Incorporating Sunflower for Science in teacher education to increase the pedagogical information technology competence of teachers and teacher students in natural science

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Abstract: The use of information and communication technology in teaching is an excellent way to visualize processes as well as promote active learning in natural science, hence providing an additional dimension in teaching. KompLIT (Competence Enhancement of Teacher Education Information Technology) is a Swedish project that aims to increase the competence in pedagogical information technology for both teachers and teacher students. As part of this project the software Sunflower for Science has been tested and evaluated by both teachers and teacher students. Sunflower for Science consists of 26 programs in physics, chemistry and biology and uses an interactive approach that engages students with an activity-based learning. The outcome from the evaluation is that Sunflower for Science is very user-friendly, it promotes deeper learning as well as increases the students' attitude towards chemistry.

Introduction

Today, ICT (Information and Communication Technologies) is a powerful tool that enhance education and teaching in ways not previously possible. In natural science many processes are often quite abstract and hard to visualize in an ordinary text book. Using animations and simulations to visualize such processes are therefore very useful (Mayer, 1989; Mayer and Gallini, 1990; Mayer and Andersson, 1991; Kraidy, 2002; Mayer and Moreno, 2002). Utilization of animations to visualize processes in natural science has also been shown to help students' retention of the processes (McClean *et al*., 2005; O´Day, 2007), something that will aid the students in future studies and in their profession. Moreover, in natural science it is also an advantage if individual parameters affecting a process can be varied so its effect can be studied, resulting in enhanced understanding of the specific process. The incorporation of ICT in teaching is an excellent way to visualize processes as well as promote active learning in natural science, hence providing an additional dimension in teaching (Kraidy, 2002; McClean *et al*., 2005). Thus, it is essential to supply teacher students with knowledge and experience of using ICT so they can use it as a natural part of their own future teaching.

KompLIT (Competence Enhancement of Teacher Education Information Technology) is a Swedish project financed by the Knowledge Foundation with the aim to increase the competence in pedagogical information technology for both teachers and teacher students at the University of Skövde, Sweden, as well as teachers working in the Skaraborg County. A central element of KompLIT is a focused and continuous development of teacher education making information technology a natural part of this education.

Sunflower for Science is a web-based software that offers an interactive approach that engage students with an activity-based learning. Sunflower for Science includes 26 programs in physics, chemistry and biology and should therefore be suitable for teaching in natural science. The advantages with Sunflower for Science is that it uses an interactive approach to visualize different processes in natural science and provide a possibility to influence processes by varying the conditions, thus aiding the students to obtain a deeper understanding of the processes (Figure 1). With this pedagogic tool it is possible to create different applications, such as fun lectures, laborations, exercises, homework or even exams, hence offering an alternative approach in teaching as opposed to traditional teaching based on text books. Sunflower for Science is flexible in that way that the complexity of the material can be adjusted by the teacher allowing the software to be used at various levels. In addition, Sunflower for Science is

Internet-based and is therefore not limiting students to the schools facilities, allowing them to perform their work anywhere.

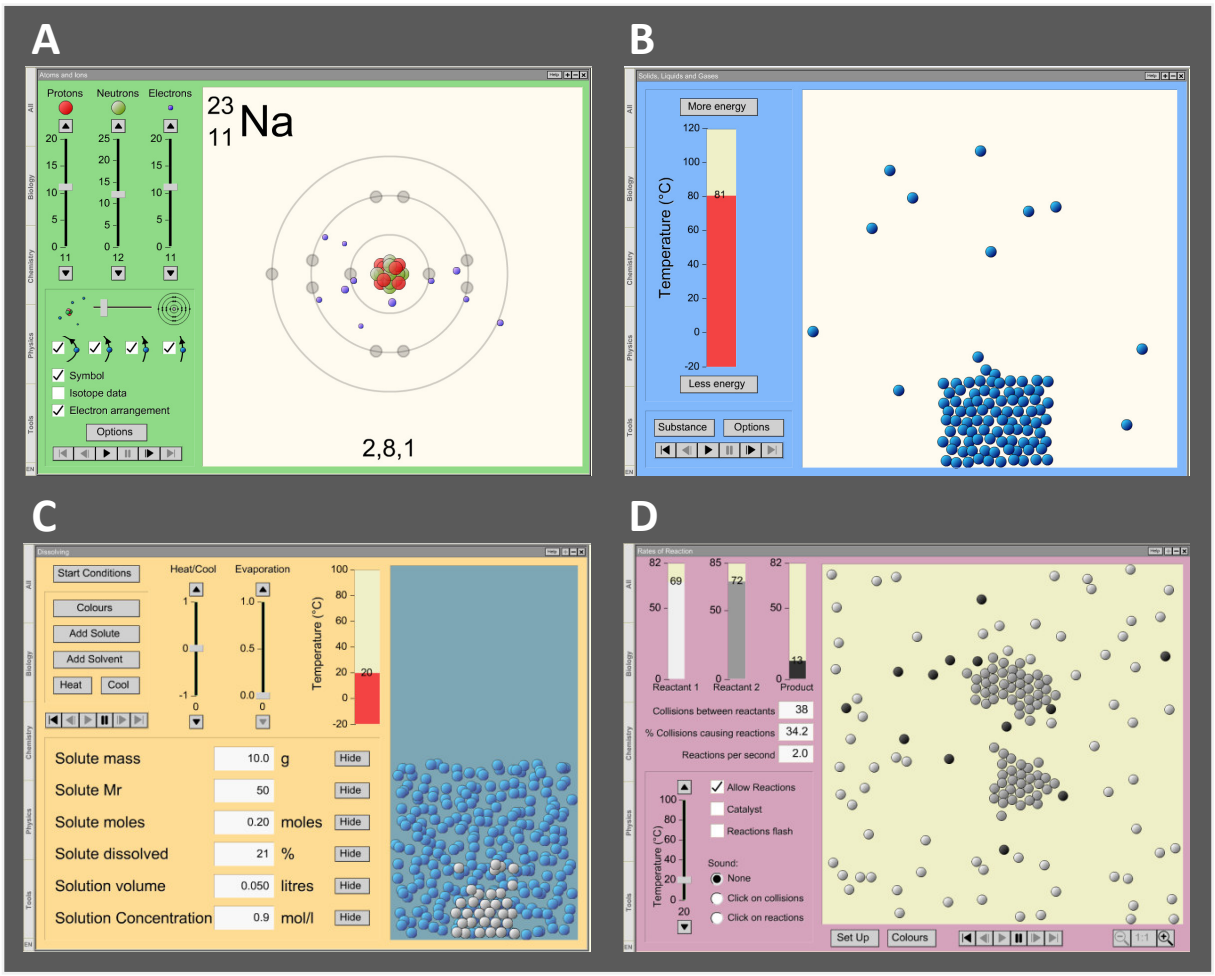

Figure 1. Four different chemical processes presented in Sunflower for Science. A) Application where atoms, isotopes and electron configuration are studied. B) Visualization and study of sublimination. C) Study of solubility and parameters influencing solubility. D) Study of factors (e.g. activation energy, catalyst present, temperature and concentration) affecting reaction rate between a gas (white) and two solid particles (gray) resulting in a gaseous product (black).

The BETT Award rewards creative and innovative products for learners as well as teachers and Sunflower for Science has received the BETT Award for Best Secondary Science. Considering the aim of KompLIT and the possibilities Sunflower for Science provides, it seemed to be suitable tool for the goal to increase the amount of information technology in the teacher education, both from students' as well as a teachers' point of view. To verify that Sunflower for Science is suitable it was tested in the teacher education at the University of Skövde. The major questions were if this software had a high usability (allowing use by inexperienced students), if it would increase student learning and understanding of chemistry and if it would increase the students' interest in chemistry. Moreover, based on the outcome, could Sunflower for Science be used as a natural part of the teacher education and at the same time help the teachers in their pedagogical work?

Methods

Sunflower for Science was tested in a chemistry class with the total number of 80 students. This class has traditionally been based solely on text book teaching together with PowerPoint™ lectures, exercises and some

laboratory work. At a scheduled exercise the students were given access to Sunflower for Science as well as assignments/questions which the students were supposed to solve on their own using Sunflower for Science. These assignments were based on theory the students previously had studied during the class. To evaluate the usability of Sunflower for Science no survey of how to use it was given. However, supervisors were present during the exercise to help the students if they encountered any obstacles, but also to observe the students work and thus evaluate their own opinions about Sunflower for Science.

The students' opinions were assessed by a questionnaire of three questions, which were ranked according to a five rank grade. The questions were as follows:

i) How user-friendly is Sunflower for Science?
ii) Did Sunflower for Science further your understanding of the studied chemical processes?
iii) Has Sunflower for Science increased your curiosity towards chemistry?

In addition, it was also possible for the students to further express their opinions by writing their own comments.

Results and discussion

When the students were working with Sunflower for Science the supervisors observed that it was very user-friendly. This reflection was based on the fact that the vast majority of the students did not need to consult the supervisors before starting with their assignments or during their work (except for subject related questions). However, as discussed later, a few students experienced problems due to poor computer competence (not related specifically to the use of Sunflower for Science).

During the exercise with Sunflower for Science the supervisors made three additional distinct observations. First, the supervisors noted a much deeper understanding than previously shown by the students. This was in agreement with previous research that has shown that animations significantly improves student learning and understanding (Mayer, 1989; Mayer and Gallini, 1990; Rieber, 1990, 1994; Mayer and Andersson, 1991; Kraidy, 2002; Mayer and Moreno, 2002).

Second, as a result of the increased understanding, students expressed questions and thoughts that they previously had been unable to express. As described earlier, the students had previously studied the theory but many students had never obtained any deeper understanding about the studied processes. Sunflower for Science allows manipulations of the simulations/processes (by varying certain parameters, such as temperature, activation energy etc.). Hence, students could test different scenarios which fostered new thoughts resulting in deeper questions, something that is fundamental in natural science.

Third, the origin of new questions and thoughts motivated and encouraged the students to explore further and try new scenarios (not given in the assignments), which enhanced their understanding of the processes even further. As an outcome of the deepened understanding the supervisors also noticed an increased interest in chemistry, at least during the class. Similar results when using ICT in natural science have also been noted by others (Yu, 1998; Soyibo and Hudson, 2000).

The students' opinions were assessed by a questionnaire with three questions. Each question was graded from 1 to 5 with the possibility to freely add any comments. The results from the questionnaire are presented in Figure 2-4. In Figure 2, the students' opinion of the usability of Sunflower for Science (without a survey before exercise) is presented. As visualized, most students (median value = 4), experienced that the Sunflower for science had a usability above average, whereas only a few experienced a usability below average. These opinions agreed with the supervisors reflections during the exercise. Still, based on the students' comments, some minor improvements can be done, e.g. there were some difficulties to enter text in the tables in the user interface.

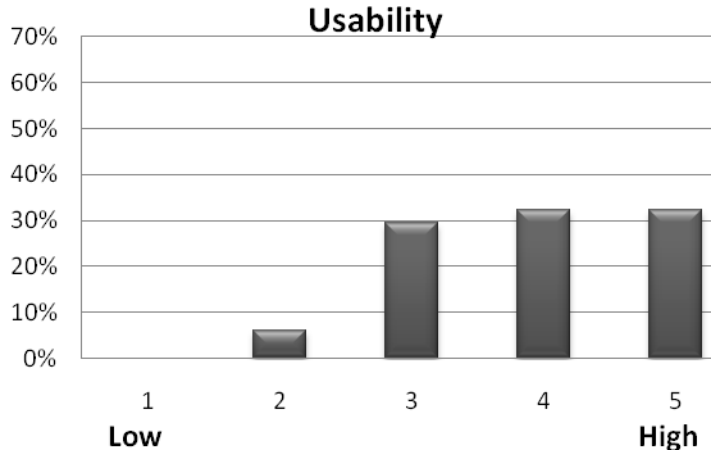

Figure 2. Students' evaluation of the usability of Sunflower for Science. The bars represent the percentage of the number of students for each grade.

As described previously, the supervisors observed that Sunflower for Science aided the students to obtain a deeper understanding about the chemical processes studied. As Figure 3 imply, a majority of the students indeed felt that Sunflower for science increased their learning and understanding of the processes studied (median value = 4). As one student expressed: "I gained a much greater understanding of how things look and how things react.".

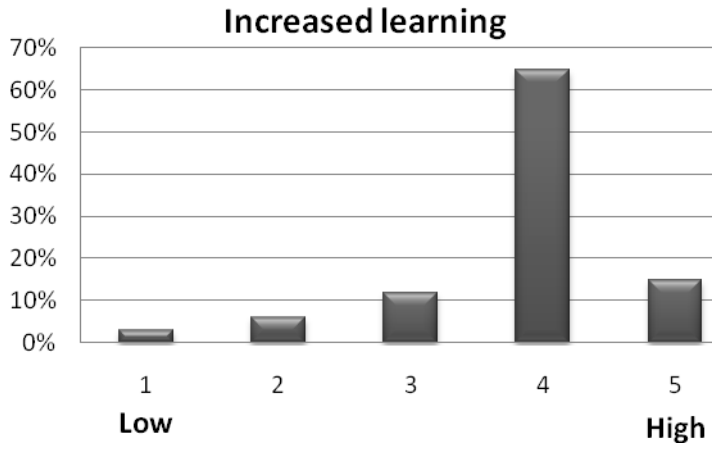

Figure 3. Students' evaluation of their increased learning after using Sunflower for Science. The bars represent the percentage of the number of students for each grade.

Finally the students evaluated if using Sunflower for Science increased their interest in chemistry (compared to working solely with the text book). As Figure 4 demonstrate, the majority of the students felt that working with Sunflower for Science increased their interest in chemistry (median value = 4). "It is more interesting when you are allowed to explore and to do things practically" is one opinion that was expressed by a student. The increased interest was also noted by the supervisors, who observed an increase in the number of questions as well as their complexity.

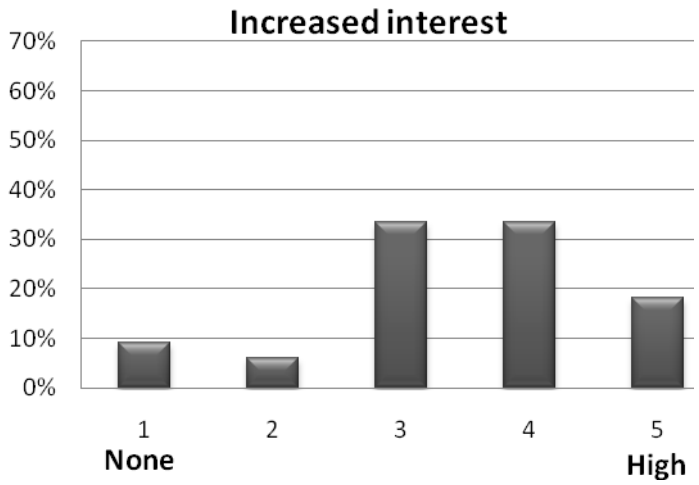

Figure 4. Students' evaluation towards increased interest in chemistry. The bars represent the percentage of the number of students for each grade.

Despite the user-friendliness of Sunflower for Science the supervisors noted that some few students had problems, due to poor competence in computer skills, and there was also an obvious correlation between age and these students, who were mainly middle aged. This is rather problematic! As described by Paterson (2000) there is a risk that these teacher students will have a fear of ICT during their future teaching due to lack of skills in general computer handling. Consequently, there is a need for more opportunities to practice such skills so that ICT can be used without fear or obstacles, since ICT (if correctly used) foster active learning which results in increased understanding. Today's young are brought up in a world where computers are a natural part of their lives. This development will continue and therefore older (at least compared to the students) teachers will always be one or several steps behind. Teachers are obligated to be a part of this development and therefore are projects like KompLIT, which aims to increase the competence in pedagogical information technology for both teachers and teacher students, extremely important to reduce the barriers of using ICT in teaching.

The supervisors involved in the class experienced that Sunflower for Science has great potential since the degree of difficulty of different applications can be adjusted. Hence, creating an opportunity to use this software for a wide range of levels, all depending of what you think is appropriate for your class. Sunflower for Science can also be used during classes to demonstrate processes, a function that was appreciated by the supervisors. Also, as shown by this study, Sunflower for Science is a user-friendly tool that will promote learning, understanding and increase the interest in chemistry. Therefore, using Sunflower for Science is suggested to be an excellent tool to increase student learning and attitude towards natural science and is thus recommended in teacher education.

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