Towards a New Biology Education for Future Scientists

Introduction

This presentation elaborates on observations from the European Science Olympiad (EUSO) which was organised in Cyprus and took place in May 2008.

We attempt to address the issue of the degree to which knowledge from physics, chemistry and biology could coexist in an integrated manner at the upper secondary level of education.

Introduction

Twenty two European countries participated in EUSO 2008. The students were under 17 years old and each country had the opportunity to participate with two teams of three students.

Each student was representing a team for one science topic: Physics, chemistry or biology.

Innovative Approach

For the first time in the EUSO, one of the examination tasks included a field trip theme, which represented an attempt to undertake a holistic, transdisciplnary approach to the study of an ecosystem.

The field trip experiment was designed to:

- **Provide another activity besides listening, reading, or watching.**
- **Provide an opportunity for students to appreciate their experimental observations.**
- **Gain an appreciation for the limitations which apply when you design an experiment**
- **Gain technical experience**
- **Gain an appreciation for the ecosystem which was under investigation.**

Classification

In section 2 of the exam paper there was a question which allowed the students to learn how to classify a specific plant species. The students where asked to name a specific plant species by **observing adaptations** of the leaf structure of a specific plant.

- The study of ecology has fundamentally changed since the 1980s and now there is major focus on the increased use of resources and the human impact on Earth. It is not possible to understand human effects on the environment without knowledge of physics, chemistry, mathematics and biology.

- Classical biology can explain biological phenomena but modern biology must now find new innovative ways to stimulate the intelligent mind and science inquisitiveness?

Biological classification attempts to group living organisms according to how closely related we believe them to be (phylogenetic classification by Carl Limnaeus 1735).

For example we now believe that basic structural similarities, such as the skeleton in a bird's wing and a human arm, indicate that these homologous structures have each evolved from a single type of structure which was present in both groups, perhaps many million years ago.

Integrated Science

Further discussion with students about classification triggered their curiosity to ask the following question: Can we use similarities and differences in the biochemistry of organisms, especially DNA and proteins, as clues on how closely related are different organisms?

In modern biology an appreciation of bio-chemistry is essential. Most schools in Europe teach evolution with reference only to similarity of anatomy, embryology and physiology.

Syllabus

Is it time to study molecular evolution by comparing protein and gene sequences between organisms at the upper secondary level of education in the European schools?

It is time to change the syllabus emphasis so as to reflect the curiosity of students and allow flexibility to answer questions raised by them as a result of what is initiated by their instructor/teacher?

Innovation in Cyprus

- **In section 3 the students observed the xenomorphic adaptations of a specific plant.**
- **In section 4 they were asked to draw the reproductive organs of a specific flower which was present in the ecosystem.**
- **In section 5 each team was expected to *plan an investigation* in order to be able to estimate the density of two specific plants (*Convolvulus oleifolius and Thymus capitatus*) that are present in "ATHALASSA PARK" ecosystem.**

Discussion with students may trigger the students to ask the following questions:

- **Which organisms will be facing the threat of extinction?**
- **Are organisms evolving new adaptations in their ever-changing environment?**
- **Are humans adapting to their new environment?**
- **How are humans evolving?**
- **How is water scarcity affecting the organisms in their environment?**
- **How are we going to regulate or even manage to live without rain water?**

All the above questions require understanding of how science works and it will be a success if the students attempt to answer such questions in their future projects

New applications of science attempt to answer the above questions.

Desalinization of sea water is a solution for countries rich in fossil fuels. However the ancient fossil fuel reserves are nonrenewable. It is estimated that only a few hundred years supply of fossil fuels are available at our current rate of consumption.

The obvious question for a student to ask here is whether we can use alternative sources of energy?

Integrated Science

In a second EUSO 2008 experiment the EUSO students extracted pigments from plants and they used them to fabricate a solar cell (Nanocrystalline Solar Cell Kit). This solar cell kit illustrates **energy conversion principles that can be integrated with mainstream topics in biology, chemistry, and physics** courses. It deals with thermodynamics of energy conversion and technology's impact on society.

This experiment took place in a laboratory which was provided by the Cyprus university.

Conclusions

- The input of research scientists with communication skills is needed as teachers may lack knowledge about scientific advances.

- Educating teachers and increasing teacher's competence and confidence in new and emerging areas of physics, chemistry and biology.

- We must encourage students to enjoy science so that they become interested and curious, so that they develop knowledge building skills.

Reccomendations

Biology must now move away from a mainly descriptive approach.

There is a need for changing the emphasis in science syllabi?

Students should now be tested in their understanding of how science works and its social, moral and ethical implications.

Sections in the curriculum should be drawing specific attention on recent advances and students must become familiar with new science applications.

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