A Research Project:

Teaching and Learning

Kinetics and Chemical Equilibrium

with a Help of

Computer-Aided Modelling

Activities

1 Introduction

It is well known that learning to model in scientific context is a
basic activity which all science students should experience as part of their education.

There are more and more references to research that describe some special difficulties to understand kinetics and chemical equilibrium.

2. Computer-aided modelling

In order to provide computer support for modelling activities, it is needed to design a necessary computational environment.

The environment used in this research is created by PowerSim(© ModellData AS).

3. Research Setting

An empirical study in this research was conducted in Helsingin Suomalainen Yhteiskoulu in a Finnish Secondary School with an International Baccalaureate Section

There were altogether 38 students who took part in the learning period of the study, but only 35 of them took part in both; in the modelling activities and in the post test at the end of the learning period, as well.

The learning period was started by a theory lesson during which basic concepts of the topic area were introduced. The second lesson was used in problem solving and the third lesson for planning how to measure rate of reaction in reality. The planning task was to serve as a reliable pre test. The idea behind this was that students' conceptual writing in their planning task could reflect their level of understanding in the topic area before the modelling activities.

The following research questions were set:

1. Does the computer-aided modelling approach engage the students in reflective activities - such as explaining, justifying and evaluating?

2.Does the computer-aided modelling approach facilitate teacher's monitoring and evaluation of student progress during the teaching unit?

3. Does the modelling approach result in improved learning as the traditional approach?

4. Data collection and analysis

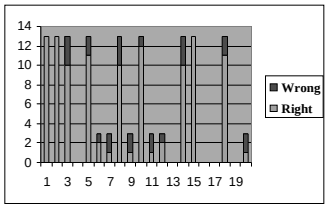
Findings Stage1: The first set of data is comprised of thirteen students' post test results. These students were not taught by the modelling approach.Their ways of studies represent simply a traditional approach.

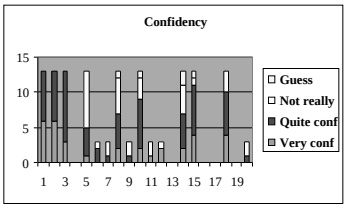
The data was gathered in the purpose to serve only as a reference set of data.

Students' responses to the post test questions

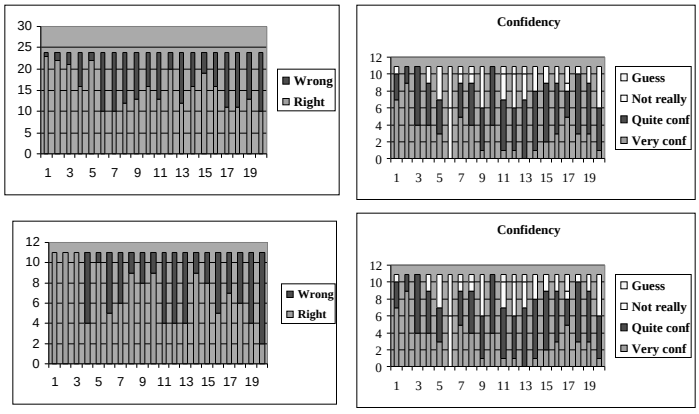
(4% guesses, 82% right

with 71% confidence):



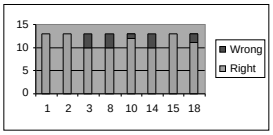


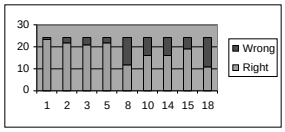
Findings Stage2 and Stage 3:
In the tables below are represented the post data from these stages.
The third stage students passed the similar learning period. There were altogether 24 students in the second stage and 11 students in the third stage.

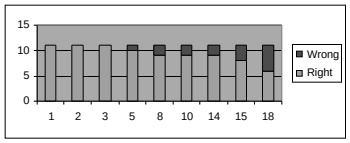


In order to get a closer look at the results they are divided into groups according to the question types they represent.

Basic questions:

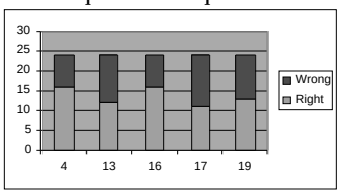


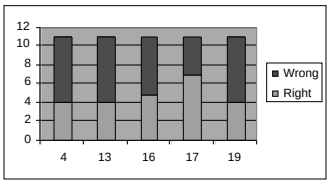




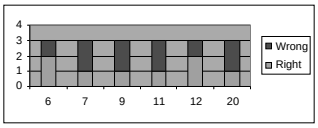
The amount of the right answers is high, 88%, 75% and 85%.

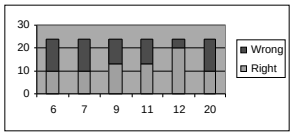
Equilibrium questions:

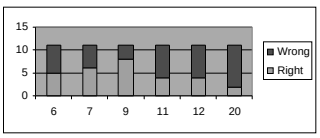




Advanced questions:







The amount of the right answers is in general at the same level in both of the question types. It is 53% in the second stage and 44% in the third stage. The result of 44% is in fact the same which was reached by the students who did not had the modelling activities at all.

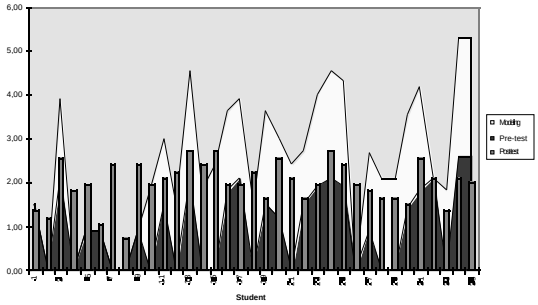
They, instead of activities in the school had used their own time in preparing themselves to the test at home.

5. Results

The table below shows the combined results of the whole study:

Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Pretest	10		21		01	01			01		13		21			13	21	
Model			1,8							1,8	1,5	1,5	2,4	1,8	2,4	1,8	1,8	1,5
Posttest	05	03	25	13	05	05	28	05	28	05	20	25	20	28	20	05	05	25
Student	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Pretest		13	1,2		13	13	21	1,9		0,9			12	1,8	2,1		2,6	2,6
Model	1,5	2,1	1,8	2,4	1,2	2,1	2,4	2,4		1,8	2,1	2,1	2,1	2,4		1,8	2,7	2,7
Posttest	25	15	25	20	15	15	20	28	15	13	15	15	13	25	20	15	20	20

The pre test and the modelling activities have been graded first 0-10 according to the specific factors and then linearly transferred to 0-3 scale. The post test results have linearly transferred from scale 0-20 to 0-3.



Unfortunately the closer analysis of some students modelling activities was not possible. Some students lost their works in saving their models. All the pairs had loaded the program at the same time and the program was thus loaded only partially. They did not succeed to load the saving properties of the program at all.

6. Discussion

Improved learning:

The results show that only five out of the thirty students got less than a half of the post test questions right. The results do not, however, show whether the activities had improved learning.

The results only show that the topic area had been well learned through the activities.

One could ask whether the students all were very capable students. The results support the fact that even among the capable students it is important to find the way how the students' interest can be aroused.

They were only the most responsible students who accomplished the planning task to the end. On contrary the modelling task was liked very much by the students. Some students even wanted to have extra time to get it finished and get it done further.

Reflective activities:

The students quickly learned to rely on the program. They trusted the results the program produced. This type of reliance, believing that the program did only what was the reality in their models, forced them to check their models as long as they were satisfied with the outcomes of them.

They came across some problems by which they realised that they did not have thorough understanding of the topics under study. They had to ask their teacher's or their classmates' help and thus also the collegial relationships among the pairs working together were really a positive force a learning.

Facilities to teacher's monitoring:

The most frequent problems that came up were when the concentration change after the reached equilibrium state had to be tested and also when the coefficients of the equilibrium reaction equation had to be notified. In fact, both are very known difficulties with which chemistry students commonly struggle with.

As a teacher I find that a great significance of the modelling activities could be summarised as a thing that it gives the possibility for the teacher to give his/her advise in a very crucial moment.

This in turn supports the process of concept formulation in a right way.