

PERCEPTION OF COMPUTER ASSISTED LEARNING BY TEACHERS AND CONSEQUENCES FOR THE DEVELOPEMENT OF AN AUGMENTED REALITY TEACHING SYSTEM¹



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Augmented reality provides a technology which gives the impression of touchable computer generated objects. This technology could be used for educational purposes. The EU-funded ARiSE project is developing an augmented reality system for school use. The requirements of teachers to such a system were to be explored. A questionnaire for teachers has been prepared and was distributed to teachers in Germany.

Key Objectives

- 1) Main difficulties of pupils in understanding chemistry
- 2) Requirements of teachers for a new visualisation of atomic models
- 3) The current situation of computer use in chemistry lessons
- 4) New impulses for computer use in school chemistry

Questions and Answers

Table 1. Difficulties pupils have with atomic models as stated by teachers; opinions uttered <2x are not listed.

Questions and Answers	Absolute quantity	Relative rate
1) Please give examples for difficulties that pupils encounter when dealing with models of the atom and the atomic bond.		
- topology of the molecule	5	(42%)
- spatial imagination	4	(33 %)
- leaving the atomic model of Bohr for more complex atomic Models	2	(17%)

The topology of the molecule and spatial imagination in general seem to the most challenging topics in school chemistry. This suggests that pupils have difficulties in imagining invisible objects of the microcosm with the existing visualizations. Therefore these visualizations need to be improved or could be replaced by new methods such as augmented reality. The teachers also mentioned that the atomic model of Bohr is an obstacle for understanding more complex atomic models.

Table 2. School chemistry topics with a need for better visualization from the teacher's point of view; opinions uttered <2x are not listed.

2) For which chemical topic would you wish a better visualization (several answers are possible)?		
- structure of the electron shell	8	(67%)
- formation of chemical bonds	7	(58%)
- atomic nucleus	3	(25%)
- atomic fission	3	(25%)
- emission of light and spectra	3	(25%)
- structure of the atom	3	(25%)

Two thirds of the teachers are not satisfied with the usual visualization of the electron shell and more than half of them wish for a better demonstration of the formation of chemical bonds. For the last-mentioned a dynamic visualization could be of help. Other topics which teachers find difficult to illustrate are the atomic nucleus, atomic fission, the structure of the atom and the emission of light and spectra.

Table 3. Commonly taught atomic models in comprehensive school; opinions uttered <2x are not listed.

3) Which atomic models do you use in grade 5 to 10?		
- atomic model of Rutherford	9	(75%)
- atomic model of Dalton	8	(67%)
- atomic model of Bohr with electrons on circles	7	(58%)
- shell model	5	(42%)
- electron cloud model	5	(42%)
- atomic model of Thomson	3	(25%)

Teachers tend to explain the atomic structure using the models of Rutherford, Dalton and Bohr. Traditionally these three models are taught in the introductory courses, possibly because they are rather simple and can be explained with the classical conception of particles. The shell model and the electron cloud model are taught by almost half of the teachers up to 10th grade. Both are intermediate steps to quantum mechanics.

Results

- 1) Main difficulties of pupils in understanding chemistry
Spatial imagination and Topology of molecules
- 2) Requirements of teachers for a new visualisation of atomic models
Electron shell; Chemical bond; Dynamic formation of a chemical bond
- 3) The current situation of computer use in chemistry lessons
Computers are rarely used in chemistry courses; They are considered as not useful
- 4) New impulses for computer use in school chemistry
Dynamic formation of a chemical bond; Demonstration of different atomic models; direct learning with augmented reality

Conclusions

The augmented reality prototype of the ARiSE project for chemistry needs to fulfil the following preconditions: Being developed for use in chemistry lessons; ability to demonstrate the atom in the atomic models used by the teachers; short time of getting acquainted with the system; prove of pedagogical efficiency within the course of application

Pic1. The first Scenario



Table 4. Teacher's expected knowledge of pupils in 10th grade concerning atomic models; opinions uttered <2x are not listed.

4) Which idea of the atom should a pupil in grade 10 have?		
- the atom consists of nucleus and shell	7	(58%)
- electrons have a probability density of appearance around the Nucleus	4	(33%)
- electrons move on circles	2	(17%)
- models have restricted validity	2	(17%)
- rule of the octet	2	(17%)

58 % of the teachers are of the opinion that pupils should know at the end of grade 10 that the atom consists of a nucleus and a shell. The other learning targets are mentioned less often. There seems to be no uniform common sense on what the pupil needs to know at this point.

Table 5. Teacher's ideas for computer application in lessons; opinions uttered <2x are not listed.

5) Please make suggestions how to use a computer for learning support.		
- demonstration of atoms	7	(58%)
- dynamic formation of a chemical bond	4	(33%)
- visualization of complex experiments	2	(17%)
- information research	2	(17%)

Teachers see the main field of application for computers in chemistry classes in the visualization of the atom and the formation of chemical bonds. Other domains could be information research and the demonstration of complex experiments.

Table 6. Teacher's evaluation of existing computer programs for chemistry; opinions uttered <2x are not listed.

6) Please evaluate existing computer learning programs for chemistry.		
- I don't know them.	4	(33%)
- the 'Klett mediathek [®] ' program is useful	3	(25%)
- programs are not made for school lessons	2	(17%)
- poor enduring effectiveness	2	(17%)
- too expensive	2	(17%)
- not practical with over 30 pupils	2	(17%)

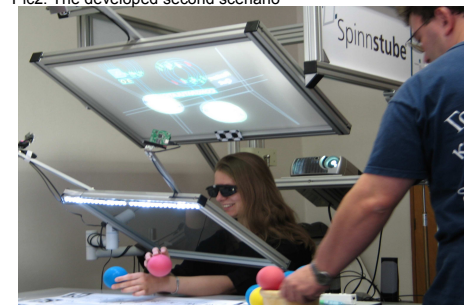
The 'Klett mediathek[®]' program which is a German learning program is popular among some German chemistry teachers. In general the acceptance of learning programs in chemistry lessons is low. This can be related due to the costs and the usability. One third of the teachers does not know any chemistry learning program.

Table 7. Present use of computer programs in school lessons by teachers

7) How often do you use computer programs in all your lessons?		
- never	6	(50%)
- 1-6 times in a semester	5	(42%)
- 1-4 times in a month	1	(8%)

The outstanding result of the questionnaire is that half of the participating teachers do not use computer programs in their lessons at all, the others apply them seldom. Only 8% of the teachers use computer programs regularly. Possible reasons are named in table 6.

Pic2. The developed second scenario



¹ This research is carried out within the frames of the exam work of Nicholas Domes for the scientific project „ARiSE“, <http://www.arise-project.org>