

Editorial

The theme of this issue of the CEPS journal is *Challenges for Biology Education in the 21st Century*. In recent decades, biology has evolved from a classical (descriptive) to modern (explanatory) science. Following the era of engineering (19th century), chemistry and physics (20th century), biology has started to play a key role in tackling the global/complex problems of the 21st century. These problems or challenges must be tackled in an integrative way. Integrating knowledge from various disciplines will permit deeper understanding of biological systems and help us find better biology-based solutions to societal problems. The main purpose of this issue is a discussion of the challenges biology educators face with new discoveries and global ecological and societal changes. In the thematic part of this issue, five papers from authors from Finland, Germany, Ireland, Slovenia, and the United Kingdom, discuss the above-mentioned challenges with which biology education is faced.

In the first article, entitled *Education for Sustainable Development, Nature and Vernacular Learning*, David Selby discusses the limitations mainstream education for sustainable development has in relation to the perception of the natural world. He argues that the natural world is accorded only instrumental or utilitarian value. This de-natured nature of education for sustainable development makes it unlikely that the learner will become motivated to care and act for nature; therefore, the author proposes an alternative, vernacular learning, i.e. place-based learning rooted in close intimacy and connection with the natural world, with nature perceived as intrinsically valuable. Practical examples of vernacular learning activities are enumerated in the article, in which the importance of nurturing a sense of wonder and joy in the young learner is put forward as vital in fostering an ethic of concern for the planet. Among others, the author is calling for children to become feral (i.e. released from captivity and domestication) and learn to be denizens, something just as important as learning to be citizens. In fostering learning for denizenship, biology education has a crucial part to play.

In the second article, entitled *Professional Competence of Student Teachers to Implement Species Identification in Schools – A Case Study from Germany*, Petra Lindemann-Matthies, Martin Remmele and Eija Yli-Panula investigate how well prepared student teachers are to implement species identification in school. They present results showing that participating student teachers identified plants mainly by flower characteristics and leaves, and animals mainly by shape and colour. The number of correctly identified plant and animal species increased with student interest in identifying species and participation in

species identification courses. The authors emphasised the crucial role of the initial teacher preparation system in familiarising graduate students with local organisms, and with suitable approaches on how to carry out species identification later in school. The authors concluded that in times of an increasing loss of biodiversity is important that teachers are able to familiarise their pupils with species. They are convinced that qualified teachers should at least be familiar with common wild plants and animals in their neighbourhood, in order to understand and teach the very nature of biodiversity. For a majority of people, naming, for example, one hundred species of animals is far from a trivial task. This demonstrates well what our real (societal) interest in nonhuman entities is, as the estimated total number of eukaryote species on Earth is over 8 million (Mora et al., 2011).

The next three articles explore different aspects of perception of scientific biological concepts. The article by Darja Skribe Dimec and Jelka Strgar entitled *Scientific Conceptions of Photosynthesis among Primary School Pupils and Student Teachers of Biology* presents scientific conceptions of photosynthesis, by far the most important biochemical process for the vast majority of organisms on the Earth. The authors explored the scientific conceptions about photosynthesis held by primary school pupils and student teachers of biology in Slovenia. They found that these two groups differ greatly concerning scientific conceptions of photosynthesis. The student teachers showed good and complex understanding of photosynthesis, while pupils showed misconceptions. Analysis of the development of scientific conceptions about photosynthesis with age showed that there is very little progress among primary school pupils. In conclusion, the authors suggest that student teachers should have more direct work with pupils during their study in order to be aware of the problem and to better understand the origin of pupils' misconceptions.

In the article entitled *Fragmented Knowledge and Missing Connections between Knowledge from Different Hierarchical Organisational Levels of Reproduction among Adolescents and Young Adults*, Andrej Šorgo and Rebeka Šiling present the results of a study conducted among students of secondary and tertiary schools on a number of tasks covering reproduction from the molecular to organism level. Their knowledge was seriously flawed. Students had difficulties in building a consistent body of knowledge on the genetic–inheritance axis, and expanding it to the anatomy and physiology of reproduction. Teaching about reproduction is not only a classical biological topic, essential for understanding the phenomenon of life, but is, especially in the case of human reproduction and sexuality, an urgent socio-scientific issue; therefore, the authors contemplate the quality of biology subjects in primary and secondary

schools, being aware that for the greatest number of citizens this will be the last formal contact with some key topics, perhaps influencing their life decisions.

In the third article exploring scientific biological concepts, entitled *Personal Constructions of Biological Concepts – The Repertory Grid Approach*, Thomas J. J. McCloughlin and Philip S. C. Matthews discuss repertory grid analysis as a mathematical tool for investigating the structures of students' representations of biological concepts. Repertory grid analysis provides the researcher with a variety of techniques that are not associated with standard methods of concept mapping for investigating conceptual structures. The technique can be used diagnostically and allows the teacher to gain a visual impression of how a student's concepts are related to each other. It can be used to give an overview of the conceptual structures of a class group. The biological concepts covered in this article are 'natural kinds': a technical class of concepts which 'appear' to have invisible 'essences', meaning they carry more perceptual weight than being perceptually similar. The authors outline one case-study in a small group of secondary school students exploring the concept of 'equine' – that is, what is an equine? In the conclusion, recommendations are offered in applying this approach to biological education research. The authors emphasise that the educator can gain an appreciation of how ideas are modelled or structured by the students. In all these respects, repertory grid analysis can be used by researcher and teacher alike to evaluate teaching and learning.

Practical work in science and biology education is seen as a way to learn practical process skills (e.g. laboratory skills), to learn scientific results, how scientific knowledge is produced and also to enhance students' motivation and interest (White, 1996; Millar, 2010). However, less is known about other affective learning outcomes. The article *Dissection of Mammalian Organs and Opinions about It among Lower and Upper Secondary School Students* by Andreja Špernjak and Andrej Šorgo is a valuable contribution to understanding this aspect of practical work in biology education. The article describes the results of a study that investigated the use of the dissection of mammalian organs in anatomy and physiology classes in Slovenian lower and upper secondary schools. Students' opinions on the dissection of mammalian organs during the courses on human anatomy are positive, and only a minority of students would prefer to opt out. The authors discuss how these practical activities should be presented or replaced by alternatives such as 3D models and virtual laboratory.

There are two articles in the Varia section. The first is by Mojca Žveglič Mihelič, entitled *Assessment Accommodations for Foreign Pupils in the Light of Educational Justice: Empirical Research among Slovenian Primary School Teachers*, and presents the findings of an empirical study on teachers' perspectives on

assessment accommodations for foreign pupils. The results show that teachers who have recent experience of teaching foreign pupils are more aware of the need for assessment accommodations than those who do not. The majority of the teachers accommodate assessment and grading even after the two-year period (i.e. the period of allowed adjustments), and some of them have lower expectations with regard to achieving knowledge standards for these pupils. While the majority of the teachers perceive accommodated assessment as being just, they are unsure of whether the period of allowed adjustments should be longer. This raises the questions about teachers' understanding of educational justice and the application of the principle of justice in practice.

In the second article in the *Varia* section, entitled *The Role of Cultural Capital in Higher Education Access and Institutional Choice*, Iva Košutić explores perceptions of social inequalities in school achievement and the educational decision-making of the final-year students of secondary schools in the City of Zagreb and Zagreb County, Croatia. The author builds on the theoretical framework of Bourdieu's theory of cultural and social reproduction. The main objectives were an analysis of the association between the students' cultural capital and their school achievement and analyses of the predictive power of the cultural capital theory in the context of educational decisions in the transition to tertiary education. The results indicated that cultural capital had statistically significant correlation with school performance. A detailed presentation of results and discussion tend to support Bourdieu's theory of cultural reproduction through education.

A book review completes the contents of the issue. The book is entitled *Multiple Representations in Biological Education, Models and Modeling in Science Education* (2013) by editors David F. Treagust and Chi-Yan Tsui, published by Springer (ISBN: 978-94-007-4191-1).

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