

Teaching biodiversity with online identification tools from *KeyToNature*: a comparative study

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Abstract — This paper reports on new pedagogical approaches in teaching biodiversity by using online interactive identification tools developed by the European project *KeyToNature*. A comparative educational study was carried out on two classes of students, revealing the educational value of the interactive identification tools. A systematic evaluation of both the educational processes and the acquired skills was conducted, and the results are presented here.

Index Terms — biodiversity, online identification keys, e-learning, assessment.



1 INTRODUCTION

Biodiversity represents the variety and variability of living organisms at the taxonomic and ecosystem levels [4]. Every species has a well-defined niche in natural ecosystems. Relations among species are complex and of different kinds, the disappearance of some species can bring imbalance in ecosystems [2].

Knowledge of biological diversity through curricular and extra-curricular activities is one of the main objectives of environmental education. Education on biodiversity is important for raising environment-aware citizens: the students have to be aware that every species has its own place and role in the maintenance of the ecological balance of the Earth, and that biodiversity safeguards the order of the planet affecting climate change, keeping the air clean, providing food, resources, medicines and potable water.

The teaching of biodiversity is a complex process: it needs a blend of classic educational methods (observation, simulation, explanation, field-work, visits to botanic gardens, zoos, natural history museums, etc.) with modern approaches such as the use of educational software and related questioning and team-

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research projects. These allow the forming of abilities in measurement, phenomenon recognition, ecosystem research, and – a basic task - identification of species.

2 EDUCATIONAL PROCESS

2.1 DIDACTIC METHODS

Didactic methods – when used skillfully - lead to systematic and progressive enrichment of knowledge. They can be defined as “ways of acting, by means of which students can - independently or under the guidance of teachers - acquire knowledge, build up their skills, abilities and attitudes, develop their world and life outlook” [5]. Modern methods of teaching and learning with educational software (Fig. 1) are important in this context. They help students by providing a large amount of well-organized and structured opportunities for practicing skills in various fields of knowledge, allowing an easy and often playful simulation of processes and phenomena which are often hard or impossible to access directly [1], [3].

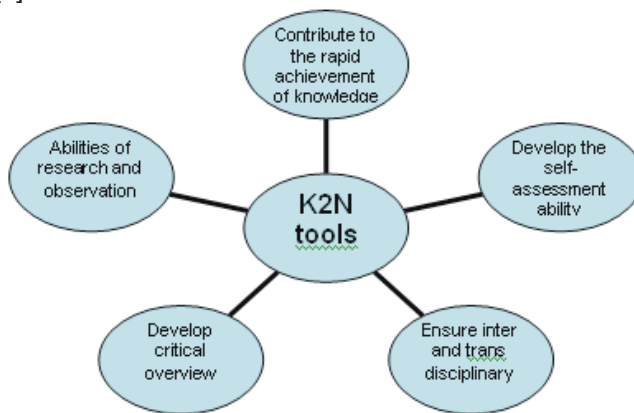


Fig. 1 – Using the identification tools of *KeyToNature*.

We have conducted a comparative study in teaching the identification of Spermatophytes to two classes of students. Teaching methods were identical in the two classes (see Tab. 1): observation, modelling, a study tour, explanation, a botanical atlas, worksheets. For identification, however, a class used a pictorial botanical atlas, the other class used computer-assisted learning tools developed by the European project *KeyToNature* [6, 7].

2.2 LEARNING ACTIVITIES

The developed learning activities (see Tab. 1) aimed at teaching the general characteristics, recognising some representative species, discussing the ecology and economical/ecological importance of Spermatophytes.

Systematic group	Topic / time	Training scenario	
		Class A	Class B
Gymnosperms	General characteristics (1 hour)	<ul style="list-style-type: none"> grouping students in four groups (collaborative tasks) the students study the available biological resources they observe the morphology of leaves and cones identifying the main characteristics of gymnosperms; these were written down afterwards on a dedicated worksheet 	
	Identification & description of the species (1 hour)	<ul style="list-style-type: none"> place: biology lab usage guidelines use of a botanic atlas to identify five species use of worksheets for Class A 	<ul style="list-style-type: none"> place: computer lab usage guidelines use of a KeyToNature interactive key [7] using the worksheets for Class B (e.g. Tab. 2)
Angiosperms	General characteristics (1 hour)	<ul style="list-style-type: none"> grouping students in four groups (collaborative tasks) the students study the available biological resources they observe the morphological characteristics of leaves, flowers and fruits, identifying the main characteristics of Angiosperms; these were written or drawn (leaves, flower) afterwards on the worksheet. 	
	Identification & description of the species (1 hours)	<ul style="list-style-type: none"> place: biology lab usage guidelines use of a botanic atlas to identify five species worksheets 	<ul style="list-style-type: none"> teamwork - computer lab usage guidelines use of a KeyToNature interactive key worksheets
Spermatophytes	field training (1 hour)	<ul style="list-style-type: none"> visit in the park near the school identification of the species studied in the lab comparing the characteristics of different species (Gymnosperms vs Angiosperms) discussing the adaptations to climate. 	
Evaluation (1 hour)		<ul style="list-style-type: none"> evaluation test (see section 2.3 in this paper) 	

Tab. 1 – Design of the teaching scenario.

The training activities were organised in a learning unit of six hours, combining: in-class training, visit outdoors, and evaluation. Tab. 2 shows a sample of the student worksheet for Class B (studying Gymnosperms).

No.	Name of species	Bole	Leaves	Seeds/ Cones	Areal/ Importance
1.	Taxus baccata	Straight ascending	Acicular, flattened	A single seed with a woody skin, covered by a red, fleshy Aryl	Hardwood used for fine carpentry and sculpture....
2.	Thuja orientalis	Straight	Small, scaly, have a dimple on the underside...	Several seeds included into a cone	Cultivated as ornamental plant in gardens and parks.
3.

Tab. 2 – Example from the worksheet used by students to fill in their responses.

2.3 METHODS AND TOOLS USED FOR EVALUATION

Knowledge evaluation was carried out using different methods: systematic observation, self-assessment, correctness of identifications, as well as written paper. Both classes received the same test. The evaluation tool contained: short answer items, double choice items, pair items, questions on identifying and classifying, other structured questions. The evaluation was centered on: a) recognition of morphological characteristics of leaves and flowers of Gymnosperms and Angiosperms, b) description of the general characteristics of Spermatophytes, c) identification of species and their assignment to the correct systematic group.

Several questions concerned the recognition of morphological characteristics of leaves and flowers. The students in Class B (those who learned through the *KeyToNature* tools) identified better the morphological characteristics of leaves (Fig. 2) rather than those of flowers (Fig. 3). This probably depends on the fact that the interactive keys of *KeyToNature* were mostly based on leaf morphology.

The knowledge of the general characteristics of Spermatophytes was checked through short answers and double choice answers, with four statements on Gymnosperms and four on Angiosperms. For Gymnosperms, students in Class B had 25% more of correct answers compared with those of Class A, whereas for Angiosperms the results were similar in both classes. This probably depends on the fact that Gymnosperms are a much smaller group with distinctive characteristics, which are easily appreciated by all students.

Finally, we have evaluated the ability of students to use morphological characteristics for identification and classification in the correct systematic group. The students had to identify four species of gymnosperms and four of angiosperms. Students from Class B had better results: most of them identified and classified correctly all species (Fig. 4). For example, 18 students correctly identified all species of Gymnosperms, 2 students correctly identified only 3 species, and 1 student only didn't identify any species (Fig. 4).

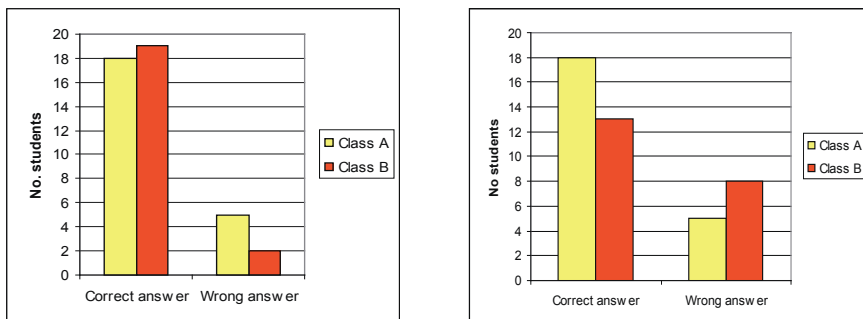


Fig. 2 (left) – Evaluation item: leaves morphology.
Fig. 3 (right) – Evaluation item: flower morphology.

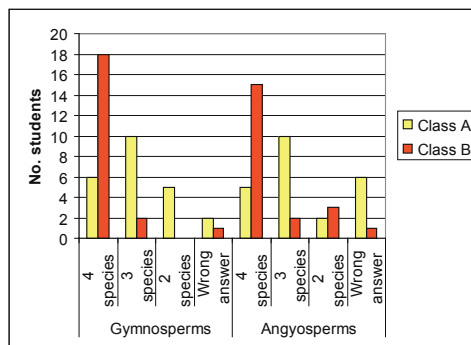


Fig. 4 – Evaluation item: systematic recognition and classification of species (number of correctly identified and classified species from a total of four).

These results indicate that the use of identification keys for the study of biodiversity allows students to develop observing, research and analytical skills, to enhance their intellectual work, and to improve their digital skills.

3 CONCLUSIONS

The study of biodiversity is one of the major goals of the scientific community and of worldwide policies. Educational goals can be achieved through trans-disciplinary approaches by bringing together traditional methods and innovative teaching. The use of computer assisted-learning such as the identification keys of *KeyToNature* proved to increase the quality and efficiency of the teaching–learning– assessment process.

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