CONNECTING PLANETARY SCIENCE AND ENVIRONMENTAL SCIENCE IN EDUCATION FOR MUTUAL BENEFITS. Sz. Bérczi[1], Zs. Angyal[2], [1]*Eötvös University, Institute of Physics, H-1117 Budapest, Pázmány Péter sétány 1/a, Hungary, (berczi szani@caesar.elte.hu),* [2]*Eötvös University, Center for Environmental Studies, H-1117 Budapest, Pázmány Péter sétány 1/c, Hungary, (dranzsu@gmail.com).*

Introduction:

University Courses always needs refreshment from the actual research fields. Environmental science education receives actual topics not only from terrestrial pollution, atmospheric aerosols, technology and environment interactions but from the new planetary discoveries. Planetary science introduces several new complex balances of extraordinary environments like geysers of Enceladus, volcanoes of Io, ethane oceans in Titan, etc. For environmental science education planetary science serves new exciting topics which help trigger enthusiasm in students. That is why we studied the possibilities coming from planetary science education.

Environment and technologies:

Planetary environment steps into interaction with our instrument-rich space probe when landing on the surface of a planetary body. The interactions can be summarized in a table, where the environmental streams (columnar arrangement) meet with measuring instruments in boxes, one above the other. At the same time measuring technologies form technology operations, a sequence, where operations step by step may have interactions with one of the streams of the environment. This is a woven system [1] from environmental streams (columns) and technology sequences (rows).

This system forms a background for the planetary surface environmental measurements and for the terrestrial interactions. For example the pollution coming out from the technologies (one factory technology sequence in a row), and appearance of these pollutions as outreach to the streams (air, water, soil-ground-chemistry, noise, light, etc,) of the environment forms a town pollution case study. The scale of the study may be diminished (town district size) or enlarged (regional, or country sized).

Planetary Science and environmental soil physics and geochemistry field works:

Planetary environmental field trip courses with comparisons between the Martian planetary regolith and the terrestrial paedosphere: also preparation studies for the Hunveyor-Husar space probe model experiment and instrument planning [2, 3]. Instrumental measurements of the planetary regolith have several analogies with the terrestrial paedospheric monitoring works. Therefore preparations for instrumental measurements with space probes are given by the terrestrial field works where the complex soil analyses are carried out. The most important analogs between the two systems may be the following topics: (1) the mineral composition of the soil, (2) the various forms of the H2O, (3) the chemistry of minerals and salts, and (4) the solved and fluid chemical materials. The terrestrial environment is enriched by a subsystem of indicators: by the actors of the biosphere: plants, animals and microbes. Although this group of actors does not (yet) play on Mars, their presence and appearance through the model space probe measurements (for example by chemistry) may serve useful knowledge for planetary geology.

For the measurements of the whole soil and regolith systems we plan such experiments on to the Hunveyor-Husar models, which use several structural hierarchy levels of the subsystems. have developing role in forming the view of the students. The chemistry measurements give exciting challenges for students from the selection and planning, through the construction, testing and field work carrying out, and finally the evaluation of the experiment: following them through all important phases of the planetary research works. From nuclear level (nuclear radiations), through atomic and molecular level (spectroscopy), through micro-sized grain components (size distribution), over macroscopic level (rock texture), till the macroscopic level (hardness) measuring methods are connected not only a characteristics but to a structure level. This sequence is continued when we begin to study physics starting from our sensory organs, too.

Planetary Science and environmental physics

Even at the introductory courses it is an attractive aspect to study simple measurements though the eyes of a space probe constructor. Considering the human hody which is provided by rich sensorial „equipments", the sensory organs we have a starting point to exploit. This possibility is even strongly exploited if a parallel line of measurements are associated: the instruments of a space probe. Fort he human approach (1) the sensors and simple measurements are enumerated and studied in details, however parallel with the technological approach, where the sensors are built or constructed by the students to be deployed on their „Hunveyor", a self-made space probe model, a lander type.

If students built connections between everyday life size, and measuring systems to the simple instrumental ones, next step is to introduce more modern instrumentations to the Hunveyor.

The following simple sensors and instruments form a parallel thread between the two approaches.

Table 1.

HUMAN PERCEPTION	MEASUREMENT by some INSTRUMENT
Temperature perception by touch	Temperature measurement by clinical thermometer
Measuring length by span	Measuring length by pole
Time period measuring by pulse of hearth-rate	Time period measuring by dropping
Measuring distance by counting the steps	Measuring distance by number of rotation of wheel
Ordering the colors according to the fruit colors	Using the prism for order of light colors
Measuring hardness by scratch sequence	Measuring hardness by indentation of a sphere
Distribution of the pebbles according to size	Measuring size-distribution by a series of sieves
Light intensity measuring by eyes and comparison	Measuring light intensity by standard light-sources

Planetary Science and environmental chemistry and industrial technologies:

Ancient chemistry began probably by human sensors at tasting and smelling. The touching may have also relations to chemistry, too. In order to exploit a parallel line of measurements on the space probe model instruments and human sensors the following steps were important. Our earlier work [4] oriented us when we should like to measure from burning of a materials in an alien atmosphere (Lavoisier cycle). Classical spectroscopy also related to chemistry structural levels. One interesting product of the planetary –terrestrial environment comparisons may be the table where various styles of measurements are connected to structural hierarchy levels, too [5]. This systematic can be continued with the material maps, which also connects at least two structural hierarchy levels. One example: Cooling sequence type TTT diagrams are projections between minerals and textures. Several material maps are used in industry, which connect compositional (chemical compounds) level with some final product of multi-mineral composition (ceramics, metallurgy), while some more sophisticated technologies use textural transformational TTT maps (steel industry) [6]

Summary:

Hidden sources of interesting classroom teaching emerge if we use connections between Planetary Science and Environmental Science. We build upon the impressions and experiences, but reorganize these experiences to a higher level knowledge. Comparison between local and planetary environment develops a readiness for applying one local knowledge – even if it is an old impression – to a larger, foreign system. Structural hierarchy comparisons help in finding the corresponding levels which interact inside the systems (soil, geo, chemo, and physico levels). Finally, both systems (planetary and local environmental) are built into the considerations of activities, when problem solving in environmental effects need solutions.

References:

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