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EFFECTIVENESS OF REPTILE SPECIES IDENTIFICATION – A COMPARISON OF A DICHOTOMOUS KEY WITH AN IDENTIFICATION BOOK

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ABSTRACT. Species identification tasks are a prerequisite for an understanding of biodiversity. Here, we focused on different educational materials to foster the identification of six European reptile species. Our educational training unit was based on natural plastic models of six species and pupils either used an illustrated identification book or a dichotomous key. 71 secondary school pupils (6th graders) from four classes participated in our study and received a hands-on lesson about the identification of these species. 37 of them were aided by an identification book, and 34 received a dichotomous key. We found a significant increase in identification skills immediately after and with a delay of four weeks in both treatment groups. Further, we found no differences in achievement between both groups nor did we detect differences in the emotional variables (well-being, interest, boredom) or in the difficulty of the task. We propose that species identification should be taught in everyday school life using models and identification materials that allow a learner-centred environment.

KEYWORDS. Identification Skill Training, Classification Task, Self-Regulated Learning, Identification Keys, Model Specimen, Taxonomy.

INTRODUCTION

One major prerequisite for an understanding of ecology and ecological interactions is some basic knowledge about species and their natural and life history (Lindemann-Mathies 1999, Randler & Bogner 2002, Randler 2006). This is especially true when it is taught at the school level. Training in identification skills or making use of identification books, therefore, is an important task in biology teaching. Previous studies found that some basics must be considered when pupils were taught species identification: The number of species taught during such an educational unit should not be exceedingly high (Randler & Bogner 2002), and approximately five to six different species should be considered as sufficient (Randler & Bogner 2006). Further studies revealed that student- or learner centred environments often cope better with the need of pupils to autonomously explore new fields of knowledge, to perceive competence and to be socially related (self-determination theory; Deci & Ryan 1990).

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Usually, outdoor educational settings are given preference over classroom instruction (Killermann 1998), however, most of these empirical studies are related to plant species or invertebrate identification or to measuring abiotic factors (Killermann 1998). Identification tasks in a herpetological context have been seldom empirically tested (Randler et al. 2005). In amphibian identification, for example, pupils were instructed in the classroom (pre-visit instruction), then encountered living amphibians during a conservation action, and the field trip received a post-visit instruction (Randler et al. 2005). In contrast to amphibians during their spring night-time migration, reptiles are highly mobile species in their natural environments and difficult to observe and identify at least on the level of pupils. Therefore, we developed an identification task that used model specimens instead.

Different identification materials can be used during such a learner-centred environment. Identification books represent the most common media used for animal identification, and, by using them, pupils learn how to cope with such reference material which emphasises the value of identification in their everyday life and encourages a lifelong learning. From a scientific viewpoint however, pupils should be enabled to make us of dichotomous identification keys (Randler 2006). Such a dichotomous key is always based on two alternatives (decisions) which were subsequently followed by another pair of alternatives unless the final species name (or other taxonomic level) is reached. Such keys were developed, e.g. in human biology (Bavis et al. 2000), plant identification (Ohkawa 2000), fruits, nuts and cones of trees (Collins 1991), timber (Thomas 1991) or in amphibians (Randler 2006), but most of these have not been evaluated. The benefits of an identification book is its value as a real or original medium, while its disadvantages may be that they are costly and often depict many more animals than were explored during the lesson. However, this, in turn, fosters competence and skills in pupils to use such books as references. Another disadvantage of pictures in books is that pupils focus on the pictures alone and discard reading the specific text which usually supports identification features and is helpful for memorising. Therefore, an identification key based on dichotomous decisions between two alternatives and on language may provide a closer and more detailed look at the objects and these keys are usually scientifically precise and afford the understanding of specific scientific terms. In a pilot study, using tracks and signs of animals as original objects (Randler & Knape 2007), pupils using an illustrated identification key (a selection of pictures for identification) achieved significantly higher scores compared to pupils using a dichotomous, language-based identification key. Therefore, to cope with these results, we used a dichotomous key that was supported by a few black-and-white pictures which aid the final identification of the respective species. The benefit of this key is that it can be copied and pupils can take them home for their personal use.

The aim of this present study was to enhance learning and retention effects when pupils in small groups were working together in an identification skill training using model specimens of reptiles and either using a dichotomous key or an identification book. Therefore, the educational material was the variable in question, and the educational treatment, namely group-based learning (Lou et al. 1996), hands-on science (e.g. Stohr-Hunt 1996) and the use of models remained equal in both approaches.

METHODS

Species selection

As outlined previously, we focused on six autochthonous species of reptiles that could be encountered in Baden-Wuerttemberg, the federal state where the educational unit was carried out. We selected models of six species: Western green lizard *Lacerta bilineata*, sand lizard *Lacerta agilis*, smooth snake *Coronella austriaca,* grass snake *Natrix natrix*, adder *Vipera berus*, and slow worm *Anguis fragilis*. These models closely resembled original reptiles and were obtained from a scientific producer (SOMSO; Schlüter Biologie, Winnenden, Germany).

Materials for identification

Two different identification materials were compared with each other. The identification key was obtained from Schroedel-Verlag (Schrodel, Braunschweig, Germany) and was explicitly made for the use in a school setting (biology lessons, 5th and 6th graders). It contains a DIN A 3 page in black-and-white that can be easily copied and given to the pupils. The key has a dichotomous structure where there is always a decision between two alternatives, e.g. whether the pupil of the eye is vertical or horizontal. When you have gone through all alternatives the final species' name is reached and there is a black-and-white illustration to further support the identification.

The identification book (Amphibien und Reptilien erkennen und schützen, amphibians and reptiles; total pages: 159; Blab & Vogel 1996) was also obtained from a commercial producer. This book depicts a total of 19 reptiles species on 37 pages. The book provides various photographs and sketches in colour and verbal information about identification, behaviour, natural history and ecology.

Educational program

Pupils worked together in groups of 2-4 pupils and each group received either an identification book or the dichotomous key. The plastic models were presented in a kind of workstations (Schaal & Bogner 2005). Pupils then moved from one desk to another, looked at the models and identified them. After pupils had finished their work, results were discussed and corrected in the classroom.

Test instrument

Tests were based on a slide presentation. Pupils received a sheet of paper where they had to label the species as precise as possible. The species were numbered and the pupils wrote down their identification at the respective number. This procedure was repeated three times (pretest, posttest and retention test). The posttest was applied immediately after the lessons and the retention test with a delay of four weeks. However, the order of presentation of the species was changed between all three test sessions to avoid effects produced by order. Each correct identification on the species level was scored with 1.0, each correct identification on the genus level was scored 0.5. Others received the value 0. This was added to a total score for each participant. The logic behind this scoring is that a gain in knowledge must not result in the correct species identification – for example, a species may be totally unknown to someone but after an educational treatment it is identified on the genus level (e.g. as a lizard). Further, we consider it as an improvement or refinement of a concept when there appears a shift from the genus identification, e.g. previously identified as a lizard and later on identified correctly with the species' name (sand lizard; see discussion in Randler & Bogner 2006).

Additionally, we measured emotional variables derived from the inventory proposed by Laukenmann et al. (2003) and Gläser-Zikuda et al. (2005). We measured these constructs based on four different dimensions: interest, well-being, boredom and difficulty of the questions based on a five-point Likert-scale. Each dimension was tested with one question immediately after the lesson.

Pupil sample, randomisation

71 (14 boys, 57 girls) pupils from four different classes of two schools participated in our study. The design was balanced because the treatments were randomly assigned to the two classes of each school (quasi-experimental approach). One class out of each school received the identification book and the other one received the dichotomous key. One school was mono-educative (girls only), therefore, the sample is biased towards girls. 37 pupils (7 boys, 30 girls) received an identification book to support their learning and 34 pupils (7 boys, 27 girls) received the black-and-white illustrated dichotomous key.

Statistics

For comparison of the means of both approaches we used T-tests and to further investigate differences in a more complex manner and controlling for covariance and interactions a general linear model was applied (GLM). All tests were carried out two-tailed. We used SPSS version 13.0. Means ± standard errors (s.e.) are given.

RESULTS

Species identification

Pupils did not differ in their prior knowledge (book: 1.18 ± 0.11 versus key: 1.48 ± 0.10; T-test: T=-1.90; df=69; P>0.05; Figure 1). Immediately after the educational treatment there were no significant differences between both treatment groups (book: 4.52 ± 0.19 versus key: 4.66 ± 0.19; T-test: T=-0.48; df=69; P>0.05). After a delay of four weeks, there were also no differences in retention (book: 3.85 ± 0.20 versus key: 3.51 ± 0.14; T-test: T=1.29; df=69; P>0.05). This suggests that both educational materials are equivalent in their effectiveness and that both may be used to achieve a sustained learning and retention (Figure 1). Examining the species in detail found interesting results. Prior to teaching, only the slow worm was identified correctly on the species level by most pupils, while both lizard species were known as lizards (genus name) to the pupils (Figure 2). In the posttest, most pupils were able to recognise both lizard species, the slow worm and the adder on the species level while smooth snake and grass snake were more difficult to identify (Figure 3). Retention test revealed similar results although the scores were generally lower. Scores of adder and slow worm remained high suggesting that these species were recognised on the species level by most pupils even after a delay of four, while smooth snake score was extremely low.

The multivariate general linear model (GLM) used pretest as covariate and both gender and treatment as factors. There was no significant effect of gender, treatment and pretest in the multivariate model. Univariate models revealed a significant influence of pretest on posttest (F=3.82; df=1; P=0.05) but not on retention test (P>0.05).

Emotional variables

We found no significant differences between the treatments in emotional variables (P always >0.05). Generally, interest was rather high (≈ 4 on the five point Likert scale), as was well-being (≈ 4). Boredom was perceived as low (≈ 1.6) and the task was not considered difficult (≈ 1.8). This suggests that the educational treatment was well-accepted in the assessment of the pupils. Further, as the pupils perceived their task as equally difficult, we suppose that both identification materials are suitable for species identification.

DISCUSSION

Model specimens, identification tools (either books or keys), hands-on instruction and group-based learning approaches provide successful learning environments for secondary school pupils. This was proved in some earlier studies (Randler & Bogner 2006, Randler & Knape 2007). Here, we used these previous results and focused on the identification material itself. We found that both treatment groups significantly improved their species identification knowledge about reptiles and we further suggest that such methodological teaching sequences should be embedded into everyday school practice. Further, we emphasize that the number of species that should be taught during such lessons should not be exceedingly high – approximately six different species seem sufficient for 5th and 6th graders.

The general linear model did not detect differences between boys and girls, however, this might be hampered by the low sample size of boys in the groups. Nevertheless, we feel that boys and girls equally benefit from this kind of instruction since other recent studies also did not reveal gender differences although they provided larger samples of boys (discussion in Randler & Bogner 2002, 2006). This might also result from the content of the lessons as reptiles may be equally interesting for boys and girls. In plant identification, for example, girls usually score higher (Killermann 1998, Scherf 1985).

With regard to our identification materials, we found no significant difference between both approaches, suggesting that either the identification book as well as the black-and-white key were equally suitable for this identification task. The advantages of the key are clearly its low costs, i.e. it can be copied and each pupil may retain the key and may use it further in out-of-school settings. Further, this key trains pupils to look critically at verbally explicated differences and to scrutinise the models in detail. However, the identification book also has its advantages. The book consists of many pages and, therefore, pupils must thoroughly go through it to find the correct identification. Further, such books also provide a wealth of information about the respective species' ecology and behaviour.

Why are some species more easily to memorise? There were only two species of lizards and most pupils were able to identify them prior to the educational unit on the genus level, thus they had a concept of lizard and refined it during the identification task. The slow worm was correctly identified prior to the lesson by more than 60% of the pupils and afterwards by nearly all. This species closely resembles a kind of worm rather than a reptile which may also make it easy to recognise. Three species of serpents were used, all rather unknown prior to teaching. In retention, the adder was most often labelled correctly, followed by the grass snake and the smooth snake. The adder is one of two venomous snake species in Germany which made it perhaps impressive for the pupils. Grass snake has two yellow patches behind the head – a very conspicuous trait while the smooth snake does not show any pronounced coloration. Both snake species presented difficulties during the identification lessons (IZ; pers. observ.) which might explain the low retention scores.

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Table 1. Results of a multivariate general linear model (GLM) using pretest as covariate and gender and identification material as factors.

	Wilks-Lambda	F value	P
Constant	.225	112.039	.000
Pretest	.942	1.990	.145
Identification material	.994	.212	.809
Gender	.960	1.338	.270
Interaction gender * material	.965	1.171	.316

FIGURES.

Figure 1. Comparison of two different identification materials (coloured identification book versus language-based dichotomous key). Mean scores of tests were depicted (maximum: 6 points). Posttest was applied immediately after the lessons and retention test was applied after a delay of four weeks.

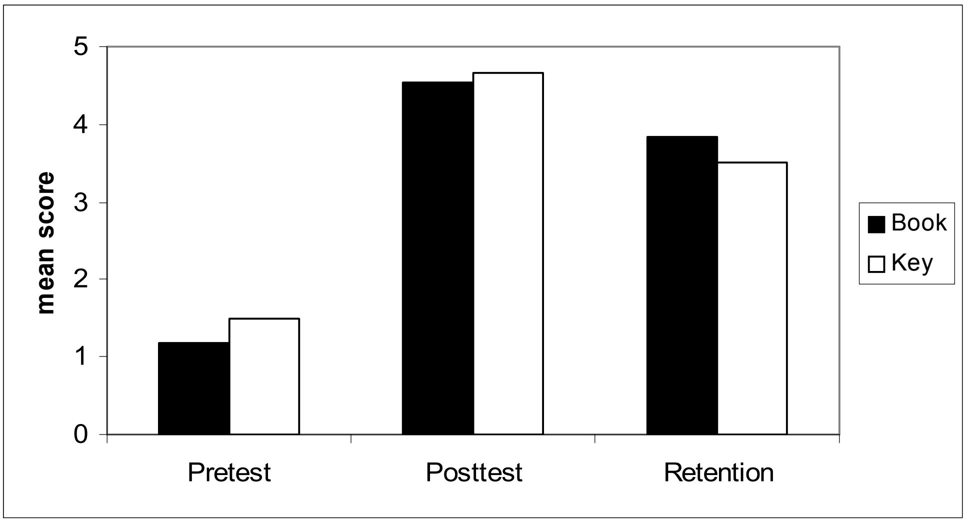


Figure 2. Percentages of correct identification of six different reptile species prior to the educational unit. Data from both treatment groups pooled.

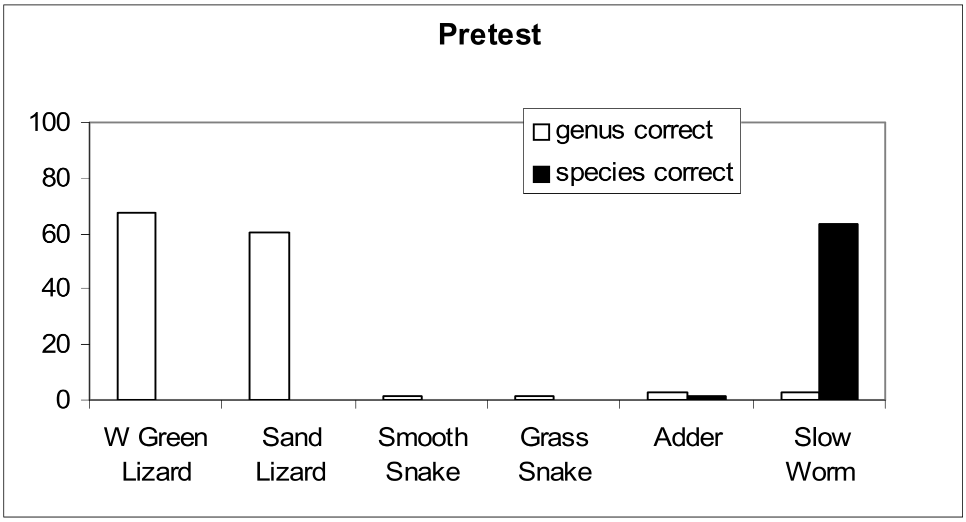


Figure 3. Percentages of correct identification of six different reptile species immediately after the educational unit. Data from both treatment groups pooled.

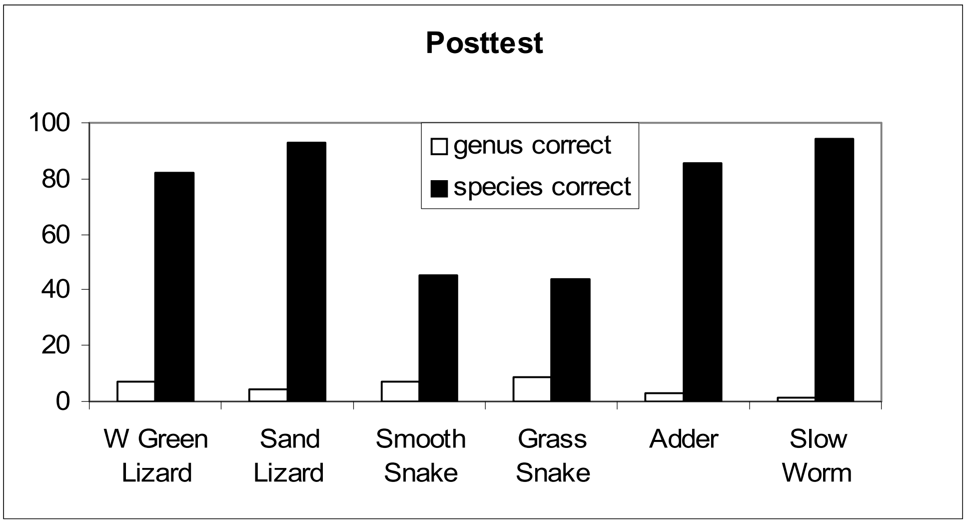


Figure 4. Percentages of correct identification of six different reptile species four weeks after the educational unit. Data from both treatment groups pooled.

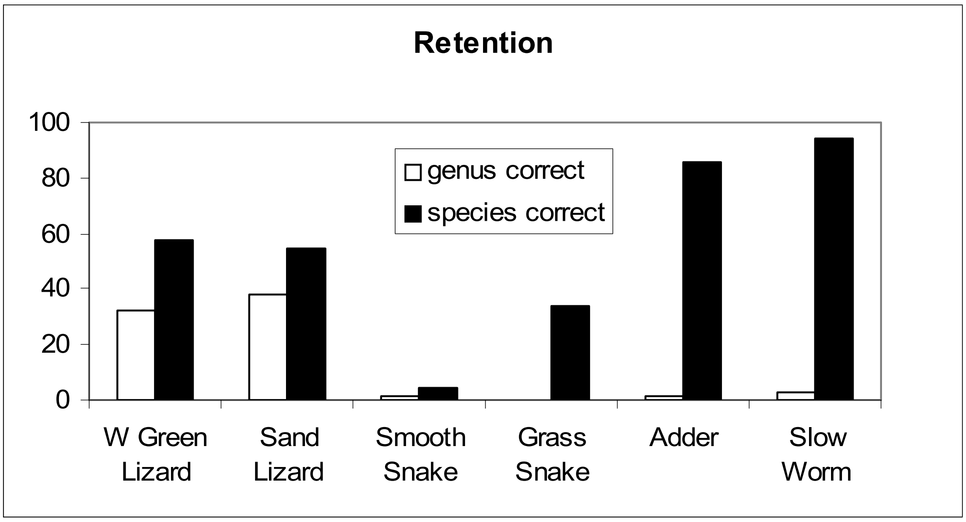
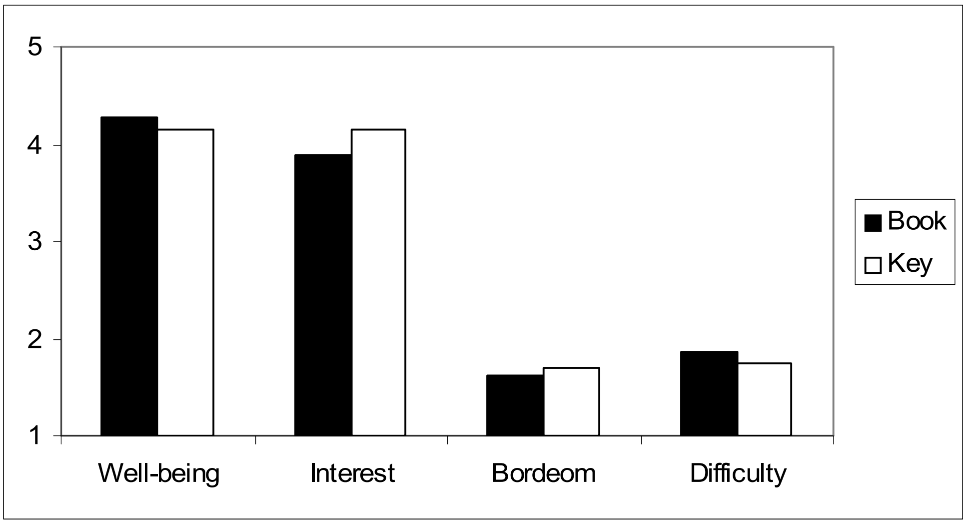


Figure 5. Comparison of two different identification materials (coloured identification book versus language-based dichotomous key). Mean scores of emotional variables were depicted (Likert-scale 1=lowest, 5=highest value).



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