JOURNAL OF BALTIC SCIENCE EDUCATION
ISSN 1648-3898

THE USE OF REALIA VERSUS POWERPOINT PRESENTATIONS ON BOTANY LESSONS

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Abstract. *Botany is traditionally viewed as less attractive than zoology for students, despite the fact that plants play a key role in natural ecosystems. It is hypothesized that survival-relevant information may enhance learner's attention and that this information might be better remembered than others. Additionally, the use of the PowerPoint (PPT) presentation software in teaching biology is questionable, particularly in comparison with the use of realia. A theory of adaptive memory was employed in an experiment, in which the presence of fruits, their colour and their toxicity on samples of plants was handled. The memory scores and interest in plants of the participants were measured. The effectiveness of the PPT compared with the use of realia (live plants) was also analysed. The memory scores were highest in treatments with living samples of plants containing fruits. Survival-relevant information (plant toxicity) was better retained than survival-irrelevant information. Participants retained information about plants with dark fruits better than about plants with red fruits. The activities with live plants, but not the PPT, increased participant's interest in plants. In summary, using living plants and fruits over the PPT is recommended when teaching botany.*

Key words: *adaptive memory, biology education, PowerPoint programme, realia.*

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Introduction

Botany, a natural science concerned with the study of plants, is not considered to be of interest for students of various age groups internationally (Schussler & Olzak, 2008; Bybee & McCrae, 2011; Prokop *et al.,* 2007a, b; Fančovičová & Prokop, 2010). Zoological topics are more attractive for students in comparison with botanical topics (Uno, 1994; Lindemann-Matthies, 2005; Martín-López *et al.* 2007), in all probability due to the high mobility of animals (Kinchin, 1999) and their phylogenetical similarity with humans. Plant prejudice (Hershey, 1993) and plant blindness, an ignorance of botanical facts and concepts, is also prevalent among students of all age groups (Wandersee & Schussler, 1999; Allen, 2003; Schussler & Olzak, 2008). Furthermore, students often express little interest in plants (Fančovičová & Prokop, 2010; Selvi, 2012) which could be changed for example by means of practical work with plants (Fančovičová & Prokop, 2011b; Ward *et al*., 2014) and/or with scientific activities with plants (Bokor *et al*., 2014).

On the first look, low interest in plants may be considered surprising, because plants are all around us and are extremely important for life on Earth (Buhner, 2002). They have been used predominantly as sources of food and medicine by people (Wood, 1997). Plant fruit demonstrates great diversity in colour and size. Fruit served as an important part of the diet of human ancestors (Ungar & Teaford, 2002) and fruit continue to be important in the diet of modern people. Europeans, for example, consume approximately 166 g of fruit and 220 g of vegetables per day (WHO, 2006).

Both empirical (Uitto *et al*., 2006; Holstermann *et al*., 2010) and experimental work (Thompson & Soyibo, 2002; Prokop *et al*., 2007) have revealed that hands-on activities enhance positive attitudes toward science and scientists. By analysing the self-reports of students' experiences and interests with various hands-on activities, however, Holstermann *et al.* (2010) found that there were *no* significant differences in interest between adolescents with experience and those without for most of the examined activities, including the botany topics. Moreover, time shortage, a lack of funding for projects and teaching and learning resources, motivation and expectations are common barriers for teachers who cannot invest all of their teaching time into practical activities with their students (Doyle, 2002; Beath *et al*., 2012; Heeralal, 2014; Motlhabane, 2014). Thus, a significant part of the learning process is realised with traditional teaching methods. PowerPoint presentations (PPT) in lectures are currently replacing traditional chalk and talk methods (Bartsch & Cobern, 2003; Isseks, 2011). Recent research had indicated that advantages of PPT over traditional methods are doubtful (Amare, 2006; Jones, 2009; Seth *et al*., 2010), although some research work has revealed that the use of PPT is more advantageous than traditional teaching methods (Trifan & Axinti, 2010; Bartsch & Cobern, 2003). However, no study has examined the effectiveness of PPT with practical work in biology lessons.

A number of evolutionary psychologists have proposed that human memory systems evolved in order to remember certain kinds of information better than others (Nairne *et. al*, 2007). Certain experiments (Nairne *et al*., 2007; Nairne *et al.*, 2008; Weinstein *et al.*, 2008), where participants were given a surprise recall task after they rated words for their relevance in survival, moving to a new house, planning a bank heist, pleasantness and other contexts, revealed that participants always recalled most of the words in a survival scenario. The mechanisms of adaptive memory, however, are only very recently being utilized in teaching biology (Prokop & Fančovičová, 2014; Štefaniková & Prokop, 2015). It has been shown, for example, that children are able to remember more information about predators which pose a threat to humans than about harmless animals (Barrett & Broesch, 2012; tefaniková & Prokop, 2015). Similarly, the toxicity of fruits is better remembered by children than, for example, their naming or occurrence (Prokop & Fančovičová, 2014). The presence of fruits within a sample of plants may also have a learning advantage, because fruits were, and still are beneficial for survival.

Present research examined how the presence and colour of fruits in samples of plants, survival relevant and irrelevant information about plants, teaching method (traditional oral presentation vs. PPT) and plant toxicity influence children's memory tests about plants. It is also examined whether the aforementioned variables influence children's interest in plants. It is hypothesized that the presence of fruits in samples of plants will enhance information retention more than using samples of plants without fruits and/or when plants will be presented in the PPT. Red fruits were expected to enhance memory tests better than dark fruits, because this colour is a cue of ripening. Furthermore, survival-relevant information (toxicity/edibility) will mediate information retention. Finally, it is hypothesized that the aforementioned variables influence children's interest in plants.

Methodology of Research

The participants were randomly assigned as whole classes to one of four treatments. Presence and absence of fruits, the toxicity/edibility of fruits and type of presentation (traditional oral presentation or using the PPT) was handled across treatments. Memory tests were applied before the experiment in order to control possible pre-existing differences in knowledge about plants between treatments. Further two memory tests (post-test and retention test) were applied after the experiment in order to examine the durability of acquired knowledge. Finally, participants rated interest in each plant species to test possible influences of treatments on their interest in plants.

Participants

The sample of 151 participants (82 females and 69 males) consisted of 10-13-year olds attending five Slovak secondary schools. The mean age of the participants was 11 years (SE = 0.67). This age group of participants was chosen because they had experience with the botany course which is taught in grades 5 and 6 (age 10/12). Additional information about the participant's age and sex were collected.

Species Selection and Procedure

All the plants were collected in local parks where they frequently occur. The plants were collected based on their fruit colour and toxicity. The set of plants was selected in order for there to be an equal numbers of plants which are toxic and non-toxic for children (Table 1). 7 toxic (4 red fruit, 3 dark fruit) and 7 edible (4 red fruit, 3 dark fruit) species were selected for the research purposes. A basic precondition for species selection was their availability in the study area. All the plant samples were first photographed, then their fruits were removed and the samples were photographed once again (Figure 1). According to current school curriculum, participants should be aware only about two of all selected species (*Sambucus nigra* and *Partherocissus quinguefolia*).

Table 1. Description of the plants used in the research

Toxicity	Colour	Origin	Latin name	English name	Slovak name
Edible	Red	Outside Europe	*Berberis vulgaris* L.	Common Barberry	Dráč obyčajný
			Hippophae rhamnoides L.	Sea Buckthorn	Rakytník rešetliakovitý
		Europe	*Crataegus oxyacantha* L.	English Hawthorn	Hloh obyčajný
			Lycium barbarum L.	Boxthorn wolfberries	Kustovnica cudzia
	Dark	Outside Europe	*Aronia melanocarpa* Michx. Ell.	Black chokeberry	Arónia čiernoplodá
		Europe	*Prunus spinosa* L.	Blackthorn	Slivka trnková
			Sambucus nigra L.	Common elder	Baza čierna
Toxic	Red	Outside Europe	*Contoneaster horizontalis* Decaisne	Rockspray Cotoneaster	Skalník rozprestretý
		Europe	*Euonymus europaeus* L.	European spindle	Bršlen európsky
			Pyracantha coccinea M. J. Roem	Scarlet firethorn	Hlohyňa šarlátová
			Viburnum opulus L.	Guelder rose	Kalina obyčajná
	Dark	Outside Europe	*Ligustrum vulgare* L.	Common Privet	Zob vtáčí
			Mahonia aquifolium (Pursh) Nutt.	Hollyleaved Barberry	Mahónia cezmínolistá
			Partherocissus quinguefolia L.	Virginia creeper	Pavinič päťlistý

14 samples of plants were presented in Real treatments and identical photographed samples in a PowerPoint presentation with 14 photos of the plants (Figure 1). Both treatments were divided into groups with and without fruits. The background for the photograph was white and the size of the plants was standardised to a similar length and colour contrast. Each slide presented in the PPT Fruit + treatment contained two photographs. One photograph was a plant with fruit and the second photograph was a detail of the plant's fruit. In the PPT Fruit - treatment, the plant photograph did not contain fruit and the second photograph was a detail of the plant's leaf. All the photographs were made from the same plant samples. They were originally collected with the fruit and photographed and later, after the removal of the fruit, photographed once again.

The participants were randomly divided into 4 groups. In the Real Fruit + group (22 females and 13 males), the participants received an oral presentation with freshly collected plants with fruit. In the Real Fruit – group (17 females and 15 males), the participants received an oral presentation with freshly collected plants without fruit. In the PPT Fruit + group (19 females, 21 males), the participants received an oral presentation, but the plants were frontally presented with the PPT presentation. In the PPT Fruit - group (24 females, 20 males) participants were instructed in the same way as in the PPT Fruit + group, but the plants presented in the PPT presentation lacked fruit. All the participants were volunteers and unaware of the hypotheses.

a

b

Figure 1: An example of photographs showing a live plant (*Aronia melanocarpa*) with (a) and (b) without fruits.

Oral Presentations

All the presentations were made by their biology teacher, who was trained by the authors of this paper. Each picture with the given plant was presented for up to 2 min. During this time, the participants received oral information about the Slovak name of the plant, occurrence and toxicity (toxic or non-toxic). The oral presentation lasted approximately 30 min. Each group of participants received one oral presentation.

Memory Tests

A pre-test was administered to the participants from all the treatments one week before the experiment and a post-test was applied immediately after the lecture. The validity of the research instrument was established by Prokop and Fančovičová (2014). The same plants were used in the pre–test, post–test and retention test. In order to preserve the plant samples alive, they were stored in a fridge. In the pre-test, the participants were shown all 14 plant species and asked to respond to 5 items: (1) What is the name of the plant? (open-ended), (2) Have you ever seen this plant before? (1 = never, 5 = definitely yes) (3) How interested are you in this plant? (1 = not at all,

ISSN 1648–3898

5 = very much so), (4) Do you think this plant is toxic? (yes, do not know, no), and (5) Does this plant come from Europe? (yes, do not know, no). The correct responses to the last two questions were coded as correct (level 3), partially correct (level 2) and incorrect (level 1) (Cronbach alpha = 0.72).

The surprise memory test (hereafter post-test) was performed immediately after the oral presentation finished. The participants were, once again, shown all the 14 species of plants and asked to respond to the same items as in the pre-test except for the second question (Have you ever seen this plant before?) (Cronbach alpha = 0.76).

The retention test was applied 14 days after the oral presentations and contained three items identical with the post-test: What is the name of the plant? (open ended) Do you think this plant is toxic? (yes, do not know, no), and Does this plant come from Europe? (yes, do not know, no) (Cronbach alpha = 0.75).

The presentation of living plants and plants in the PPT was randomized between the tests (pre-test, post-test, retention test). The participants were assured that the research was not a test, but only involved researcher's interest in what they know about certain plants. After the research was completed, the participants were debriefed about the research goals. The participants in each treatment were tested in eight independent school classes.

Statistical Procedures

A 2 (treatment) × 2 (presence of fruit) × 2 (fruit toxicity/edibility) × 2 (red/dark colour) × 3 (type of test [pre-test, post-test, retention test]) × 3 (type of question [naming, toxicity and occurrence] Generalized Linear Mixed Model (GLMM) was performed in order to investigate whether these variables influenced the mean scores of the information retention tests or the mean scores of interest in each plant (dependent variables). The participant's identification number (ID) was treated as a random factor in order to avoid pseudoreplication of the results. Interest in the plants was examined by summing up all the interest data into one composite score separately calculated for the pretest and posttest (dependent variable) by a multivariate analysis of variance (MANOVA). The effects of gender and age were never significant in the case of the memory tests (main effects: $F(1,145) = 1.2$ and 0.45, $p =$ 0.28 and 0.5, respectively) as well as in case of the interest scores (main effects: $F(1,145) = 1.19$ and 3.24, $p = 0.28$ and 0.07, respectively), thus these variables were not included in the statistical analyses. The two-way interaction terms were defined for the effect of the treatment with all the remaining categorical predictors listed above. This selection was intentional, since it was necessary to reduce the large number of interaction terms providing additional information which went beyond the primary aims of this study.

Results of Research

Real Experiences and the Presence of Fruit in the Memory Tests

There was no significant main effect of treatment on information retention among participants ($F(1,5384) = 0.44$, $p = 0.51$), meaning that participants with experience with living plants had similar information retention scores as participants who experienced the PPT. There was, however, a significant main effect of the presence of fruit on the participants' mean scores concerning plants ($F(1,5384) = 25.24$, $p < 0.001$) suggesting that the presence of fruit positively influenced memory tests (Figure 2). This effect was particularly apparent for the Treatment × Real Fruit ($F(1,5384) = 7.68$, $p = 0.006$, Figure 1). With respect to the Treatment × Fruit toxicity interaction ($F(1,5384) = 135.56$, $p < 0.001$), edible fruits received a significantly higher score than toxic fruits in the PPT treatment (analysis of contrasts, $p < 0.001$), although in the real treatment both edible and toxic fruits scored similarly (analysis of contrasts, $p > 0.05$). The interaction term Treatment × Fruit colouration was not statistically significant ($F(1,5384) = 1.4$, $p = 0.24$).

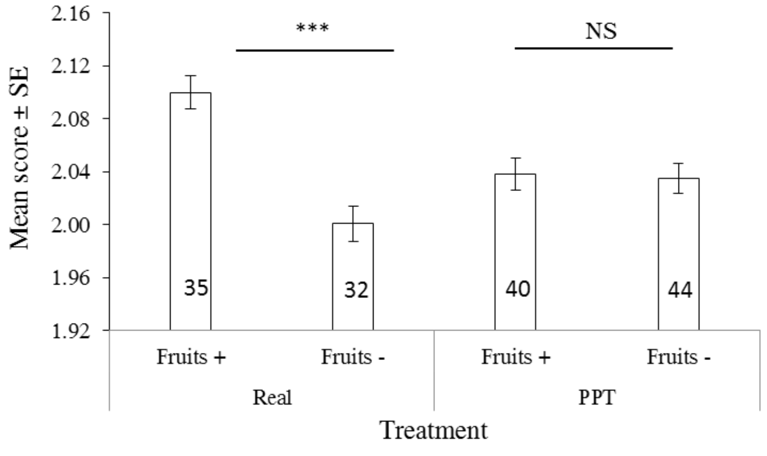

Figure 2: Differences in information retention concerning plants with respect to participants' experience (Real or PPT) and the presence of fruit.

*The numbers inside the bars are the sample sizes. *** p < 0.001, NS = not statistically significant.*

Effects of the Type of Test, Fruit Toxicity and Fruit Colours on Memory Tests

The type of test significantly influenced participants' memory scores ($F(2,5384) = 99.54$, $p < 0.001$). The participants received the lowest score in the pretest and the highest score in the posttest. The score of the retention test was somewhere in the middle between the prestest and retention test score (Figure 3). Edible fruit were remembered better by participants compared with toxic fruit ($F(1,5384) = 71.42$, $p < 0.001$). Regarding fruit colouration, dark coloured fruit received higher scores than red fruit ($F(1,5384) = 19.79$, $p < 0.001$).

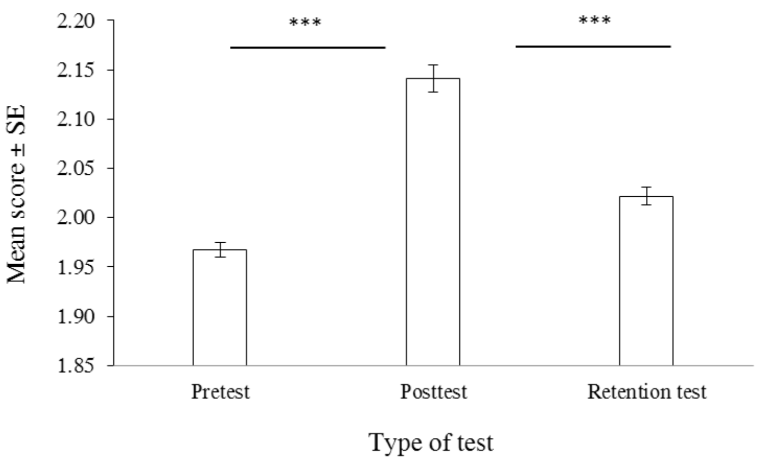

Figure 3: Mean scores of the memory tests with respect to the type of test.
*** $p < 0.001$.

The Effect of the Type of Question on the Memory Tests

Significant differences in information retention with respect to the three types of questions (naming, toxicity and occurrence) ($F(1,5384) = 58.6$, $p < 0.001$) were found. An analysis of the contrasts revealed that there were only no significant differences between the mean scores of naming and the occurrence on memory scores ($p = 0.44$). The participants' mean scores concerning the toxicity of fruits were significantly higher, however, than the mean scores of the remaining two types of questions (Figure 4).

ISSN 1648–3898

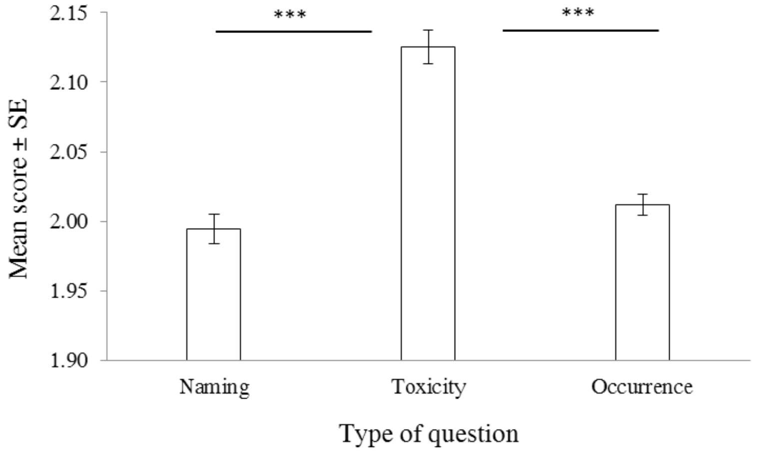

Figure 4: Mean scores of the memory tests with respect to the type of question.
*** p < 0.001.

Factors Influencing Interest in the Presented Plants

Primary effect of treatment of the interest in the plants ($F(1,145) = 4.37$, $p = 0.04$) was significant suggesting that participants in the treatment with living plants had a greater interest in the plants ($M = 3.5$, $SE = 0.1$, $N = 67$) than the participants in the treatment with PPT ($N = 3.18$, $SE = 0.09$, $N = 84$). The main effects of the presence of fruit, type of test, toxicity of the presented plants and the colour of fruit were not statistically significant ($F(1,145) = 0.59, 1.59, 0.07$ and 1.9, all $p > 0.16$, respectively). A highly significant interaction type of test × treatment ($F(1,145) = 25$, $p < 0.001$) suggests that the participants in the treatment with living plants increased their interest in the posttest, while interest in plants in the group with the PPT remained unchanged (Figure. 5). Additional differences were not statistically significant.

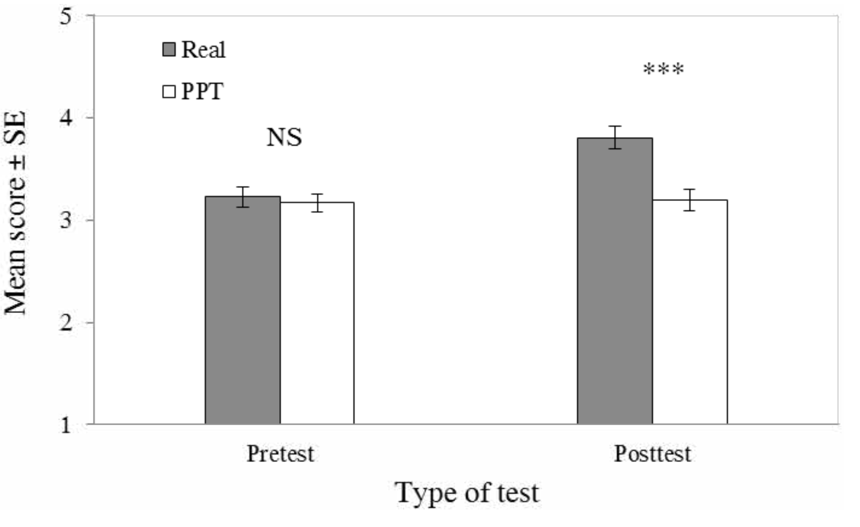

Figure 5: Mean scores of interest in the plants with respect to the type of test and treatment.
*** p < 0.001.

Discussion

Present research examined the influences of the presence of fruits, their colours, toxicity, survival-relevant and irrelevant information influence of information retention and interest in the plants. The effects of practical work versus PPT on memory scores concerning plants were additionally compared. These results suggest that the use of living plants with their fruit is more beneficial than the PPT in terms of obtaining knowledge and increasing student's interests in plants.

Students who worked with living plants with fruit scored higher in memory tests compared with other students. This result is in agreement with research indicating that hands-on activities with plants positively influence knowledge and attitudes toward them (Fančovičová & Prokop, 2011b; Ward *et al*., 2014). This knowledge is extended by adding to the literature that not only living samples of plants may be stimulating for children (Tunnicliffe & Reiss, 2000) but specifically the presence of their fruit. When considering only plants without fruit, no significant differences occurred in memory tests between groups with living plants and those with a PPT. The positive influence of fruit occurred in all probability because fruit played an important role in human survival throughout the evolutionary history (Ungar & Teaford, 2002; Prokop & Fančovičová, 2012).

This study also contributes to the emerging theory regarding the use of PPT in teaching (Bartsch & Cobern, 2003; Isseks, 2011). In the present research, the use of the PPT yielded similar memory scores as compared with the use of realia, but only when the presence of real fruit in the plant samples are not considered. The use of the PPT is consequently advantageous (Trifan & Axinti, 2010) because this method is inexpensive and a less time consuming method compared with hands-on activities. Direct experience with plants containing fruit was, in contrast, more beneficial for students in terms of obtaining knowledge about plants. Most importantly, hand-on activities resulted in an increased interest in plants (Fančovičová & Prokop, 2011b), while the use of PPT did not produce similar results. From this perspective, the use of realia are more beneficial than the PPT. It is conceivable that Holstermann *et al.* (2010) could not find any differences in interest between students with and without experience with certain botanical topics familiar to the present research (e.g., classifying trees and shrubs, assigning flowers to their families), due to absence of the higher age of participants in their study (16 year olds) in whom interest in science decreases (Osborne *et al*., 2003).

Participants remembered information about edible plants better when compared with toxic plants. Prokop & Fančovičová (2014) also found that students had the best memory scores when answering questions about non-toxic fruit, but only when the fruit colour was red. When considering the fruit colour, the memory scores of plants with dark fruit were better than the scores with red fruit. The better scores associated with red fruit would be, however, more predictable, because red fruit seem to have a higher aesthetic value for people than fruit of other colours (Prokop & Fančovičová, 2012). Further research should make use of the standardized sizes of displayed fruit since their size could be a confounding factor (Prokop & Fančovičová, 2014).

The empirical study by Fančovičová & Prokop (2011a) found that children have a better knowledge about plants with edible fruit compared with toxic fruit. Interestingly, however, the toxicity of plants was remembered better than the survival-irrelevant information (the naming and occurrence of the plants). Similar patterns were found in recent experimental research with plants (Prokop & Fančovičová, 2014) as well as with animals (Barrett & Broesch, 2012; Štefaniková & Prokop, 2015). It is suggested that information concerning plant toxicity increases children's attention more than survival-irrelevant information which is in agreement with experiments on adaptive memory (e.g., Nairne *et al.*, 2007; Nairne *et al.*, 2008; Weinstein *et al.*, 2008). Children may later use information about whether the particular fruit is edible in real life (Fančovičová & Prokop, 2011a).

Conclusions

To conclude, this research demonstrated that work with living plants is more advantageous in terms of improving children's knowledge and attitudes as compared with the PPT. Cues associated with survival in the evolutionary past, namely work with fruit and information about health risks significantly contribute to knowledge acquisition. The use of realia are therefore recommended more than the use of the PPT. Future research may benefit from examining possible influences of the sizes of fruits or their taste on participant's interest or knowledge. It is to be hoped that evolutionary oriented approach may be useful in teaching botany in schools.

ISSN 1648–3898

Acknowledgments

David Livingstone improved the English. This research was funded by a grant from Trnava University in Trnava No 3/ TU/2015.

References

Allen,W. (2003). Plant blindness. *BioScience, 53* (10), 926.
Amare, N. (2006). To slideware or not to slideware: Students' experiences with powerpoint vs. lecture. *Journal of Technical Writing and Communication, 36* (3), 297-308.
Barrett, H. C., & Broesch, J. (2012). Prepared Social Learning about Animals in Children. *Evolution and Human Behavior*, *33* (5), 499-508.
Bartsch, R. A., & Cobern, K. M. (2003). Effectiveness of PowerPoint presentations in lectures. *Computers and Education*, *41* (1), 77-86.
Beath, J., Poyago-Theotoky, J., & Ulph, D. (2012). University funding systems: Impact on research and teaching. *Economics, 6* (2), 2012-2014.
Bokor, J. R., Landis, J. B., & Crippen, K. J. (2014). High School Students' Learning and Perceptions of Phylogenetics of Flowering Plants. *CBE - Life Sciences Education, 13* (4), 653-665.
Buhner, S. H. (2002). *The Lost Language of Plants: The Ecological Importance of Plant Medicine to Life on Earth.* White River Junction, VT: Chelsea Green Publishing, USA.
Bybee, R., & McCrae, B. (2011). Scientific literacy and student attitudes: perspectives from PISA 2006 science. *International Journal of Science Education*, *33* (1), 7-26.
Doyle, M. (2002). Academic excellence - The role of research. *Journal of Chemical Education, 79* (9), 1038.
Fančovičová, J., & Prokop, P. (2010). Development and initial psychometric assessment of the Plant Attitude Questionnaire. *Journal of Science Education and Technology*, *19* (5), 415-421.
Fančovičová, J., & Prokop, P. (2011a). Children's ability to recognise toxic and non-toxic fruits: a preliminary study. *Eurasia Journal of Mathematics, Science and Technology Education*, *7* (2), 115-120.
Fančovičová, J., & Prokop, P. (2011b). Plants have a chance: Outdoor educational programmes alter student's knowledge and sttitudes towards plants. *Environmental Education Research, 17* (4), 537-551.
Heeralal, P. J. H. (2014). Barriers experienced by natural science teachers in doing practical work in primary schools in Gauteng. *International Journal of Educational Sciences, 7* (3), 795-800.
Hershey, D. R. (1993). Prejudices against plant biology. *American Biology Teacher*, 55, 5-6.
Holstermann, N., Grube, D., Bögeholz, S. (2010). Hands-on activities and their influence on students' interest. *Research in Science Education, 40* (5), 743-757.
Isseks, M. (2011). How PowerPoint Is Killing Education. *Educational Leadership, 68* (5), 74-76.
Jones, S. (2009). Exploring the appropriateness of using PowerPoint in nursing education. *Nursing Times*, *105* (6), 22-4.
Kinchin, I. M. (1999). Investigating secondary-school girls' preferences for animals or plants: A simple 'head-to-head' comparison using two unfamiliar organisms. *Journal of Biological Education, 3* (2), 95-99.
Lindemann-Matthies, P. (2005). Loveable' mammals and 'lifeless' plants: How children's interest in common local organisms can be enhanced through observation of nature. *International Journal of Science Education, 27* (6), 655-677.
Martín – López, B., Montes, C., & Benayas, J. (2007). The non-economic motives behind the willingness to pay for biodiversity conservation. *Biological Conservation, 139* (1-2), 67-82.
Motlhabane, A. (2014). The voice of the voiceless: Reflections on science practical work in rural disad-vantaged schools. *Mediterranean Journal of Social Sciences, 4* (14), 166-173.
Nairne, J. S., Pandeirada, J. N. S., & Thompson, S. R. (2008). Adaptive memory: The comparative value of survival processing. *Psychological Science*, *19* (2), 176-180.
Nairne, J. S., Thompson, S. R., & Pandeirada, J. N. S. (2007). Adaptive memory: Survival processing enhances retention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33* (2), 263-273.
Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education, 25* (9), 1049-1079.
Prokop, P., & Fančovičová, J. (2012). Beautiful fruits taste good: the aesthetic influences of fruit preferences in humans. *Anthropologischer Anzeiger, 69* (1), 71-83.
Prokop, P., & Fančovičová, J. (2014). Seeing coloured fruits: Utilization of the theory of adaptive memory in teaching botany. *Journal of Biological Education, 48* (3), 127-132.
Prokop, P., Prokop, M., & Tunnicliffe, S. D. (2007a). Is biology boring? Student attitudes toward biology. *Journal of Biological Education, 42* (1), 36-39.
Prokop, P., Tuncer, G., & Chudá, J. (2007b). Slovakian students' attitude toward biology. *Eurasia Journal of Mathematics, Science & Technology Education, 3* (4), 287-295.
Prokop, P., Tuncer,G., & Kvasničák, R. (2007). Short-term effects of field programme on students' knowledge and attitude toward biology: a Slovak experience. *Journal of Science Education and Technology, 16* (3), 247-255.
Schussler, E. E., & Olzak, L. A. (2008). It's not easy being green: student recall of plant and animal images. *Journal of Biological Education, 42* (3), 112-118.

Selvi, M. (2012). Adaptation into Turkish of the plant attitude questionnaire. *Journal of Baltic Science Education, 11* (2), 175-183.
Seth, V., Upadhyaya, P., Ahmad, M., & Moqhe, V. (2010). PowerPoint or chalk and talk: Perceptions of medical students Versus dental students in a medical college in India. *Advances in Medical Education and Practice, 1,* 11-16.
Štefaniková, S., & Prokop, P. (2013). Introducing the concept of adaptive memory to science education: does survival threat influence our knowledge about animals? *Journal of Environmental Protection and Ecology, 14* (3A), 1403-1414.
Štefaniková, S., & Prokop, P. (2015). Do we believe pictures more or spoken words? How specific information affects how students learn about animals. *Eurasia Journal of Mathematics, Science & Technology Education*, *11* (4), 725-733.
Thompson, J., & Soyibo, K. (2002). Effects of lecture, teacher demonstrations, discussions and practical work on 10th graders' attitudes to chemistry and understanding of electrolysis. *Research in Science and Technological Education*, *20* (1), 25-37.
Trifan, D., & Axinti, N. (2010). The study of efficiency learning in agricultural sciences using powerpoint and video presentations. Case study. Proceedings of the 6th International Scientific Conference "*e-Learning and Software for Education*", Bucharest, April 15 – 16, Editura Universitara, 229-234.
Tunnicliffe, S., & Reiss., M. (2000). Building a model of the environment: How do children see plants? *Journal of Biological Education, 34* (4), 172-177.
Uitto, A., Juuti, K., Lavonen, J., & Meisalo, V. (2006). Students' interest in biology and their out-of-school experiences. *Journal of Biological Education*, *40* (3), 124-129.
Ungar, P.S., & Teaford, M. F. (2002). *Human diet: Its origin and evolution*. London and Westport, CT., Bergen & Garvey
Uno, G. E. (1994). The state of precollege botanical education. *American Biology Teacher*, *56* (5), 263-267.
Wandersee, J., & Schussler, E. (1999). Preventing plant blindness. *The American Biology Teacher, 61* (2), 82-86.
Ward, J. R., Clarke, H. D., & Horton, J. L. (2014). Effects of a research-infused botanical curriculum on undergraduates' content knowledge, STEM competencies, and attitudes toward plant sciences. *CBE - Life Sciences Education, 13* (3), 387-396.
Weinstein, Y., Bugg, J. M., & Roediger, H. L. (2008). Can the survival recall advantage be explained by basic memory processes? *Memory & Cognition, 36* (5), 913-919.
Wood, M. (1997). *The Book of Herbal Wisdom: Using Plants as Medicines*. North Atlantic Books, USA, 580 pp.
World Health Organization, (2006). Comparative analysis of nutrition policies in the WHO European Region. Copenhagen: WHO Regional Office for Europe. Retrieved 1/1/2016 from http://www.euro.who.int/__data/assets/pdf_file/0004/149782/instanbul_conf_20ebd02.pdf

Received: *December 23, 2015* Accepted: *February 09, 2016*

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