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## **The use of ICT in chemistry teaching at upper secondary level**

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### **Introduction and background**

Although the offer of new tools using information and communication technology (ICT) in teaching has grown in the last years, their practical uses in the classroom remains uncommon in chemistry teaching at upper secondary school levels. A French policy maker recently claims for making common place the use of ICT in teaching, “it is a tool among other” and pre-service teachers’ formations should consider it (Obin, 2002, p.65). Although many research results claim the high potentiality of ICT in learning (see below), ICT is not a tool among other in actual science classrooms and we hypothesize that teachers must have difficulties to introduce them in their practices. The aim of the present work is to analyse few of the reasons of these difficulties. The main difference between ICT and more traditional techniques for representing knowledge, such as textbook, is based on the non linear representation of information (Jacobson & Archodidou, 2000). In hypermedia, nodes of symbols are linked together in a flexible manner that make it powerful but which increases the difficulty (e.g. for teachers) to enter the product to appropriate its potentialities.

Many researches have been devoted to ICT to understand the factors that can influence learning such as the multimedia effect – in which students learn more deeply from words and pictures than from words alone, the coherence effect – in which students learn more deeply when extraneous material is excluded rather than included, the spatial contiguity effect – in which students learn more deeply when printed words are placed near rather than far from corresponding pictures and the personalization effect – in which students learn more deeply when words are presented in conversational rather than formal style (Mayer, 2003). Relations with modelling have been largely explored so are the benefit of exploring the possibilities of multiple representations (Kozma & Roussel, 1997). The way technology can augment the cognitive and social processes of scientific understanding and learning has been largely commented (Kozma R.,B. 2000). The use of surface features has been positively and negatively described. It may shape the students’ understanding and are profitable (Kozma, 2000), or be used with no understanding and lead students to copy and paste information with low learning.

The use of models in science has been related to the importance of modelling activities in learning and interactive learning environments that associate constructivist learning with computer applications allow students to interact with accessible dynamic representations of models (Jackson et al., 2000). Learning models is a challenge that can be helped by dynamic representations. Our theoretical approach is based on modelling to analyse both the knowledge in chemistry and the cognitive activity of the learner.

### **Research questions**

Our work aims at describing teachers’ cognitive difficulties in using ICT in chemistry classroom at secondary level, either in getting through ICT contents, or in the way to use it during teaching. How are ICT, especially simulations, involved in chemistry teaching at the secondary level? What kind of knowledge do teachers involve when they are presented new teaching sequence involving ICT?

### **Methods**

The method of collecting data is threefold.

1. A set of inquiries should allow us to quantify the actual uses of ICT in chemistry classrooms at school level and to list the difficulties the teachers are able to express. Our first inquiry was done from the records of [physchim@listes.educnet.education.fr](mailto:physchim@listes.educnet.education.fr) discussion list. This regulated list had been created in 2000 to help teachers when the curricula changed. It has slowly become a forum for all subjects related to physics and chemistry teaching at school level. An average of 20 to 30 messages is exchanged daily among 1390.

The next inquiry is intended to use the same discussion list. A short questionnaire will be sent. It will deal with the number of uses of ICT per term teachers have used during their chemistry courses. Several categories will be proposed; ICT is used: by pairs of students vs. during teacher demonstrations; for simulation activities, videos, to take or process data; to recover information from the internet. Only the simulation activities are of our concern. The origin of the software (when ever used) and especially the text of activity going along with will be asked. Questions about teachers' attendance of in service formation to learn about teaching with ICT will also be addressed.

2. Tasks using ICT in the case of the introduction of chemical kinetics (3<sup>rd</sup> year of upper secondary school) and in thermochemistry (2<sup>nd</sup> year of upper secondary school) from a microscopic point of view have been separately given to a class of students during the course of their normal curriculum and, later, to four teachers during in service formation. These teachers were applied physics teachers and had never taught chemistry, nor did they learned it at an advanced level. Videos of their solving the tasks have been recorded and analysed. Results required transcription of students' and teachers' interactions, and categorisation of the kind of knowledge and their representations with the use of *vidograph*<sup>TM</sup>. Statistical data can be deduced on the time spent on different parts of the activity. Each transcript was split by episodes where the subjects develop a single idea, and the categories of knowledge in relation to the use of representations in each episode have been studied.

The ICT that we used belong to a collection of commercially accessible CDrom for teaching chemistry and physics at school level (Micromega, 2002). It has been chosen for our research due to its high level of interactivity, the optimisation of several multimedia effects, the number and the importance of dynamic representations and the positive attitude expected with the use of surface features.

Prior results are given below. They provide information on the similarities and the differences on the way students and teachers involve knowledge when they use ICT.

3. Last, we are planning an experiment that involve four teachers that already taught with a sequence that uses ICT to introduce modelling chemical reactions (1<sup>st</sup> year of upper secondary school) and three of their colleagues that will discover this sequence and the corresponding ICT in order to use them in their own class. These seven teachers are already working together on non-ICT teaching sequences. We foresee to collect data during: pre-interviews of both kinds of teachers before they start communicating on this teaching sequence, recording of the teachers' discussions when they will explain each other the ins and the outs of this sequence, the video of the actual teaching in both kinds of teachers' classrooms, and the meeting with their sharing of this experience. Post-interviews may still be possible. From these data, we expect to have an overview of the knowledge teachers may involved in preparing their teaching, and we shall see the differences between teachers that already used the teaching sequence and their colleagues who teach it with the first time. The interviews and discussion will be analysed in pointing the scientific, representational, pedagogical and technical knowledge that emerge during interactions. Scientific knowledge will be sub-categorised with a modelling point of view. Representational knowledge will be sub-categorised by semiotic registers with special care to multiple representations. The difficulties

teachers may face and the way they will solve it (or not) may be informative to understand the reasons that prevent teachers from incorporating ICT in their teaching.

### **Prior results and expected results and their implications**

In the period January – October 2005, our first inquiry proved that less than 0,3 % of the mails (N = 9,000) in a nation wide discussion list of physics and chemistry teachers exchanged information related to ICT. Such a ratio clearly indicates that teachers do not exchange information on ICT. It may be interpreted as a very low use of ICT in class.

The transcription of one pair of teachers and one pair of students solving the task on thermochemistry with ICT showed that students developed 12 different ideas in 54:00 min whereas teachers developed 34 ideas in 1 h 06:10 min. Among these ideas, 7 were the same and were discussed within 25:08 min by teachers and 35:18 min by students, which is acceptable as teachers, even not trained in chemistry, can solve tasks more easily than students. In the rest of the transcription, 12 episodes for teachers and 5 episodes for students dealt with comparable ideas. It lasted 18:32 min for teachers and 43:40 for students. Finally, teachers discussed topics that were not tackled by students for 15 episodes during 21:55 min. They dealt with concepts that are related to thermochemistry such as the energy of multiple bonds, heat of other chemical reactions, relation between heat of reaction and the progress of the reaction, etc. All these concepts were known by student, but not mentioned in the text of the task. More comparisons of the use of ICT by teachers and students such as the relation between the knowledge they used and the representation appearing in the ICT are in progress. If our results were to be confirmed, we could recommend that during teacher training sessions, students' tasks can be given to teachers but instead of shortening the time allotted to solving the tasks, an increased field of the use of the ICT could be proposed.

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