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Assessing students' knowledge of owls from their drawings and written responses

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ABSTRACT

Many children learn about and experience animals in the everyday environment where they live and attend school. One way to obtain information about children's understanding of concepts or phenomena is by using their drawings in combination with written responses or interviews. This study assesses how much Slovenian students 10–15 years old (in sixth to ninth grade) know about owls by analysing their drawings and written responses. The study included 473 students. From assessing students' drawings and written responses, it can be concluded that the respondents had some knowledge of owls' appearance, their behaviours, diet and habitats. The differences between students in different grades regarding the representations of owls was not statistically significant. Some students had misconceptions about owls, such as the idea that owls can turn their heads 360 degrees, or they confused the long ear-tufts with external parts of the ears. The students' written responses provided additional information on their ideas about owls; particularly about owls' specific behaviours, diet, and conservational status. However, some information, such as depicting owls' body parts and body proportions or their habitats, was more clearly depicted with drawings. One third of the students drew owls in trees and forests, which makes owls good candidates for promoting forest conservation.

KEYWORDS

Owls; knowledge; lower secondary students; drawings; written responses

Introduction

From their earliest years, children learn about and experience animals in the everyday environment where they live and attend school (Tunnicliffe 2011). They notice animals in the real world, in the media, and in representations in household items such as children's wallpaper and soft toys (Tunnicliffe et al. 2008). Looking after animals and direct observations of animals positively influence children's understanding of animals' biology (Hatano and Inagaki 1997; Inagaki 1990; Prokop and Tunnicliffe 2010; Tunnicliffe and Reiss 1999a). For example, Prokop and Tunnicliffe (2010) found that having pets at home was associated with more positive attitudes toward, and greater familiarity with, both popular and unpopular animals. Children's knowledge about, and attitudes towards, animals changes with increasing age (Kellert 1985; Prokop, Kubiato, and Fančovičová 2008). Kellert (1985) identified three stages in the development of children's perceptions of animals. The period from six- to nine-years

old is marked by emotional concern and sympathy for animals, followed by a major increase in factual knowledge and understanding of animals in 10- to 13-year-olds, and children 13- to 16-years old expressed their ethical concerns and ecological appreciation of animals and the natural environment.

Students' ideas about birds

Birds can be perceived in various ways: as pets (Prokop, Kubiato, and Fančovičová 2008), pests (Behrens, Rauschmayer, and Wittmer 2008), for pest control (Jones and Sieving 2006), as pollinators (Klein et al. 2007), as long-distance vectors for pathogens transmissible to humans (Tsiodras et al. 2008), as food for humans, and so on. Bird species or groups of bird species are often used as flagship organisms for biodiversity conservation campaigns because they help conservationists raise funds and change people's behaviour (Veríssimo et al. 2013). For example, the spotted owl (*Strix occidentalis*) has a symbolic position in the conservation of North American birds and their habitats, and it is at the centre of a debate about the conservation of endangered species in general, and old-growth forests in particular (Gutiérrez 2008). Despite this, we found few studies that examine children's views of birds (Hummel et al. 2015; Kubiato, Usak, and Pecušová 2011; Prokop and Rodák 2009; Prokop, Kubitako, and Fančovičová 2007, 2008; Tunnicliffe 2011).

Prokop, Kubitako, and Fančovičová (2007) and Kubiato, Usak, and Pecušová (2011) found that primary and lower secondary school students in Slovakia are inconsistent in their knowledge of birds and have many misconceptions. For example, in one study almost half of students did not classify the penguin as a bird (Prokop, Kubitako, and Fančovičová 2007). Prokop, Kubiato, and Fančovičová (2008) explored knowledge of, and attitudes toward, birds among students and found that students in lower grades (first, second, and fifth grade) had higher scores on a knowledge test than older students (in seventh, eighth, and ninth grades). Interest in birds decreased from first through fifth grade and gradually increased from fifth through ninth grade, but still showed rather neutral attitudes. A cross-cultural study by Hummel et al. (2015) including Colombia, Germany, Slovakia, and Turkey showed some notable differences in knowledge of, and attitudes towards, birds between students from these countries. The results also suggest that factual knowledge of birds is not a necessary prerequisite for interest in birds, but involvement in animal-related activities is strongly associated with an interest in birds. Similarly, a study by Bjerke, Kaltenborn, and Ødegårdstuen (2001) including Norwegian children and adolescents found that watching natural history documentaries was associated with an interest in bird conservation.

Tunnicliffe (2011) investigated children's knowledge of pigeons (*Columba palumbus*) by analysing children's drawings, and interviews with them in which they were cued to talk about what they knew about pigeons. She found that the study of everyday animals based on interviews and drawings (on separate occasions) revealed not only biological knowledge, but also social and cultural beliefs and understandings. Germ (2006, 2008) wrote that the symbolism of birds could be recognised from a variety of art monuments, philosophical, and literary writings, and descriptions of everyday life, customs, and traditions. The symbolism of birds is often derived from their appearance or behavioural characteristics.

It is known that analysing drawings constructed by children can be used to gather information about what they know (Prokop and Fančovičová 2006; Prokop, Prokop et al., 2007; Tunnicliffe and Reiss 1999b). Because there is a limit to what drawings can tell researchers, numerous studies also use interviews or written tests to investigate children's biological ideas in science (Prokop, Kubitako, and Fančovičová 2007; Torkar and Bajd 2006). Prokop and Fančovičová (2006) suggested that using children's drawings in combination with written responses (or interviews) provides more reliable information about children's understanding of scientific phenomena. Various studies have already explored children's knowledge and conceptions about many animals and animal groups.

Owls (order Strigiformes) are birds that have been greatly neglected in educational studies. They are subdivided into two families; Tytonidae (barn owls) and Strigidae (true or typical owls) (Bruun, Delin, and Svensson 2013). Owls have big heads, short necks, large, forward-facing eyes and ear-holes, and hawk-like beaks. Usually they have a facial disc around the eyes. Their heads can be turned up to

270°. They are birds of prey hunting mostly by night. Usually females are larger than males. Different species of owls produce different sounds that aid owls in finding mates or announcing their presence to potential competitors. Owl species nest in hollows in trees, on top of tree stumps, in buildings or on rocks and rocky cliffs (Bruun, Delin, and Svensson 2013). Students can potentially observe ten species of owls (Strigiformes) in Slovenia: the Eurasian eagle-owl (*Bubo bubo*), long-eared owl (*Asio otus*), Ural owl (*Strix uralensis*), tawny owl (*Strix aluco*), short-eared owl (*Asio flammeus*), barn owl (*Tyto alba*), little owl (*Athene noctua*), boreal owl (*Aegolius funereus*), Scops owl (*Otus scopus*), and Eurasian pygmy owl (*Glaucidium passerinum*). Torkar and Bajd (2006) reported that what Slovenian pre-service teachers associate most with the word 'owl' is their large eyes and hooting. Owls were described as symbols of wisdom and death. Owls were also referred to as characters in films, fairytales, and children's songs. The owl, which takes flight at sunset and has good eyesight in the dark, is an image of the wisdom that leads people out of the darkness of a lack of knowledge (Germ 2006, 2008). Rich cultural symbolism and recognition makes owls very appropriate for conservation education (Torkar and Bajd 2006).

The aim and research questions

This study assesses what Slovenian students 10–15 years old (in sixth to ninth grade) know about owls by analysing their drawings and written responses. The main aim of the research was to test if it is beneficial to obtain information about children's understanding of concepts or phenomena using their drawings in combination with written responses.

The research questions were:

- (1) What do Slovenian lower secondary school students know about owls?
- (2) What are the benefits of gathering students' knowledge concerning owls using both written responses and drawings?

Method

Respondents

The study included 467 lower secondary school students from four schools in central Slovenia. Students attended sixth ($n = 129$), seventh ($n = 132$), eighth ($n = 85$), and ninth ($n = 121$) grade. The age of students ranged between 10 and 15 years, with a mean age of 12.4 ($SD = 1.18$). In Slovenia, the educational system consists of nine years of compulsory education (from age six to fifteen). After starting school, students in first through fifth grades learn basic science concepts. In the next level of education (sixth and seventh grades), students build on their knowledge of basic science concepts, and in the last two years of compulsory education students learn more about chemistry, biology, and physics in particular.

Instrument and research design

Anonymous questionnaires were administered during regular science and biology classes. Approval from the school's head office was first acquired and written parental consent was also obtained. The work was carried out as part of a larger study focusing on student's knowledge of, and attitudes toward, owls. The questionnaire consisted of three parts. The first part gathered data about demographic variables and reported experiences with owls. In the second part, students had to report their attitudes toward owls. The third part of the questionnaire measured knowledge of owls. Children were asked to draw and to describe an owl on the same sheet of paper. Students named the owl's body parts on the drawing. A space for the drawing was provided in a rectangle (12 × 17 cm). Students completed the questionnaire in around 15 min.

Data analysis

The drawings were analysed by the authors using a ‘look re-look’ process to identify and consequently analyse the features of the birds that were portrayed (as in Tunnicliffe 1996, 2011). The answers to the open question were sorted into categories and frequency counts were done. In order to clarify what additional information is shown in written responses which was not provided in the drawings and vice versa we used unified categories for classifying students’ ideas. Details of particular criteria used are given in the findings below (Tables 1 and 2). The χ^2 test was used to test differences between the grades regarding students’ drawings and written responses. An alpha level of .05 for statistical significance was used for all analyses.

Results

The analysis of students’ drawings can indicate a lot about their view of reality. Drawings can reflect students’ perception of the real world, although poor might affect the validity of claims made only on student’s drawings. Black-and-white drawings were more common among students. Only five percent of students used colours to draw an owl. Five percent of students created an outline of a bird that did not particularly resemble an owl (e.g. drawing 1 in Figure 1) Drawings typically included basic features of birds such as legs, a body, wing(s), a head, and a beak. Most students (90.5% of answers in category physical characteristics of owls) drew an owl with some distinctive features for this group of birds. The remaining 4.5% created detailed drawings of a typical (generic, recognisable) owl. The artistic images of some showed good drawing skills. with very specific features and accurate shapes and body proportions (e.g. drawings 2 and 3 in Figure 1).

Table 1. Analysis of students’ drawings of owls by grade.

Categories*	Sixth grade		Seventh grade		Eighth grade		Ninth grade		Total	
Subcategories**	f	f%	f	f%	f	f%	f	f%	f	f%
Physical characteristics	1020	90.7	1054	88.5	695	90.4	945	92.7	3714	90.5
Body	129	100.0	132	100.0	85	100.0	119	98.3	467	100.0
Eyes	127	98.4	131	99.2	84	98.8	121	100.0	463	99.1
Wings	126	97.7	129	97.7	85	100.0	117	96.7	458	98.1
Beak	126	97.7	128	97.0	85	100.0	118	97.5	457	97.9
Legs	126	97.7	123	93.2	85	100.0	111	91.7	445	95.3
Head	117	90.7	124	93.9	82	96.5	115	95.0	438	93.8
Ears	99	76.7	105	79.5	68	80.0	97	80.2	369	79.0
Feather	74	57.4	91	68.9	56	65.9	84	69.4	305	65.3
Claws	64	49.6	68	51.5	38	44.7	44	36.4	214	45.8
Tail	24	18.6	15	11.4	25	29.4	17	14.0	81	17.3
Colour	8	6.2	8	6.1	0	0.0	1	0.8	17	3.6
Size	0	0.0	0	0.0	0	0.0	1	0.8	1	0.2
Behaviours of owls	49	4.4	70	5.9	34	4.4	40	3.9	193	4.7
Sitting in a tree	39	30.2	62	47.0	31	36.5	35	28.9	167	35.8
Flying	7	5.4	6	4.5	1	1.2	3	2.5	17	3.6
Walking	3	2.3	2	1.5	2	2.4	2	1.7	9	1.9
Habitats of owls	42	3.7	58	4.9	35	4.6	31	3.0	166	4.0
Forest and trees	42	32.6	58	43.9	35	41.2	31	25.6	166	35.5
Depiction of more than one owl	8	0.7	7	0.6	4	0.5	1	0.1	20	0.5
Other species	3	0.3	1	0.1	1	0.1	1	0.1	6	0.1
Diet of owls	3	0.3	1	0.1	0	0.0	1	0.1	5	0.1

*Proportion of answers (f%); **Proportion of students (f%).

Table 2. Analysis of students' written descriptions of owls.

Categories*	Sixth grade		Seventh grade		Eighth grade		Ninth grade		Total	
Subcategories**	<i>f</i>	<i>f</i> %	<i>f</i>	<i>f</i> %	<i>f</i>	<i>f</i> %	<i>f</i>	<i>f</i> %	<i>f</i>	<i>f</i> %
Physical characteristics	215	39.5	215	39.4	120	34.9	212	40.9	762	39.0
Eyes	41	32.3	52	40.3	38	44.7	48	39.7	179	38.7
Head	38	29.9	30	23.3	23	27.1	31	25.6	122	26.4
Size	28	22.0	28	21.7	10	11.8	26	21.5	92	19.9
Beak	20	15.7	20	15.5	9	10.6	25	20.7	74	16.0
Colour	23	18.1	21	16.3	5	5.9	22	18.2	71	15.4
Feather	15	11.8	16	12.4	9	10.6	22	18.2	62	13.4
Claws	21	16.5	17	13.2	7	8.2	12	9.9	57	12.3
Wings	12	9.4	16	12.4	9	10.6	14	11.6	51	11.0
Ears	12	9.4	8	6.2	6	7.1	4	3.3	30	6.5
Legs	5	3.9	5	3.9	4	4.7	5	4.1	19	4.1
Body	0	0.0	1	0.8	0	0.0	2	1.7	3	0.6
Tail	0	0.0	1	0.8	0	0.0	1	0.8	2	0.4
Behaviour of owls	195	35.8	183	33.5	131	38.1	170	32.8	679	34.8
Active at night	81	63.8	93	72.1	60	70.6	80	66.1	314	68.0
Turning the head	38	29.9	29	22.5	23	27.1	31	25.6	121	26.2
Hooting	20	15.7	18	14.0	12	14.1	24	19.8	74	16.0
Flying	17	13.4	19	14.7	12	14.1	13	10.7	61	13.2
Good eyesight	23	18.1	19	14.7	5	5.9	13	10.7	60	13.0
Good hearing	16	12.6	5	3.9	19	22.4	9	7.4	49	10.6
Diet of owls	49	9.0	50	9.2	39	11.3	45	8.7	183	9.4
Habitats of owls	44	8.1	57	10.4	27	7.8	43	8.3	171	8.8
Forest and trees	32	25.2	42	32.6	22	25.9	35	28.9	131	28.4
Rocks	9	7.1	10	7.8	3	3.5	5	4.1	27	5.8
Other	3	2.4	5	3.9	2	2.4	3	2.5	13	2.8
Other species	30	5.5	32	5.9	21	6.1	37	7.1	120	6.1
Conservation and protection	11	2.0	9	1.6	6	1.7	11	2.1	37	1.9
No answer	2		3		0		0		5	

*Proportion of answers (*f*%); **Proportion of students (*f*%).

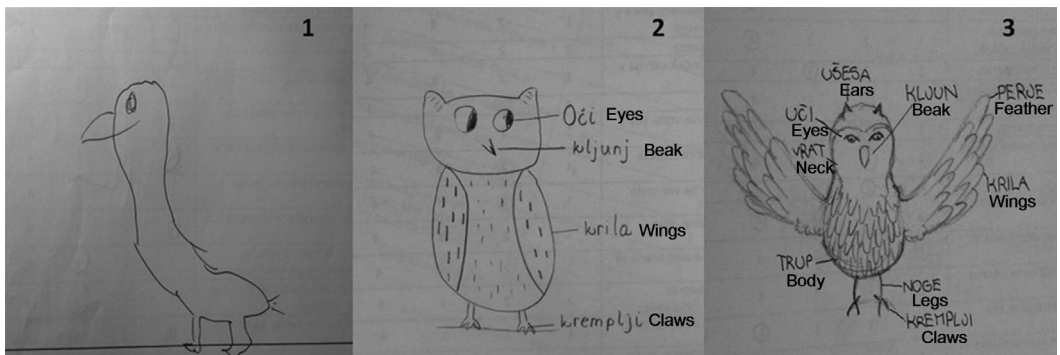


Figure 1. Students' drawings of owls in three categories: (1) outline of a bird, (2) outline of an owl and its basic features, (3) realistic depiction of an owl.

Table 1 presents the characteristics of students' drawings of owls. Most frequently they drew the owl's body (100.0%), large eyes (99.1%), wings (98.1%), a beak (97.9%), legs (95.3%), a rounded head

(93.8%), ear tufts (79.0%), and feathers (65.3%). These drawings show some features (physical characteristics) that students associate with owls (i.e. rounded head, ear tufts). Students regularly (46.4%) confused the long ear-tufts of the long-eared owl (*Asio otus*) and the Eurasian eagle owl (*Bubo bubo*), both native to Slovenia, with external parts of the ears.

In their drawings, two thirds of students depicted owls with no relation to other species, the rest including animals such as mice, insects, worms, and other birds, often depicting them as prey. Two students drew an owl in a night-time context, showing stars, the Moon, and the owl wide awake, depicting it as a night bird (Figure 2). Only a few students (20 out of 467 students) drew more than one owl. They drew more adult specimens, or an adult and juveniles, or an adult with eggs in the nest. 35.5% of students depicted them in their habitat. The birds were drawn in forests and trees. The differences between students in different grades regarding the depiction of habitat proved to be significant ($\chi^2(3) = 12.85, p < 0.05$). The percentage of students drawing owls in their habitats was higher among students in seventh (44%) and eighth grade (42%), than among students in ninth grade (26%).

Almost half of the students depicted owls exhibiting behaviour such as flying, walking, or sitting in a tree. Most of the depictions showed them sitting on a tree branch or in a hole in a tree (35.5%), which is also typically seen in the wild. Although flying is typical for birds, only 3.5% of the students presented this behaviour in their drawings. A walking owl was an even less frequent depiction (1.9%). There were no significant differences between the grades regarding drawing owls' behaviour.

Analysing students' written responses reveals additional information about their perception of owls and information they know about the biology of owls (Table 2). Most of the written descriptions of owls were classified into the category physical characteristics (39.0% of answers). Most frequently mentioned were owl's large eyes (38.7%) and rounded head (26.4%). A few of them (2.3%) mistakenly thought that the Slovenian word *sova* 'owl' referred to a female little owl (*Athene noctua*; Slovenian *čuk*).

The second most commonly mentioned category in written responses was the behaviour of owls (34.8% of answers). Altogether, 68.0% of the students pointed out that the owl is a nocturnal bird and therefore has good night vision (13.2%) and hearing (13.0%). Sixteen percent of students mentioned hooting as a typical characteristic of owls and 26.2% of them emphasised that owls twist their heads, but half (13.4%) of them mistakenly think that owls can turn their heads 360 degrees.

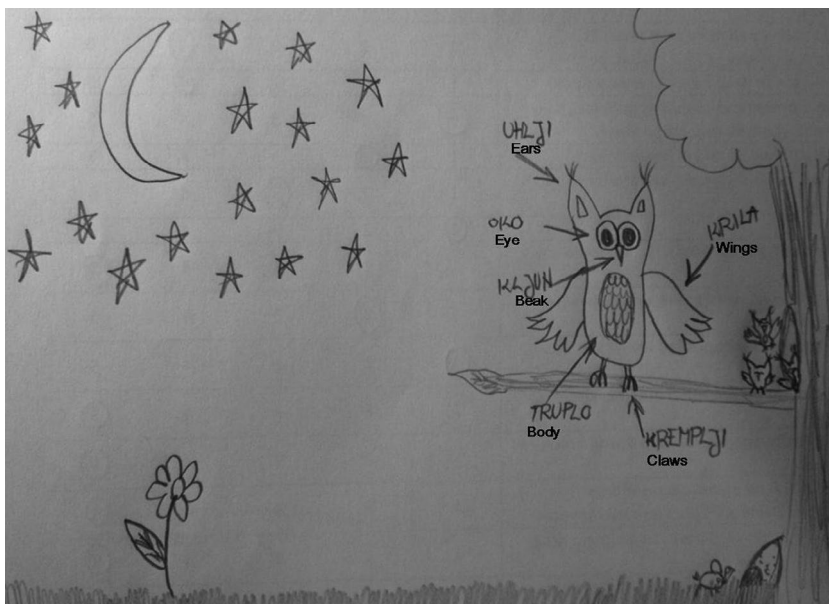


Figure 2. A student's drawing of an owl in a night scene.

Owls' diet (mice, insects and worms) (9.4% of answers) and habitat (8.8% of answers) seemed to be important information for describing them. Students mentioned forests and tree holes (80.9%) and rocks (16.7%). In the category 'other answers', answers like birds of prey, juveniles, eggs, species diversity, wisdom, death, and other associations were classified. Last but not least, a few students (3.5% of answers or 7.9% of students) mentioned owls' conservation status. They wrote that owls are endangered and protected bird species.

The differences between students in different grades regarding the categories describing owls in their written responses proved to be not statistically significant, except in the case of 'good hearing' ($\chi^2(3) = 8.30, p < 0.05$). The share of students mentioning the feature 'good hearing' was significantly higher among students in eighth grade (22.4%) than students in seventh grade (3.9%).

A comparison of students' drawings and written responses was made to answer the second research question. From the analysis of drawings, good information can be gathered about students' depictions of owls' physical characteristics such as the shape and proportion of the body, wings, eyes, legs, etc. Ninety percent of all features on drawings were categorised into this category. In comparison to their written responses, where 39.0% of the answers were categorised into the same category; the students named owl's eyes, head and other features and often described the purpose of specific features for owls. They pointed out good eyesight, good hearing, the ability to turn their heads etc. which was not possible to determine from the drawings. Two thirds drew an isolated specimen or specimens with no relation to their habitat, but in their written responses 80.9% pointed out that owls live in forests and trees and 16.7% in rocks. Very few drawings depicted owls' diet but 39.2% of students wrote about diet, most commonly mentioning mice. Half of the students' drawings depicted the behaviour of an owl in its natural habitat, such as flying, sitting in a tree, or walking on the ground. In their written responses, students rarely mentioned behaviours general for birds (i.e. flying), however, many students talked about hooting (16.0%) and turning the head (26.2%), which was not depicted in the drawings. They also wrote that owls are nocturnal birds (68.0%), but only 2 drawings showed owls in a nighttime scene. The written responses also mentioned some other information about owls, such as the diversity of owl species and their conservation status, which was not depicted in the drawings.

Discussion

Students' drawn and verbal representations show that majority of students know what an owl looks like. Drawings and written descriptions of owls are external representations of mental models that children have acquired over time (Tunncliffe 2011). From assessing students' drawings and written responses, it can be concluded that the respondents had some knowledge of owls' appearance, their behaviours, diet and habitats. Tunncliffe (2011) wrote that primary school students expressed their mental models about pigeons extrapolated from their knowledge of themselves or the behaviour of birds they knew. She stated that some students' ideas may be reinforced by cartoons and popular stories, such as the concept that all birds eat worms. This study cannot confirm that students mainly expressed their ideas about owls by extrapolating from their general knowledge of birds. It may be that owls, due to their rich symbolism and appearance in children's literature, stand out as a more recognised and attractive group of birds. Consequently, students were familiar with some of the specific features of owls that differentiate them from other birds (e.g. large head and eyes, hooting).

Many drawings and written responses included descriptions of owls' habitat (i.e. in trees and forests), which makes owls good candidates for promoting forest conservation, such as in the case of the spotted owl (*Strix occidentalis*; Gutiérrez 2008). Students mentioned only trees and forests or rocks as owls' habitats. Habitats of owls living in anthropogenic environments, such as that of barn owls, were not described or depicted by students.

Some misconceptions were found in students' written responses and drawings. A few mistakenly thought that the word 'owl' is female specimen of the species little owl (*Athene noctua*). This misconception may be connected with a popular children's song in which a little owl is married to an owl. Similarly, Prokop, Kubiátko, and Fančovičová (2008) found that many Slovakian primary

school students have misconceptions about owls; for example, they believed that an owl's eyes light up at night or that owls see only at night. Future research should address the source of these student misconceptions in greater detail.

According to Kellert (1985), students 10–13 years old rapidly progress in factual knowledge and understanding of animals, and from age thirteen to sixteen they express their ethical concerns and ecological appreciation of animals and the natural environment. In this study, the respondents, age ten to fifteen, had some factual knowledge and understanding of owls, and some students reported the conservation status of these bird species. However, significant differences in students' written responses by grades were detected only when mentioning owls' good hearing and the depiction of habitat.

Any mode of external representation of biological ideas, concepts, or phenomena uses a special way of representing real-life objects. Visualization is especially important in biology education because the objects studied are usually very complex biological systems. Tsui and Treagust (2013) presented modes of representations as a continuum of increasing abstraction, on which human language is the most abstract mode. As proposed by Prokop and Fančovičová (2006), a combination of children's drawings and written responses could provide more reliable information about children's ideas. This study assessed 10- to 15-year-old students' knowledge of owls by analysing two modes of external representations: drawings of owls (a very realistic mode) and written descriptions of owls (the most abstract mode). The results show that students' written responses provided more information on their ideas about owls; particularly about owls' specific behaviours, diet, and conservational status. However, some information, such as depicting owls' body parts and body proportions or their habitats, could be more clearly depicted with drawings. In our future research, we plan to repeat the study with Slovenian students in third and fifth grade (eight to ten years old). The main research goal will be to investigate the benefits of gathering students' knowledge from written responses and drawings and to compare the results with this study. Our assumption is that children's drawings will provide additional information to the written responses than in this study because younger children are less literate and consequently more limited in their verbal expression.

Disclosure statement

No potential conflict of interest was reported by the authors.

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