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PUPILS' FACTUAL KNOWLEDGE ABOUT VERTEBRATE SPECIES

Abstract. *Biodiversity has become a challenging educational topic and basic knowledge about animal or plant species, their identification and life history has been targeted as a fundamental aspect. There are few studies aiming at assessing pupils' knowledge about vertebrates and it's identification skills in pupils. Further, many educational practitioners and conservationists claim a significant decrease of species knowledge in today's children and adolescents. Here, I try to quantify the knowledge about animal species using a large, illustrated questionnaire dealing with 54 vertebrate species. 879 lower secondary school pupils and 65 primary school pupils (4th graders) from three geographic regions throughout Germany participated in the study. Species knowledge was dependent on educational level and gender. It did not increase parallel to age or grade but rather reached a peak during the age of 14 years or during the 7th grade, respectively. Further, species knowledge did not decrease between the early 1980ies and 2005.*

Key words: *biodiversity, factual animal species knowledge, gender.*

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Introduction

Biodiversity has become a challenging educational topic especially since the conference of Rio in 1992 (van Weelie and Wals, 2002; Gaston & Spicer, 2004). Today, the value – even in currency – and the general importance of biodiversity is unquestioned (Gaston & Spicer, 2004). However, biodiversity is a rather 'ill-defined' and complex construct at least in terms of educational circumstances (van Weelie & Wals, 2002). Such complex and abstract constructs usually have to be transformed into smaller entities to aid learning and understanding especially in school students, and of course, also in the general public. The most common entity used by conservation groups are species (van Weelie & Wals, 2002). Especially spectacular species, such as the Ivory-billed Woodpecker (*Campephilus principalis* Dalton, 2005) or dolphins (Barney, Mintzes & Yen, 2005) were used as a venue in environmental education and conservation. Therefore, basic knowledge about animal or plant species, their identification and life history has been targeted as a fundamental aspect for learning and understanding in biodiversity (Lindemann-Mathies, 2002; Randler & Bogner, 2002; Gaston & Spicer, 2004; Randler, Ilg & Kern, 2005) as well as in the framework of ecological questions (Leather & Helden, 2005). Such a fundamental view of biodiversity is shared by both, educational instructors and practitioners as well as by conservation biologists. Many conservation agencies and NGOs make use of flagship species to raise money, again, emphasising the value of species (Czeck, Krausman & Borkhataria, 1998; Dalton, 2005).

Animals are fascinating for children and adolescents, e.g. in Norway animal-related activities received high scores, such as bird feeding (74%), or watching hare, fox and moose (63%). Watching TV programmes received an almost similar proportion compared to learning about animals in schools (Bjerke, Kaltenborn & Ødegardstuen, 2001), suggesting that schooling might not be the main source of animal knowledge. Further, engagement in animal-related activities decreased parallel to age (Bjerke et al. 2001) suggesting that species knowledge may also decrease. There are few studies aiming at assessing knowledge about vertebrates and identification skills in pupils (overview: Randler & Bogner, 2002), mostly complaining about the low species knowledge in general. Further, many educational practitioners and conservationist claim – often without sustain – a significant decrease of species knowledge in today's children and adolescents. As there are not many studies in this respect, such a claim may belong to the 'folklore' of environmental education (Hendee, 1972).

The aim of the study was 1) to quantify the knowledge about biodiversity using a large, illustrated questionnaire dealing with vertebrate species, and, 2) the results will be compared with previous studies to look for possible changes during one generation.

Methodology of Research

Pupil sample

The data for the present study were collected during the second half of the German school year in 2005. In Germany, pupils were split into three different educational (or stratification) levels after the 4^{th} grade (primary school) due to their cognitive abilities. A total of 879 secondary school pupils participated in the study. Three geographical regions in Germany were covered: Schleswig-Holstein (N=139), Niedersachsen (N=222) and Baden-Württemberg (N=518). Data from Schleswig-Holstein and Niedersachsen covered the Gymnasium (highest educational level) and data from Baden-Württemberg were distributed between Gymnasium (N=365) and Realschule (N=153; medium educational level). Age was distributed from 9 to 19 years (mean = 12.67 years ± 2.09 sd) but 263 pupils were 11 years (29.9%) and 254 (28.9%) 12 years old. Therefore, a total of 30.8% were 5^{th} graders (N=271). This allows a comparison with data derived from Eschenhagen (1982; see below). 363 pupils (41.3%) were boys and 515 (58.6%) girls (one pupil did not answer the question). An additional sample at the end of the primary school (4^{th} graders) was taken (N=65: 37 boys/28 girls; mean age: 10.02 years ± 0.45 sd).

Questionnaire

To measure knowledge about species, I applied a questionnaire with colour illustrations as many vertebrate animals are richly coloured and colour is one of the main identification keys. Previous educational studies often used black-and-white illustrations to test species knowledge. Up to six photos were depicted on an A4-sized questionnaire. The pupils had to identify the respective animal as precise as possible, e.g. as Great Tit (*Parus major*) or as Mallard (*Anas platyrhynchos*). This was scored with 1.0. However, if the *genus* or family name was correct but the species identification was not, then it was scored 0.5 (e.g. tit or duck), otherwise the value 0 was assigned. This was to ensure that prevailing concepts were not emitted but taken into account (Eschenhagen, 1982 used a similar procedure). The selection of the species followed a rather detailed procedure. Previous studies often used a battery of species without any substantial reasoning about the abundance or frequency of these species. Therefore, Randler & Bogner (2002) displayed a listing which should be taken into account when selecting species for such questionnaires. Listings of different authors (review studies) were used for each taxonomic class to find the most common species (e.g. hunting statistics were used for classifying mammals, breeding bird atlases were used for classifying birds, Red Data Books were used to assess the threat status and, subsequently, non-threatened species were used).

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The final scale consisted of 28 bird, 14 mammal, 6 amphibian, 3 reptile and 3 fish species. This differed slightly from the number of species represented in the German fauna (x^2_4= 33.758; p<0.001). In detail, amphibians were over-represented (p<0.01) and fish were under represented (p<0.001; mainly due to the high number of marine fish species), while the numbers of mammals, birds and reptiles in the questionnaire were representative compared to the number of species in Germany (always p>0.05). Interestingly, there was a high congruence with a German book "100 animals one should know" (Schmid 2000) which validates the selection process: 87% of the vertebrate species used in the present study were also depicted in Schmid (2000). Further, there was a high congruence with a previous large scale study (Eschenhagen, 1982).

Previous data on species knowledge in Germany

Eschenhagen (1982) made a large survey study concerning knowledge about animal species (mainly vertebrates) using 48 species including 18 invertebrates. 21 out of his 30 vertebrates were also used in this present study which allows a comparison of correct identifications over a time span of 25 years. Eschenhagen (1982) could not use coloured printouts but he used models or taxidermy specimens that were presented to the pupils. The sample sizes was different but it comprised 604 5th graders from four different schools in NW Germany. Eschenhagen (1982) used the same method of scoring (see above) and expressed values of correct identification as percentages. For each vertebrate species a percentage of correct identification was calculated and compared with the percentage reported by Eschenhagen (1982) in a matched pair comparison.

Statistical procedures

The matched pair comparison with Eschenhagen (1982) was based on the Wilcoxon test. Thus positive ranks mean a higher knowledge in today's pupils' while a negative rank or percentage implies a lower knowledge. Apart from bivariate statistics general linear modelling was used to test the influence of all relevant factors influencing species knowledge in one single model. The first model contained such factors as age, gender, grade and educational level and all two-way-interactions. By performing a stepwise backward procedure always the variable or interaction with the highest non-significant P-value was removed until the final model contained only significant explanatory variables.

Results of Research

The biodiversity scale proved to be highly reliable (Cronbach's alpha=0.88, using all 54 items). This suggests that the scale is valid and could be used for assessing factual species knowledge ('biodiversity knowledge'). Significant differences in species knowledge existed between primary school pupils (mean score: 17.4 ± 6.9), secondary medium stratification pupils (21.5 ± 4.0) and secondary highest stratification pupils 23.4 ± 6.8 (ANOVA-$F_{2, 941}$=27.865; P < 0.001). These differences remained significant in a Post-hoc Bonferroni correction (P < 0.05).

Concerning age a quadratic or cubic function explained a higher amount of variance compared to other regression models (R^2=0.027; Figure 1) and concerning grades, also quadratic (R^2=0.057) and cubic functions (R^2=0.075) explained most of the variance (Figure 2).

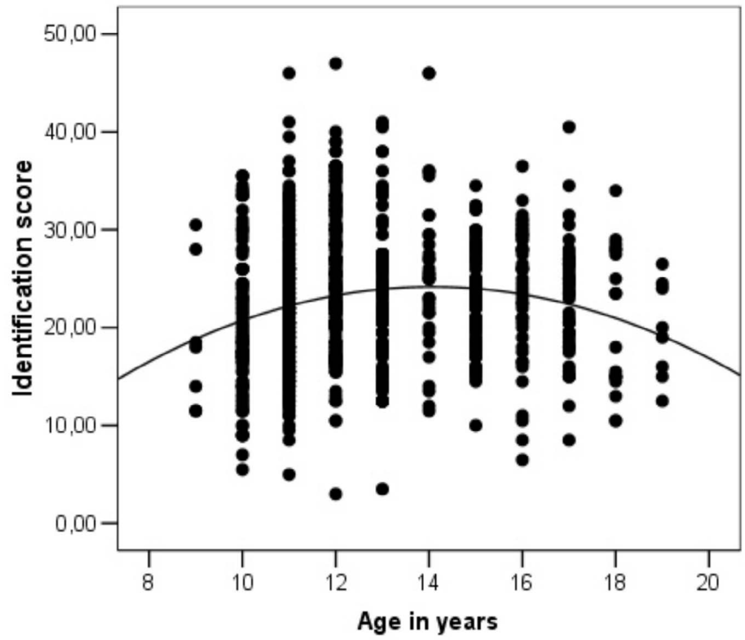

Figure 1. **Relationship between age and biodiversity knowledge in pupils. The vertical axis shows the identification score (maximum = 54).**

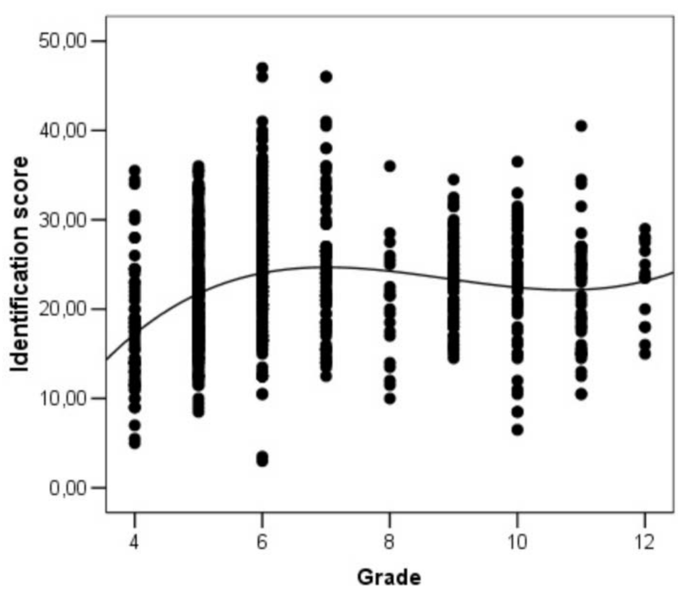

Figure 2. **Relationship between grade and biodiversity knowledge in pupils. The vertical axis shows the identification score (maximum = 54).**

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This suggests that species knowledge does not increase parallel to age or grade but rather reaches a peak during the age of 14 years or during the 7th grade, respectively. In a GLM based on the data of the secondary school pupils, species knowledge was used as dependent variable and gender, age, grade and educational level as factors. All four factors had a significant influence on species knowledge (Table 1). As both, age and grade contributed to the model, this suggests that learning about species may take place both during formal school learning and other informal settings. Pupils in the highest stratification (Gymnasium) scored higher compared to pupils in the medium stratification (Realschule), thus the educational level reflects cognitive abilities. Girls scored significantly better compared to boys although the effect size was low (Table 1).

Table 1. General linear model (Final GLM after a stepwise deletion of non-significant factors; see methods) using species/biodiversity knowledge as dependent variable. Data are based on secondary school pupils from two educational stratification levels.

Source	Sum of squares Type III	df	Mean of squares	F	P-value	Partial Eta2
Corrected Model	6324.337	19	332.859	9.266	<0.001	0.170
Constant	22166.503	1	22166.503	617.123	<0.001	0.418
Age	1928.505	10	192.850	5.369	<0.001	0.058
Grade	3984.840	7	569.262	15.848	<0.001	0.114
Educational level	2495.384	1	2495.384	69.472	<0.001	0.074
Gender	238.566	1	238.566	6.641	0.010	0.007
Corrected total variation	37142.909	877				

$R2 = 0.170$ (corrected $R2 = 0.152$)

In comparison with Eschenhagen (1982) I found no significant decrease or increase in species knowledge concerning 21 species used previously by this researcher. Negative ranks were found in seven and positive ranks in 14 species (Wilcoxon Test: Z=-0.956; P=0.339).

Discussion

Age and grade were found significant predictors of species knowledge. However, the increase was not parallel to age/grade but followed a cubic or quadratic pattern where knowledge increased until the age of 14 years or the 7th grade respectively. Usually, interest into animal species at school is highest during the 5th and 6th grade (Löwe, 1987, 1992; Vogt, 1998) and this interest extents into activities outside school. Interest in biology in general then decreases during the age of puberty (7th/8th grade) which might be reflected by the decrease in knowledge. As interest correlates positively with learning and instruction in biology (Gläser-Zikuda, Fuß, Laukenmann, Metz & Randler, 2005), a decrease in species interests might be mirrored by a decrease in species knowledge. Engagement in animal-related activities –as another possible predictor of species interest and knowledge – also decreases with age (Bjerke et al., 2001) suggesting that species knowledge may also decrease.

What are the sources of species knowledge? Apart from learning at schools, especially out-of-school activities in terms of informal free-choice learning (Falk, 2005) seem to influence learning about animal species. Such informal learning takes place in zoos, museums, parks and aquariums (Falk, 2005). Watching TV programs about animals and nature, for example, received almost a similar proportion compared to learning about animals in schools (Bjerke et al., 2001). One central question is whether this species knowledge is obtained by directly encoutering them in nature or by learning from nicely coloured books. This question si difficult to answer but Bjerke et al. (2001) found a high proportion of pupils that had etsablished a brid feeder or were watching animals outdoors.

Educational level showed a significant influence on species knowledge again emphasising that learning about species is a difficult task which is reflected by the different cognitive abilities of pupils in the different school stratifications (educational levels). Consequences for school practice might be that the number of species used in teaching and learning about biodiversity should be lower in lower stratifications (Randler et al., 2005).

Gender showed a significant but marginal influence (eta^2=0.007; see Table 1). This contrasts with other studies dealing with identification and classification tasks. For example, Lazarowitz (1981) found no gender differences in 7^{th} graders, while 9^{th} grade boys scored better compared to girls. Ryman (1974, 1977) also reported higher scores in boys, while Killermann (1998) described a different pattern in plant species identification where girls scored higher. Thus, a clear pattern is not visible and gender differences seem marginal and overestimated in the special field of species knowledge. However, it seems that nowadays girls generally perform better even in subjects that were considered to be a domain of boys such as physics.

Conclusion

It is one of the most interesting results that species knowledge did not decrease between the early 1980ies and 2005. These results seem valid because I focused on the same grade as Eschenhagen (1982) and I used the same method of scoring. Therefore, as a decrease in species knowledge is not apparent such claims should be regarded as 'folklore' of environmental education. It is far more important that species knowledge did not decrease although teaching and learning about species and species identification decreased significantly in German biology syllabi, e.g. in Baden-Württemberg lessons about the identification of animal or plant species were obligate during 1970ies and the 1980ies, but were removed from the syllabus at the end of the 1980ies and were absent during the 1990ies. This further emphasises the function of learning in informal settings outside the school curricula (e.g. Falk, 2005).

It is difficult to formalize a set of species that should be learned during the school curriculum but at least a set of 80-100 vertrebrate species seem appropriate.

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