Teaching Dissolved Oxygen concept to University students, using the Real-time Microcomputer-Based Laboratory (MBL) kit by “Science Cube”.

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INTRODUCTION

A Microcomputer-based laboratory system consists of one microcomputer unit, sensors (e.g. Dissolved Oxygen (DO), Water Temperature (Tw), pH etc.) which enable users to collect, represent and process data from the environment in real time (Lajium, 2017). Data logger unit can also be connected to a pc, using extensions of common software, such as “Science cube for excel” in the current application, thus an experiment can be alternatively conducted through a pc. Real time MBL tools have interesting affordances (Bernhard, 2003; Thornton and Sakalaff, 1990) and are considered as tools with cognitive potential (Jonassen, 1992). Their pedagogical uses in teaching activities lead to the development of high level capabilities and skills which are extendable to students’ everyday life (Wang et al., 2014; Webb, 2005).

Fig.1, 2. Microcomputer unit, DO sensor (Korea Digital, 2018)

RESEARCH HYPOTHESES

1. The Real-time MBL tool is time-saving compared to a lecture or a behaviourist lab (Bayrak et al., 2007).
2. The Real-time MBL tool results in better construction of the scientific concepts (DO, Tw), (Bernhard, 2003).
3. The Real-time MBL tool enhances students’ motivation on learning and engagement (Dimitriadou, 2018).

TIME, PLACE, PARTICIPANTS

The laboratory class took place in the frame of a project in the “ICT tools in teaching and learning” post-graduate course of the department of Educational Sciences in Early Childhood Education, under professor V. Komis.

The laboratory-class lasted 2.30΄ and took place in the Hydrogeology Laboratory of the department of Geology, University of Patras. Two 4th-year students of Geology volunteered to take the class, be evaluated and evaluate the process.

ALTERNATIVE IDEAS & ADHESIONS

- DO is not found in drinking water
- Identification of gas leakages in sea bottom as DO in sea water
- Gas state of oxygen
- Visibility of oxygen as the proof of oxygen presence in water samples.

Fig.3. DO measurement-sea sample

MATERIALS AND METHODS

The teaching scenario used common lab equipment and was mediated by “Science cube kit for Natural Sciences” a product by Korea Digital. DO and Tw sensors were used from a variety of sensors included.

Four student-centered teaching activities were designed and applied by incorporating the following Constructivist Strategies:

- Exploration and Discovery (Inquiry-based)
- Problem solving
- Decision making
- Cognitive conflict
- Obstacle-Objective

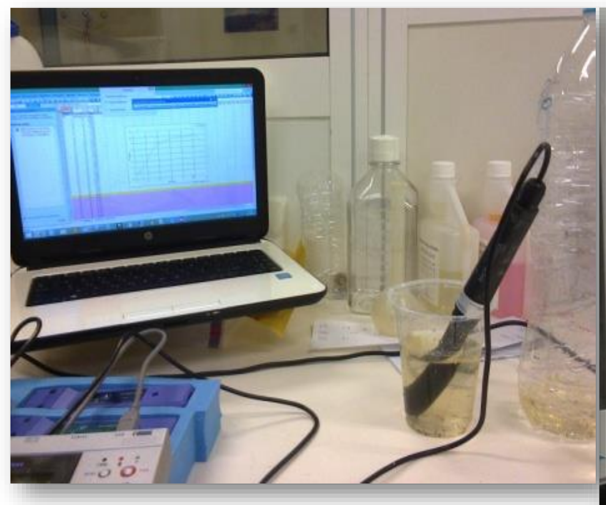


Fig.4, 5. Students during 2nd activity

Objectives

- Construction of the DO scientific concept
- Understanding the salinity effect on oxygen dilution
- Brackish water type identification
- Complete experimental process (combining DO and Tw)
- Skills of handling equipment (datalogger, sensors, pipets etc.)
- Calibration process of scientific instruments
- Calibration plot as a tool for prediction
- Double representation of data (tables of values, plots)

Teaching Activities

1) Measurement of DO concentration in tap water and bottled water samples.
2) Measurement of DO concentration in sea water samples, collected from Patras coastline nearby Patras Marina.
3) Students in the position of researchers who need to identify blank water samples (by their DO concentration value) aiming to order reverse-osmosis membranes displayed on provider’s catalogue as TDS: 300 mg/L, 5000 mg/L, 35000 mg/L (social practices of reference).
4) Students use a boiler and the Tw sensor to report the alterations of Tw in real time (online real-time t-Tw plot and table of values).

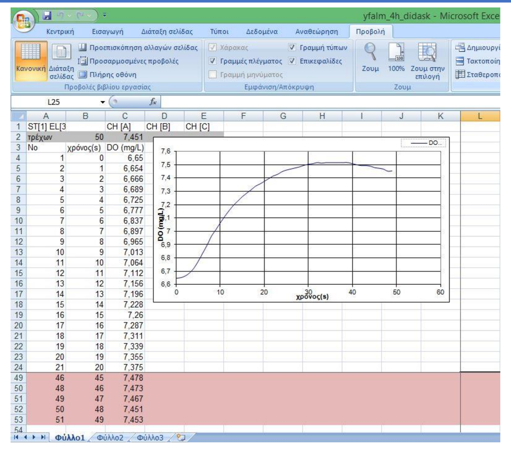
Evaluation Activities

Students in the role of experts, hired by the Municipal council to decide if the development of a fish-farming unit of the x-species can be located in the coastline nearby Patras Marina. The x-species demands DO greater than 5 mg/L and Tw between 17 and 23 °C. (tips: Check only one-day period. Use the sea samples provided).

RESULTS

Students worked in a synergetic way. Instructor’s role was facilitating. Concepts (DO, salinity effect etc.) were sufficiently constructed. By the ending of the scenario implementation, improvements of the following capabilities and skills were reported to the group:

- Capabilities & Skills
  - High level capabilities
    - Problem solving, Decision making, Exploration & Discovery, Critical thinking (Bernhard, 2003; Depover et al., 2010, Thornton & Sakalaff, 1990)
    - Social capabilities (Depover et al., 2010): “Classroom culture”, Cooperation
    - Emotional capabilities (Depover et al., 2010): Self-control, motivation towards research
  - Skills
    - Handling datalogger, sensor, pipets Conducting calibration, double data representation, prediction.



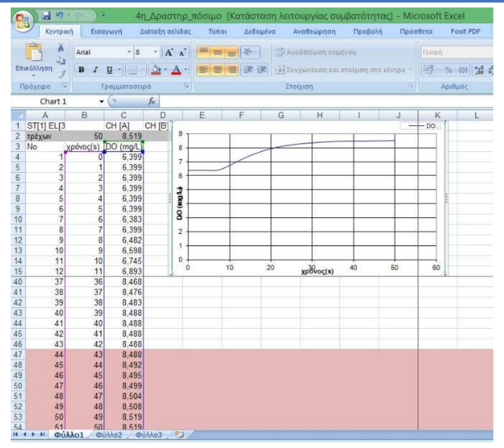


Fig.6, 7. Real-time data collection (Science cube for excel interface)

Students’ feedback

“Interesting”, “time-saving”, “inspiring”, “I prefer this over lecture”, “We could conduct and upload experiments on youtube” indicate the enhancement of students’ motivation.

COLLABORATION

Real-time MBL tools improve students’ cognitive background, self-efficacy, are cheaper than the corresponding scientific tools, they promote constructivist student-centered strategies, thus are recommended to be incorporated in the teaching process. Although MBL tools cover a wide range of environmental experiments (in lab/field) only few studies are found in the literature.

In this direction, interdisciplinary teaching scenarios on environmental sciences like the one presented, are suggested to be applied in different Universities in Europe and the USA. The cognitive progress of students could be assessed through quantitative analysis (pretest-post test) while interviews could depict students’ opinions. Moreover, by using online concept mapping, peers from different Universities could share feedback of the cognitive tool and develop research interactions with future potential.

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