„COMPUTER ECOLOGY“ – KNOE-HOW FOR CLASS PROJECT

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Abstract

The increased consumption and the using of Information and Communication Technologies (ICT) are leading to dynamical applications as well as to increased problems with ICT-waste. A big amount of valuable material is disappearing at the dumps. How are knowledge of students and teachers in the mentioned area – it is the content of school curriculum or it is necessary to add this topic into the school curriculum? Do students have any knowledge about materials on the electronic devices and how much costs their recycling? Some answers gives questionnaire "What with old computers?" distributed to students of teaching. By results we propose some activities, classes or class projects, for primary and secondary science education oriented to integration of science subjects (experimental activities, data mining and evaluation, calculations, geographical aspects, work with foreign texts, etc.).
Key words: class project, "Computer Ecology", science education, electronic waste, opinions of students.

Introduction

Present state and perspectives of natural science teaching and also related attitudes of the whole population towards natural sciences bring the need to think about possibilities of more attractive presentation of new information, which touch both methodological views and their content of the above mentioned process. To be capable of explaining elementary phenomena surrounding us in everyday life is an actual need from the point of general education and is thus a rightful requirement creating basis for natural science teaching. For example we can think about chemistry. Many people's attitude towards chemistry is nowadays negative. Under the term „chemistry“ people mostly imagine matters negatively influencing the nature and particularly living organisms. On the other hand chemistry plays its part in upgrading life style (insect extermination, synthesis of new pharmaceuticals and development of new technologies). This role is, however, ignored. The problem of the devastated environment is not caused by chemistry itself, but it is caused by misusing of chemical products, by irresponsibility or by neglecting of working procedures (waste, improper dosing of fertilisers, pesticides, abusing of medicaments, etc.). The above mentioned characteristics of general opinion are very often transformed into pupils´ thinking and attitudes towards lessons of chemistry. This is mostly the case of pupils who do not regard chemistry as their main subject. A teacher of chemistry faces a serious problem: how to make chemistry interesting in an attractive and unforced form (Bendel 1987).

Lessons of chemistry or other natural science on basic education may become more interesting if we succeed in emphasising the connection between the presented subject matter and phenomena and processes which pupils meet in everyday life. This is mainly the teachers´ task because it is impossible for the textbooks to cover everything. The textbooks only cover general information or essential facts and they often lack motivation power. Many experiments, which illustrate phenomena and processes from everyday life, may be carried out with simple substance and using elementary equipment. Chemistry is everywhere and particularly where an ordinary human being would not suppose it to be. From the view point of many educators of chemistry a particular system incorporating the chemistry of everyday life

into topics and complete it with corresponding simple experiments would be desirable. Then either the system should be made part of the present curriculum or new projects based on that should be worked out. This is the way to create new teaching projects. Some of such projects would present, for instance, chemistry of washing, cleaning, food, textile materials, etc.
Another type of classification is also possible, for example focussed on methodological approaches:

1) Analytical approaches (What is it made of...?)
2) The preparation of some chemicals from simple materials (How to make...?)
3) The impact of the particular chemicals (What effect does it have on...?)

To bring it into effect a teacher should search for every possible way, how to do it, including modern media use. Internet belongs, without doubt, to them. Its immense capacity provides a lot of ideas and suggestions to use (f. e. Brestenská 1998 or Turčáni 2000).

"Computer Ecology" in Numbers"

The information society implies both growing amount of information and dynamic development and use of information and communication technologies. Increasing number of applications leads towards higher consumption of electric energy and waste from the devices. It threatens the environment by large amounts of dangerous matters on waste dumps, disposal sites and incinerators. Great capacity of noble metals is missing.
The first generation of computers has worn out and the second one is reaching the time but the others will follow. Where will we place old monitors, discarded data carriers, defective main boards, printers etc.?

What is the level of knowledge of educational faculty students´ on the topic? Have the met with it or would they consider important to add it to the curriculum? Are the able to answer questions like what materials electronic devices consist of, how much the recycling is? We were trying to get answers in questionnaire: "What can be done with old computers?" (see Part 3).

Computer emergence

Computer production is demanding from energetic and financial point of view. Up to 240 kg of fossil fuel is necessary for one computer which means ten times more than it weighs, than 22 kg of various chemicals and 1500 l of water (Mach 2004). The USA produce more than 25 million computer every year, their average age is less than two years. An average computer set (computer, monitor, mouse, and keyboard) contains about 3 kg of plastics, which means only in the USA 142 million l of oil and 212 million m^3 of natural gas (Pittner 2006).

What matters do the computer devices contain?

When recycling the combination of materials causes biggest problems – metals (40%), plastics (30%) and ceramic materials (30%) (Beneš 2006).

Polymers are the most widely used materials: ABS (akrylo-butadien-styrole), PMMA (polymethylmetakrylate) a PVC (polyvinyl-chloride), metals like Cu (20%), Fe (8%), Sn (4%), Ni (2%), Pb (2%), Al (2%), Zn (1%), Ag (0,2%), Au (0,1%), Pd (0,005%) etc, ceramic materials like SiO_2 (15%), Al_2O_3 (6%), other oxides (6%), $BaTiO_3$ and mica (3%).

Tab. 1 Contents of "average" main board of a computer (according to Petera, M.: Personal Computers and Environment (Petera 2006))

In 1 kg "average" main board of computer can be found:		
272 g plastics	18 g nickel (Ni)	0,17 g tantalum (Ta)

130 g copper (Cu)	10 g antimony (Sb)	0,14 g molybdenum (Mo)
41 g iron (Fe)	4 g zinc (Zn)	0,11 g palladium (Pd)
25 g brome (Br)	0,45 g silver (Ag)	0,08 g beryllium (Be)
24 g lead (Pb)	0,45 g gold (Au)	0,08 g cobalt (Co)
20 g tin (Sn)	0,36 g cadmium (Cd)	0,05 g cerium (Ce)

Why is the waste of electric and electronic devices dangerous?

The danger is caused by their structure, they contain:
- toxic and carcinogenic metals (about 0,5%) bound in compounds,
- halogens,
- oils,
- PCB,
- And other organic and inorganic dangerous materials.

Heavy metals are included in innocuous forms in metals and alloys. They also may be released by the influence of acid rains, diffusion waters, sun shining and by bacteria activities from waste on dumps, especially from As, Be, Cd, Cu, Hg, Mn, Se, Sn, Te Tl, V a Zn, or by volatilizing into the air during burning communal waste (As, Be, Bi, Br, Cd, Cl, Ga, Hg, In, Pb, Sb, Se, Te, Tl) (Beneš 2006).

Contribution to the ecological disposal of old electric devices in the Czech Republic

Since 2005-8-13 several enactments (of amendment) on electric and electronic waste have become effective with the purpose of preventing the emergence, i.e. general decrease of this type of waste. The aim of this activity is to reuse and recycle the mentioned devices. Each producer must contribute financially for the recycling. This contribution may be written down separately on sales receipts so that it was clearly visible what amount of money would be used on recycling (ASEKOL 2006).

Survey "What can be done with old computers? "

In April 2006 a questionnaire research was done at several faculties of education to reflect students´ knowledge and interest in this topic integration into curricula. 253 respondents aged under 25 years (65% women, 37% men, 53% future Science teachers, 32% future Humanities teachers, and 15% with combination of Science and Humanities) participated in the research. Some of the questionnaire items are presented below:

1. Annual production of communal waste in the Czech Republic was 278 kg per capita in 2005 (ČSÚ 2006). The question was as follows: "In your opinion what was the annual production of communal waste per capita in the Czech Republic? (Write down your estimation in kg per capita in the Czech Republic)". 55% of respondents estimated correctly, i.e. in hundreds of kilograms, 16% estimated tens of kilograms of waste, 24% estimated thousands of kilograms. Only 6% of respondents stated 260 – 300 kg, fewer kilograms gave 43%, and more kilograms gave 46% respondents.
2. The following question mapped students´ experience in old computing devices disposal: "Have you disposed of old computing or electronic devices on your own? " 80% of respondents stated not yet. They usually determined scrap yards in towns or mass refuse collection in villages as the place where the disposal proceed.
3. Another question aimed at fees on recycling electric waste: "Enactments of amendment on waste valid since 2005 obliges duties on sharing financially on recycling. The fee on monitors under 21", notebooks, laptops, printers, copiers and

multifunctional devices under 20 kg is:“ 73% respondents gave the correct price 60 CZK, 15% gave 6 CZK, and 11% respondents gave 600 CZK.

4. Electric and electronic waste contain on average 30% of plastics, 40% of metals, 30% of ceramic materials. The question examined percentage share of various materials: “Electric and electronic waste contains three basic groups of matters: plastics, metals, ceramic materials. Match groups and shares presented below.“ PLASTICS: 34% of respondents matched 20 – 40%, 6% of respondents matched fewer, and 60% of respondents matched more. METALS: 57% of respondents matched 30 – 50%, 27% of respondents matched fewer, and 16% of respondents matched more. CERAMIC MATERIALS: 28% of respondents matched 20 – 40%, 70% of respondents matched fewer, and 2% of respondents matched more.
5. The copper (20%) is the most frequently contained metal in electric waste. The question was as follows: “Electric and electronic waste from devices contains various metals. The biggest share (up to 20 %) has: 49% of responses were correct, 31% of responses were aluminium, 17% of responses were iron and 3% of responses were silver.
6. One ton randomly sampled main boards contains up to 450 g of gold. The question was: “In the Czech Republic during the process of gaining pure metal out of an amount of ore, the average profit is 1,5 – 2,5 g of metal per 1 ton. One ton randomly sampled main boards contains on average:” there were 3% of correct responses, 43 % responses were 4,5 g, 28 % responses were 0,45 g and 26% responses were 45 g.
7. The question: “On your opinion the level of information on possible risks in electric and electronic devices disposal and their ecological recycling is in our country: aimed at the level of information.” 75% respondents gave unsatisfactory, 24% of respondents would appreciate more information, and the only 1% of respondents would consider more information useless.

The following questions aimed at school instruction. 75% of respondents said they had not been taught topics like these ones. 87% of them think the topic should occur at basic schools in science subjects. 74% of respondents were able to imagine any class project on recycling old computers and their peripheries. Selected names of class projects are presented below: “What to do with a veteran computer?; Computer - grandfather.; Where to put it?; Computer is counted in even if it does not count.; Our good but old friend PC!; The electronic brain burial place.; Count it, computer!; Where to put the old mate?; Where to do with veterans?; Bye, bye, computer!; Do you know how recycle old computers? If not, now there is a chance!; Recycling old computers and their peripheries.; Having served they served out, and what’s on? Computer having served – what follows?; etc.

Proposed Classes or Class Projects with Ecological Orientation

A. Creation and Destruction of Computer Devices

Browsing the information on Internet about construction of computer devices; recycling charges (Fig. 1); marking of products; etc.

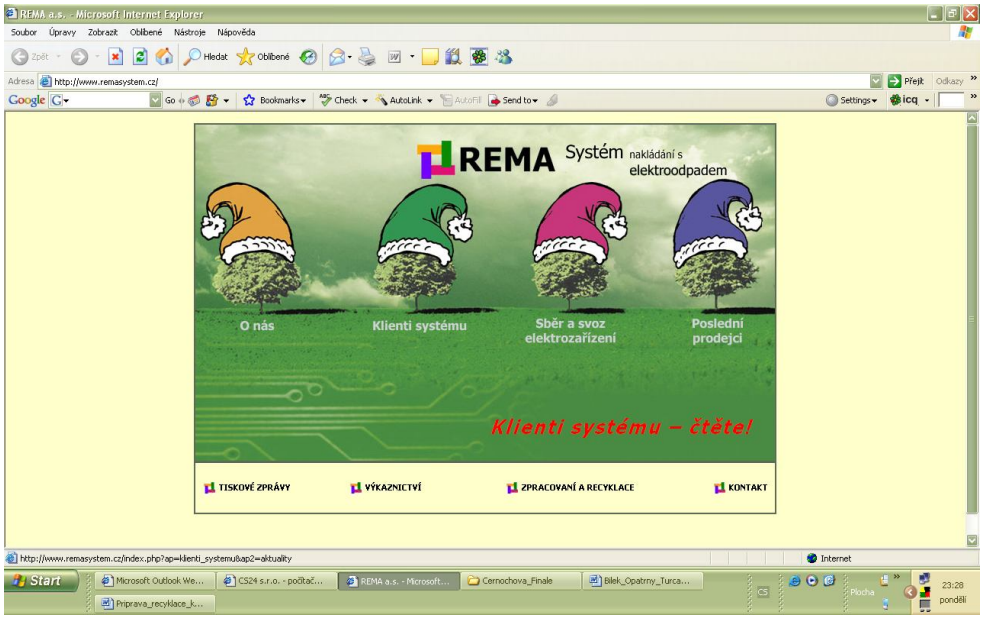


Figure 1 Web of the REMA – System – Society for recycling of e-waste in Czech Republic (http://www.remasystem.cz/)

B. World of Electro Waste

Working with foreign texts about recycling of PC; metals production; problems and benefits of recycling; etc.

Figure 2 Migrant child from Hunan province sits atop one of countless piles of unrecyclable computer waste imported from around the world. Guiyu, China. December 2001. © Basel Action Network. (http://www.ban.org/photogallery/index.html)

C. What Contents the PC?

Demonstration of computer parts and peripheries; materials for constructing of computers; scaling of PC parts; etc.

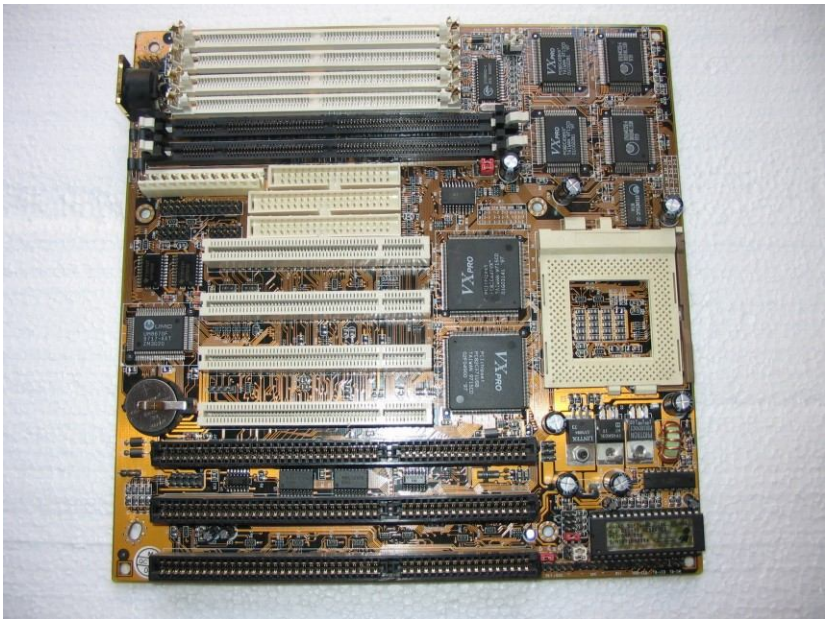
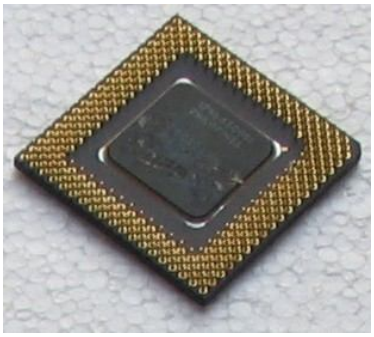


Figure 3 "Average main board" of computer for analysis

D. Testing of Materials in PC

Plastics: Test of solubility; Flame test; Pyrolytic test; Test of halogens on organic compound. Metals: Gold test; Chemical changes of copper.



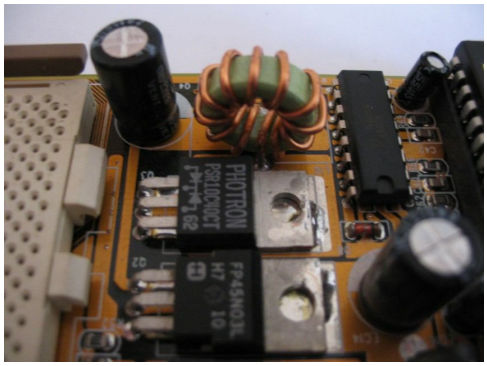


Figure 4 Parts of computer for gold and copper tests

Conclusions

Ecological topics including recycling old electric and electronic devices are gradually getting on our minds. Only half of the respondents (see Part 3) have some knowledge on waste production and more than 2/3 of them have never disposed old computer devices, despite of growing production. The fact of providing mineral resources is known only to a small amount of them. This may cause missing this "rich" waste on dumps not being recycled. Most of the respondents, future teachers, realize the necessity of more information in this field which may be a sufficient motion for preparation new curricula for general subjects on all levels of the educational system.

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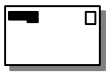

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