

INTRODUCTION

The goals of laboratory activities for medical or veterinary students, biologists and for prospective biology teachers often include development of students' skills and techniques that are important for their future careers (Wiles 2012). Dissections have ancient tradition, documented for example in Aristotle's work or in Galen's publication of the results of his investigations

on animals (see De Villiers & Monk 2005 for review). The modern tradition of the use of dissection in biology education began in the early 20th century (Kinzie et al. 1993).

Some authors argue that animal dissections are controversial in pedagogical practise (e.g. Oakley 2012) due to ethical and environmental concerns regarding the killing the animals (PETA 2004) and ignoring of animal welfare standards (Bishop & Nolen 2001, Hug 2008, Oakley 2009). A result, a debate over alternatives to dissection, such as various anatomical models (real or virtual), has started (Fowler and Brosius 1968, Balcombe 2001, Predavec 2001, Franklin et al. 2002, De Villiers & Monk 2005, Khalil et al. 2005, Maloney 2005, DeHoff et al. 2011). On the one side, alternatives to dissection bring some advances, such as low time/payment costs,

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State of the literature

- Dissections have ancient tradition, but debates over alternatives to dissection have started due to ethical concerns regarding the killing the animals.
- Supportive attitudes toward dissections are influenced by gender (males more) and by disgust sensitivity (disgust sensitive students have more negative attitudes).
- National Science Teachers Association and some researchers support integration of real animal dissections in the classrooms.

Contribution of this paper to the literature

- Slovak prospective teachers had neutral/slightly positive attitudes toward dissections and their prior experiences with dissections and low perceived disgust positively correlated with attitudes toward dissections.
- Owning animal(s) at home was associated with less positive attitudes toward dissections suggesting that there may be a conflict between preferences of animals and dissection support.

high flexibility of the use of alternatives and/or better visibility of animal internal organs (Predavec 2001, DeVilliers & Monk 2005). On the other side, opponents of dissection alternatives argue that models, videos or diagrams do not provide the same kind of learning that students experience in real dissection (Offner 1993), that students trained with computer dissection could not transfer their knowledge to the real animal (Duhropf 1998) and that such students cannot learn practical dissection skills (for review see DeVilliers & Monk 2005).

Disregarding current debates about relevance of real animal dissections, National Science Teachers Association (NSTA 2005; the largest professional organization of life science educators in the world) supports integration of real animal dissections into the classrooms. However, the NSTA also calls for more research in this area in order to objectively determine the effectiveness of real animal dissections. Recent research focused on the importance of emotions on learners' outcomes (Pekrun et al. 2002, Randler et al. 2005) revealed that students who felt disgust of dissection considered themselves as less effective at mastering the dissection (Holstermann et al. 2009, 2012), but students with more experience in dissections reported lower pressure (Randler et al. 2012a) and greater interest toward dissection (Holstermann et al., 2010). Females have obviously less supportive attitudes than males (Lock 1995, Akpan & Andre 1999, Holstermann et al. 2012, Quince et al. 2011). This suggests that perceived disgust of dissection and gender

would be associated with less supportive attitudes toward dissection in schools. Another, potentially important factor that would influence attitudes toward dissection, is owning a pet. Having an animal at home is associated with better knowledge of (Prokop et al. 2008) and more positive attitudes toward animals (Bjerke et al. 2003, Prokop et al. 2009, Prokop and Tunnicliffe 2010). However, building supportive attitudes toward animals by keeping them at home on one hand and killing/dissecting them on the other hand might be a conflicting situation, where animal owners are expected to have less supportive attitudes toward dissections. The potential of this idea can be reinforced by the fact that almost all veterinary students, who are expected to experience dissections in the university, had experiences with keeping pets (Serpell 2005). Thus, having an animal at home can potentially negatively influence attitudes toward dissections, but, as far as we are aware, no research in this field was conducted.

In this study, we investigated Slovak preservice biology teachers' attitudes toward real dissection. This demographic group of students is of special importance because future teachers should have developed skills and techniques that are important for their future teaching. Although doing dissections in secondary schools need not to be obligatory for prospective biology teachers, we agree with DeVilliers and Monk (2005) who suggested that "it makes sense to have first-hand experience of what one is teaching" (p. 595) for secondary biology teachers. We further investigate whether having animal(s) at home negatively influences attitudes toward dissections and whether Slovak students have any elementary or high school experiences with dissections, and which animals they dissect, because data in this field are scarce. We did not survey schools, but we instead used respondents' memories (which also can be noted as reflections), as a viable method for assessment of student perception of science education (Taylor et al. 1999, Hudson et al. 2010). We included gender and respondents' residence to our analyses, because females are expected to have different attitudes toward dissections than males (e.g. Lock 1995, Holstermann et al. 2012) and urban citizen show greater environmental concern (Van Liere & Dunlap 1981) and larger number of environmental responsibility values (Berenguer et al. 2005) than rural citizens.

METHODS

Respondents

The research was carried out between September 2009 and January 2010. A total of 397 students attending two universities located in Western (Trnava, N = 201) and East (Košice, N = 196) universities were involved in the research. This increased the probability

that students' experiences with dissections they experienced previously are not local, but they cover diverse parts of Slovakia. Basic demographic variable we asked students were 1. Sex, 2. Age, 3. Grade and 4. Whether they have any animal at home (a total of 259 of students [65%] reported that yes). All students were prospective teachers from various grades (1 – 5) who were voluntarily willing to participate on our research. The mean age of respondents was 20.8 year (SE = 0.08, range = 18 – 26). The sample was female-biased (351 females, 46 males) which is typical in Slovak educational universities (see Prokop et al. 2007). Respondents studied biology in combination with other subject (e.g. biology with chemistry, biology with math etc.). Preliminary analyses of differences between universities showed no significant differences, data were therefore pooled together.

Research instruments

Past experiences with dissections

Student memories about dissections were examined with a series of identical questions focused on different levels of schools. We asked whether they dissected any animal in their 1. elementary school (hereafter ESED), 2. high school (hereafter HSED), 3. in the university (hereafter UED) and 4. whether they ever dissected any animal (hereafter LED). Because ESED were generally scarce (see Results), we did not include this variable to multiple regression models. Similarly, UED must be influenced by grade, thus we omitted this variable from multiple regression models and rather controlled dependent variables for the effect of grade (see below).

Attitudes toward dissections questionnaire

A self-constructed questionnaire with 28 Likert-type items (rated from strongly disagree [1] to strongly agree [5]) was developed to examine attitudes toward dissections. Our intention was to examine perceived disgust of dissections, perceived importance of dissections in education, attitudes toward virtual dissections, attitudes toward practising dissections in elementary and high schools and ethical issues of dissections. The items were constructed either according to published papers that investigated costs and benefits of real and virtual dissections (Predavec 2001) as well as according our personal experiences with students who experience dissections in our courses of zoology. Furthermore, we followed recommendations of Eagly and Chaiken (1993) to ensure that the items reflect all three domains of attitudes: behavioural (example item: Each students studying biology should experience real dissection in practical works in the university), cognitive (example item: Real dissections are in accordance with

educational goals) and affective (example item: When I see a dissection, I am disgusted). A total of 16 items were negatively worded (i.e., they supported negative attitudes toward dissections), thus score of these items was reverse-scored for the purpose of factor analysis and reliability calculations. High mean scores generally reflect positive attitudes toward real dissections and low mean scores reflect negative attitudes toward real dissections. However, the disgust of dissections was, for the purpose of multiple regression and descriptive calculation, scored such that high score means high disgust of dissections and low score mean low disgust of dissections to make the results more understandable.

Raw scores were first analyzed with appropriate statistical methods to examine whether they are appropriate for factor analysis. Both Kaiser-Meyer-Olkin (KMO = 0.93) measure of sampling adequacy and Bartlett's Test of Sphericity ($\chi^2 = 5210.6$, $p < 0.0001$) resulted in high and statistically significant values suggesting that the strength of the relationship among the variables was strong. This meant we could use factor analysis to analyze the data.

Factor analysis (PCA with Varimax rotation) resulted in five factors with eigenvalues > 1.0 . All factors were interpretable and none of items were removed. Items showed high loadings in respective factors (values exceeding 0.5).

The first factor named Disgust of dissections domain explained 36% of the variability of results. Example of items include: When I see a dead animal, I feel uncomfortable, The blood of animal in real dissection would impede me (both items reverse scored). The second factor named Importance of dissections in biology education explained 9 % of the variability of results. Example of items include: Real dissections in anatomy education are necessary, I think that 3D models are better for dissections than real models (reverse scored). The third factor named Virtual dissections explained 6% of the variability of the results. Example of items include: Virtual dissections cannot replace real dissections, Virtual dissections are substitute for real dissections (reverse scored). The fourth factor named Dissections in elementary and high schools explained 5% of the variability of the results. Only two items belonged to this domain: Real dissections should not be practised on elementary schools and Real dissections should not be practised on high schools (both reverse scored). The fifth factor named Ethical aspects of dissections explained 4% of the variability of the results. Example of items include: The use of animals in education is OK, I support the use of dissections in universities. The reliability of the whole questionnaire was high (Cronbach $\alpha = 0.91$).

Statistical analyses

To control for potential effects of experiences with dissections obtained on practical works in the university, we controlled the effect of grade (independent variable) on each dependent variable in multiple regression models. Independent predictors in multiple regression models were gender, residence, LED, HSED and having animals at home.

RESULTS

Experiences with real and virtual dissections

Experiences with dissections were reported by 16 students (4%) at elementary school, 104 students (26%) at high school and 251 (63%) reported to have lifetime experiences with dissections. Most respondents with LED reported that they had experiences with dissections of fish, chicken, earthworm and rat (Fig. 1). Only 102 students (26 %) reported experiences with virtual dissections.

Attitudes toward dissections

Table 1 provides a summary of Slovak students' scores on five attitude domains. Data analysis has shown that students consider disgust of dissections to be about average and rather important for biology education. Real dissections received higher support than virtual dissections (note that support for virtual dissections was reverse scored, thus high mean score favours real dissections), but dissections at elementary/high schools were less favoured. Importantly, however, the lower mean score in this domain is caused by disagreement with dissections in elementary schools ($M = 2.14$, $SE = 0.05$), not in high schools ($M = 2.91$, $SE = 0.06$). The difference between

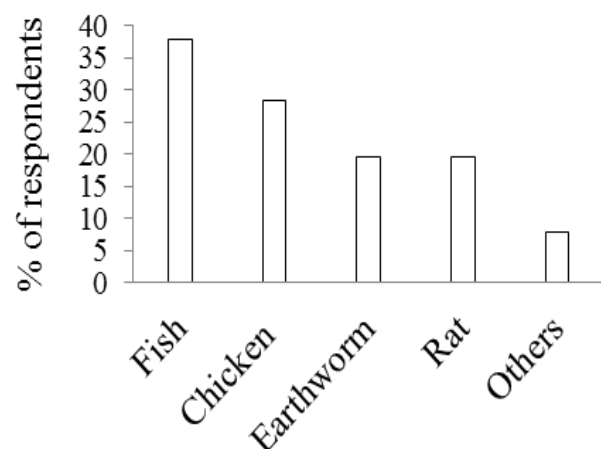


Figure 1. Most frequently cited animals used for dissection.

these two items were significant (paired t-test, $t = 14.03$, $df = 396$, $p < 0.00001$). Ethical aspects of dissections received positive score which reflects general support of dissections by students in schools.

Disgust of dissections

Multiple regression resulted in significant model ($R^2 = 0.07$, $F(3,390)=10.220$ $p < 0.00001$, Table 2). Respondents who reported to have LED had lower disgust of dissection than those without experiences and females reported to have higher disgust of dissections than males. Respondents who reported to have any animal(s) at home showed higher disgust of dissections than those who did not report to have any animal at home.

Importance of dissections in biology education

Multiple regression resulted on marginally significant model ($R^2 = 0.01$, $F(2,391) = 2.69$ $p < 0.069$). Only two predictors entered the model: LED and having animal(s) at home ($\beta = 0.09$ and -0.07 , $p = 0.06$ and 0.16 , respectively). Other predictors were excluded from the model. This suggests that respondents with LED tended to attribute greater importance to dissections than those without LED. Respondents who reported to have any animal(s) at home tended (but not significantly) to underestimate the importance of dissections.

Virtual dissections

Multiple regression resulted in non-significant model ($R^2 = 0.003$, $F(1,392) = 1.2402$ $p < 0.27$). This suggests that independent predictors were not correlated with the mean score of the virtual dissections domain.

Dissections in elementary and high schools

Multiple regression resulted in marginally significant model ($R^2 = 0.02$, $F(3,390)=2.45$ $p < 0.06$). Three variables entered the model suggesting that HED, LED and gender (males more) were positively associated with the support of dissections in elementary and high schools, but none of these associations were statistically significant (all $\beta \leq 0.073$, all $p > 0.15$).

Ethical aspects of dissections

Multiple regression resulted in significant model ($R^2 = 0.04$, $F(4,389)=2.45$ $p < 0.01$, Table 3). Respondents with LED favoured dissections significantly more than those without LED. Males tended to favour dissections more than females respondents who reported to have any animal(s) at home showed less supportive attitudes toward dissections than non-animal owners.

Table 1. Students' attitudes toward dissections.

Domain	Min	Max	Mean	SE	Number of items	Cronbach α
Disgust	1	5	2.87	0.05	9	0.90
Importance	1	5	3.85	0.03	7	0.82
Virtual dissections	1	5	3.36	0.04	3	0.77
Dissections in schools	1	5	2.53	0.05	2	0.73
Ethical aspects	1	5	3.65	0.04	7	0.85

Table 2. Multiple regression (forward stepwise method) on disgust of dissection domain. Residence and HED predictors were excluded from the model.

	β	SE of β	B	SE of B	$t(390)$	p
Intercept			34.70	12.89	2.69	0.01
LED	-0.21	0.05	-0.39	0.09	-4.29	0.00
Gender	-0.13	0.05	-0.34	0.13	-2.68	0.01
Having animals	0.11	0.05	0.20	0.09	2.21	0.03

Table 3. Multiple regression (forward stepwise method) on disgust of dissection domain. The HED predictor was excluded from the model.

	β	SE of β	B	SE of B	$t(389)$	p
Intercept			-27.36	13.30	-2.06	0.04
LED	0.13	0.05	0.20	0.08	2.55	0.01
Having animals	-0.14	0.05	-0.22	0.08	-2.75	0.01
Gender	0.09	0.05	0.19	0.11	1.75	0.08
Residence	0.05	0.05	0.08	0.08	1.06	0.29

Table 4. Partial correlations between attitudes toward dissection domains. The effect of gender, grade, having animal(s) at home and LED was controlled for.

	Importance	Virtual dissections	Dissections in schools	Ethical aspects
Disgust	-0.42***	-0.25***	-0.33***	-0.60***
Importance		0.36***	0.26***	0.65***
Virtual dissections			0.17**	0.28***
Dissections in schools				0.36***

Relationships between attitude domains

Partial correlations were performed to examine correlations between the attitudes toward dissections domains (Table 4). Disgust of dissections negatively correlated with all attitude domains suggesting that more disgust sensitive respondents favour dissections less. Other correlations were positive and statistically significant meaning that respondents who favour dissections support especially real dissections in schools.

DISCUSSION

Animal dissections are inseparable components of physiology or zoology courses in many universities. To enhance their effectiveness, it is important to understand to learners' opinions and attitudes toward dissections, because negative attitudes influences

learning outcomes (Randler et al. 2005, Holsterman et al. 2009, 2011). Here we investigated factors influencing attitudes toward dissections among preservice biology teachers, a focus group of students that are expected to acquire practical dissection skills. Results revealed that only 1/4 of students experienced virtual dissection, but more than 60 % of students experienced real dissection suggesting that virtual dissection are virtually rarely used as alternatives to real dissections by Slovak teachers. This would reflect low number of computers per student in Slovakia (Fančovičová & Prokop 2008) and/or insufficient support by virtual dissection software. Although not all students reported to experience real dissections, we believe that it was caused by large (about 30 %) of first years respondents who did not dissect in the university yet. Obviously, second year students start with dissecting invertebrates (e.g., earthworms) and third graders continue with dissecting vertebrates. Data also suggests that dissections in

elementary schools are exceptional and the rates of dissections in high schools are infrequent (reported by about ¼ of students). Most frequently cited animals being dissected were fishes, probably due to their availability, then chicken, earthworms and rats. All these taxa reflect our personal experiences with the use of these animals in the universities, which support reliability of these data.

The mean scores of attitude domains suggest that students hold slightly positive attitudes toward dissections. Cahill and Ettarh (2009) and Quince et al. (2011) found that the majority of medical students in the UK held positive attitudes toward dissections, but it is more expectable, because the likelihood that dissection skills will be used by medical students in the future is higher. One exception is Dissections in schools domain with relatively low score. Along with the low effect of HED variable on attitudes toward dissections, this would suggest that students support dissections in universities rather than on lower levels of schools. The question is whether older, experienced students, are planning dissections in elementary/high schools or not. Slovak laws do not explicitly ban dissecting animals in schools, but there are recommendations about the use of alternatives rather than live animals. Thus, individual differences between teachers would be responsible for doing dissections in Slovak schools.

Disgust of dissections was significantly influenced either by prior experiences with dissections, gender and having animal(s) at home. Prior experiences with dissections reduced disgust of dissections (e.g., Holstermann et al. 2009, Randler et al. 2012a) suggesting that the exposure to dissection has positive effect on its acceptance. Interestingly, lifetime experiences with dissections influenced attitudes toward dissections significantly more than high school experiences. This would either explain why students were reserved in their support of dissections in high schools and it also suggests that students consider real dissections in universities as more important than dissections in lower levels of schools. Although the present study is correlative in nature and cannot rigorously examine causal relationships between variables, recent research support an idea that physical experiences with the exposure to disgusting animals like mice or snakes (Ballouard et al. 2012, Randler et al. 2012b) and to dissections (Holstermann et al. 2010, 2012, Randler et al. 2012a) reduce disgust sensitivity. Thus, physical experiences seem to positively influence acceptance of dissection in university students. Females hold less supportive attitudes toward dissections (Lock 1995, Akpan & Andre 1999), which probably reflects their higher disgust sensitivity, relative to sensitivity of males (e.g., Haidt et al. 1994, Oaten et al. 2009, Prokop and Fančovičová 2013). Although interest and disgust of dissections need not to be mutually exclusive

(Holstermann et al. 2012), the disgust of dissection domain in the present study negatively correlated with all other attitudes toward dissections domains suggesting that perceived disgust show negative correlation with supportive attitudes toward dissections.

Having animal(s) at home showed significant and negative impact on three out of five attitude domains. As far as we are aware, this is the first study that showed negative associations between these variables. Negative attitudes toward dissections in animal owners was probably not influenced through an association with disgust sensitivity, because animal owners are generally less disgust sensitive than non-owners (Prokop et al. 2010a,b). Animal owners are probably more familiar with animal rights and welfare. Moreover, close relationship with pets increases and empathy toward animals (Ascione 1992) which would also negatively influence dissection support. Science teachers should therefore use sensitive approach to students who likes animals more than for example non-animal owners.

To conclude, attitudes toward dissections in Slovak prospective biology teachers are slightly positive, which suggests that more effort is necessary to improve dissection support in these students. Physical experiences with real dissections showed positive correlations with supportive attitudes. Special attention should be dedicated to females and to students with more positive attitudes to animals (e.g., animal owners), because preference for animals may be in conflict with support of dissection.

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