On-line Simulation of Classical Inorganic Analysis.

Jens Josephsen, Department of Life Sciences and Chemistry, Roskilde University, Denmark
phjens@ruc.dk

Laboratory exercises, investigations, and experiments are invariably included in university chemistry teaching. The learning of empirical facts, chemical procedures and methods in chemistry depends heavily on the experience, which may be obtained from such teaching activities[1]. Experimental work in teaching is, however, both expensive and time consuming, and should therefor effectively benefit from the allotted student time, money, and staff time. If the instructions are too ambitious regarding what the students can manage to do and are overloaded with information[2,3] , it may result in the students simply following a recipe, which is probably not effective relative to the efforts. The use of pre labs and post labs may be a way to enhance the effectiveness of the work in the laboratory[4,5]. If the purpose is not that the students become perfectly trained on the manipulative side of the procedure (and in university programmes it often isn't), but rather to give them experience with chemicals and methods, a computer-based laboratory simulation may function as a cheap and fast extension of student lab time. Virtual investigations seem to be a promising kind of tool[6,7,8] for several reasons and this has lead to the development of self-instructive, interactive PC-based learning resources closely related to an actual, running course in introductory inorganic chemistry[8]. Such a development is rather time consuming, but since the first experience was positive[8], it was considered worthwhile to develop the idea further for that course. This development of further resources to simulate a laboratory investigation will be described.

Classical qualitative and quantitative analysis of relatively simple soluble salts or co-ordination compounds with inorganic ligands only, has for a long time been part of introductory inorganic chemistry in spite of the fact that professional chemical analysis currently is far more advanced than chemical separation and identification reactions in test tubes and volumetric analysis. The reason to keep and use such an "anachronistic" element in an introductory inorganic chemistry course is first of all that this type of simple and classical procedures has a great learning potential; it offers a practical setting which can give a lot of experience with chemical reactions. We include a 20 hours laboratory assignment where simple soluble solid inorganic compounds and minerals, containing common s-, d- and p-block metal ions together with simple p-block anions and/or ammonium/ammonia are identified within a classical analysis scheme. The quantification of the compounds is not part of this limited laboratory investigation, but certainly of the "dry" part of the course. The students seem to accept this setting and some even enjoy the "game" of finding the identity of "unknowns".

To optimise the outcome of the experimental work it should be supported by other activities. An interactive laboratory simulation for that purpose was developed, and the procedures in this electronic simulation follow the laboratory manual, which should be at hand and in mind when working with the simulation. The students are thus offered three different, but closely related learning resources to reinforce each other: the laboratory investigation, the computer simulation of it, and written problems involving the same macroscopic description of the chemistry to be solved by the paper-and-pencil method.

The laboratory simulation programme was designed for use on a standard web-browser platform (se fig.1 for its simple appearance).

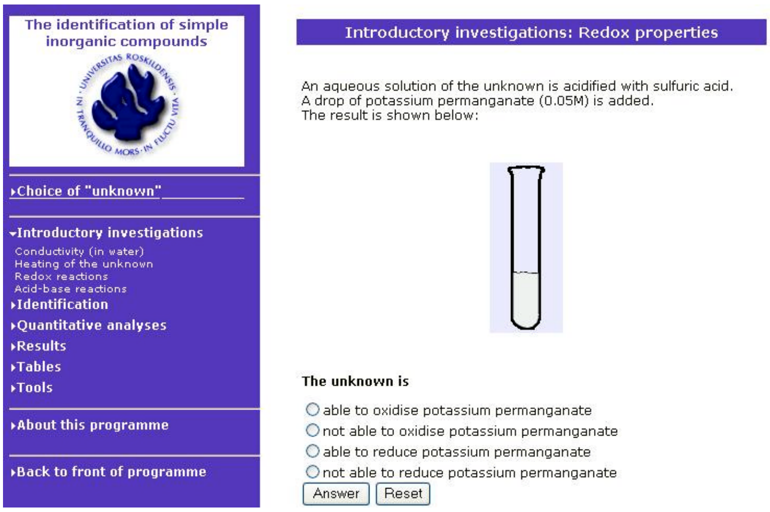

Figure 1:Appearance of one of the introducing experiments on redox-properties in the interactive simulation programme.

Figure 1 may illustrate the type of interactivity. After having got a specific "unknown" different introductory investigations may be done in some order: The solubility properties of it (soluble in water, different acids of different strengths, or in sodium hydroxide, etc.) further acid-base properties of the "unknown", and its redox-properties. As seen the reducing power of the "unknown" is tested with potassium permanganate and the result is given as a picture of the test tube. This macroscopic result have to be interpreted and checked, and because quite a few students mix up oxidising and reducing power when presented to a result of this type, the potential correction of an erroneous conclusion is built into the programme. This simple kind of interactivity gives a specific response to each possible answer. For example, the correct answer gives a prompt to consider possible reducing agents, and tables of reducing and oxidising reagents are also included in the programme.

This simulation programme is expected to possess the same advantages as the previously described programme [8], and thus to provide the students with the opportunity to do experiments (to use different laboratory procedures and investigate different substances) outside the laboratory at the time, speed, and place chosen by the students themselves. They find this option useful as a supplement to the real laboratory.

---

[1] J.Josephsen, Chem. Educ. Res. Pract. 4, no.2 (2003) 205, and references therein

[2] A.H.Johnstone, Uni. Chem. Educ. 1 (1997) 8

[3] A.H.Johnstone, Educ.Chem. (1999) 45

[4] J..F.Vianna, R.J.Sleet and A.H.Johnstone, Stud. Higher Educ.19 (1994) 77

[5] A.H.Johnstone, A.Watt and T.U.Zaman Phys. Educ. 33 (1998) 22

[6] C.J.Garrat, Uni. Chem. Educ. 1 (1997) 19

[7] S.P. Lajoi, Computer Environments as Cognitive Tools for Enhancing Learning. In: Lajoie, S.P. & Derry, S.J.(eds.), *Computers as Cognitive Tools*, (Lawrence Erlbaum Hillsdale, New Jersey 1993) pp.261-288.

[8] J.Josephsen, Proceedings from the 7th ECRICE , Ljubljana, 2004