Development of a General Chemistry Course for teacher students of Primary Education adapted to the European Credit Transfer System (ECTS) by means of the use of the Communication and Information Technologies

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In this work we have tried to present, using the new possibilities that offer Multimedia systems technologies, the teaching of the General Chemistry for teacher students of Primary Education taking into account its history, antecedents, profits, errors, relations, possibilities, applications etc. We have made this using the most possible attractive, motivated and intelligible way for students who are not going to dedicate professionally to Chemistry. Doubtlessly the depth with that the topics will be treated treat will be different for each case, being able of including all or only some of the developed contents. This is complemented with the new educational methodology imposed by the adaptation of the University Education in Spain to the new Higher Education European Space (HEES) by means of the application of the European Credit Transfer System (ECTS). This system implies a greater participation of the students in their own process of learning and the development of instrumental competences such as computer basic abilities (handling of programs, search of information in the network, etc.) and the basic abilities of management of data obtained by the diverse sources that can be used.

Keywords: Chemistry, EHEA, ECTS, ICT, Periodic table

1. Objectives

To present, using the new possibilities that offer Multimedia systems technologies, the teaching of the General Chemistry for teacher students of Primary Education within the frame of the European Higher Education Area and with the European Credit Transfer System methology

To take into account its history, antecedents, profits, errors, relations, possibilities, applications etc. establishing the relationship of this methodology with the constructivist paradigm of the chemistry teaching/learning process.

To make this using the most possible attractive, motivated and intelligible way for students who are not going to dedicate professionally to Chemistry (Teacher Students of Primary Education).

To develop a series of general and specific competences:

Abilities and skills related to intellectual tasks, including problem solving.

Abilities to demonstrate knowledge and understanding.

Transferable skills: Communication skills and problem solving skills.

2. –What are we going to talk about?

Here there are some points that can be taken into account when talking about chemistry teaching/learning process and the Information and Communication Technologies:

1- **What has changed in the research in chemistry and in the education in Chemistry with the Communication and Information Technologies?:**

It is enough to observe how chemists worked 50 year ago in a laboratory and how they do nowadays. And we can wonder how have the ITC influenced in chemistry?. the things that have changed are:

- The access to the information: to the data, to the antecedents.
- The prediction of new molecules: They are simulated before being obtained and verified their properties in the laboratory.
- The collection of experimental data by means of sensors.
- The organization and transformation of the data: tables and graphs are shown in real time.
- The quickly accomplishment of very complex calculations.
- The possibility of making simultaneous experiments in remote laboratories sharing data at the same time.

- The discussion about the interpretation of the results can be made among quite different persons working in diverse places.
- The communication of the new ideas with the help of all kind of computer programs (drawings, presentations, animations…)

In short: ***the way to make chemistry has changed as much as the way to communicate it.***

2- Teaching to learn Chemistry: some conditions.

At school what has changed in the teaching of chemistry with the arrival of the new technologies? In general teaching methods have not changed, just in some cases a few programs and techniques are sporadically used. The school evolves much more slowly [(1)].

Other question is: do the ICT make possible that students and teachers consider new questions in the chemistry classes? Do they generate new methods to answer them and all kind of students can more meaningfully learn? In this sense, we must consider that teaching to learn Chemistry involves changing the ways to perceive, think, speak and relate three worlds: the world of facts, the world of models and theories and the world of symbols. This implies, for instance, when talking about a chemical reaction:
- learning to observe a phenomenon in a different way.
- learning to imagine what changes and what does not.
- learning to talk about it in the language of chemistry.

3- In Chemistry Education what can Information and Communication Technologies be useful for?

Some utilities of ICT in the chemistry teaching/learning process are:
- facilitating the possibility of working in small groups instead of just the class-group
- working the application instead of just reading and reciting the lesson
- improving the motivation of all students instead of motivating just a few
- paying attention to all students instead of just the students according to the *average*
- evaluating the progress and effort instead of just basing on final exams
- promoting a greater cooperation instead of just a competitive social structure
- implementing classes where students make different things instead of just making all the same
- developing classes in which the visual and oral thinking are integrated instead of just the oral thinking

3. Frame of the didactic experience

3.1 Studies and student sample

This experience has been carried out in the Teacher Training School of Primary Education of Cuenca (University of Castille-La Mancha) in Spain with 25 students of the optional subject: Basic Chemistry with a charge of 4 credits (ECTS)[1] the contents of the subject are the following:

Chart1

(a) CONTENTS OF THE SUBJECT "SCIENCES OF NATURE I"

Presential Class	Contents	a
1 h	**Presentation of the subject.** Work methodology. Evaluation criteria	
4 h	**Matter and its properties**. States of matter. Changes of state. Physical and chemical properties. Pure substances. Elements and compounds. homogeneous and heterogeneous mixtures. Dissolutions. Separation of mixtures. Laws of mass and energy conservation.	1
4 h	**Atomic structure**. The four elements. Dalton´s Tehory. Subatomic particles. Atomic and massic numbers. Isotopes and atomic weight. Nucleus. Quantum mechanical model of the atom. Quantum numbers. Electronic configuration	2
4 h	**Chemical quantities.** Measure of matter quantity. Quantity of substance. Mole. Moles and particles. Avogadro's number. Moles of a gas volume. Empirical and molecular formulas.	3
4 h	**Periodic Classification.** Electronic configuration and properties. Development of the periodic table. Periodicity. Blocks of elements. Tendencies in the periodic talbe. Atomic volume. Ionization Energy. Electronegativity. Metals and no metals. Properties of the elements and their properties.	4
4 h	**Chemical bonds**. Molecules and ions. Valence electrons. Stable electronic configurations. Ionic bond. Ionic compounds. Molecular compounds. Lewis Structures. Bond energy. Polarity of the covalent bond. Metallic bond. Intermolecular forces. Attraction among molecules. Molecular structure and physical properties.	5
4 h	**States of matter. Gases.** Kinetic molecular theory. Molecular interpretation of temperature. Pressure. Avogadro's Hypothesis. Diffusion. Behaviour of gases. Laws of gases. Liquids. Solids. Changes of state.	6
4 h	**Dissolutions. Colligative properties.** Measure of concentration. Molarity. Molality. Ebulloscopy. Cryoscopy. Osmotic pressure. Vapour pressure. Raoult's law.	7
1 h	**Chemical Reactions.** Chemical equations. Balance of reactions. Types of chemical equations. Combination reactions. Decomposition reactions. Replacement reactions. Burning reactions	
30 h		

Pedagogical and didactic methodology

In this context we have applied the new educational methodology imposed by the adaptation of the University Education in Spain to the new Higher Education European Space (HEES)[2] by means of the application of the European Credit Transfer System (ECTS). This system implies a greater participation of the students in their own process of learning and the development of instrumental competences such as computer basic abilities (handling of programs, search of information in the network, etc.) and the basic abilities of management of data obtained by the diverse sources that can be used[3].

The key consists , today as always, of teaching to learn chemistry what implies to teach to change the ways of perceiving, thinking, speaking and relating three different worlds: The Macroscopic world (world of the facts), the Microscopic world (world of the model and theories) and the symbolic world[4].

The use of the new information and Communication Technologies (ICT): with an effective utilisation of the virtual learning facilities provide for the computer application (RedC@mpus) a virtual platform of the University of Castille-La Mancha.The surfing in the web to find applets and interactive applications about chemistry. For example the use of interactive Periodic Tables available in the network

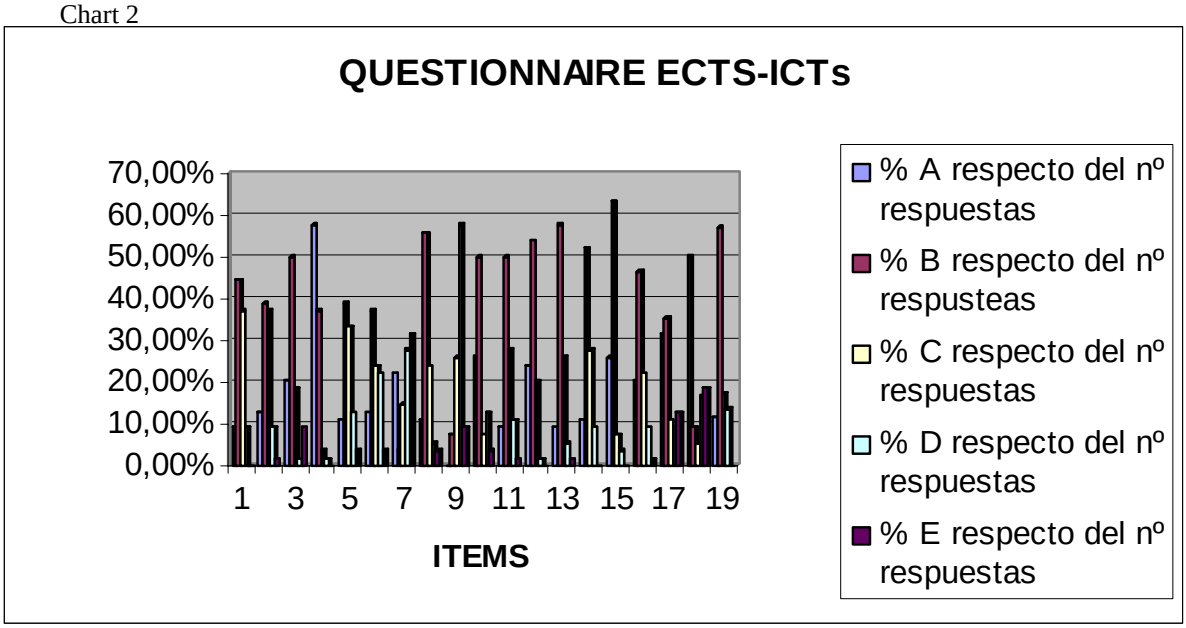
The application of a constructivist methodology[5] mainly based on the personal work of the students guided by the teacher, taken into account their previous ideas or preconceptions.

Finally, students filled a Questionnaire about the ECTS methodology inside the EHEA

Results

The questionnaire consists on 19 items. The statistical graphic of these results are shown in the following chart

Chart 2



QUESTIONNAIRE ABOUT ECTS METHODOLOGY
(BASIC QHEMISTRY) 3º PRIMARY EDUCATON

1- The amount of hours weekly needed to prepare this subject has been:
a) between 0 and 2
b) between 2 and 3
c) between 3 and 4
d) between 4 and 5
e) more than 5

2- In my opinion, I consider that the number of hours of personal work that should be spent on this subject in order to take advantage of it **for each hour of given class** is:
a) more than 2 hours
b) between 1 and 2 hours
c) 1 hour
d) less than 1 hour
e) no time of extra work needed

3- The aspects developed in the subject that have interested or motivated me most have been:
a) The individual works about "History of Chemistry" or about "Science, chemistry and environment"
b) The elaboration of Didactic Unities about Science in Primary Education
c) The oral presentation in class as a mean to develop communicative competences
d) The use of the new Information and Communication Technologies in the individual work
e) The inclusion of the Sciences Museum as an external resource into the teaching/learning process in the curriculum.

4- The Didactic Unit orally exposed in class as a result of a cooperative work of collaboration with other students seems to me:
a) very positive
b) quite positive
c) indifferent
d) little interesting
e) nothing interesting

5- Which of the following **instrumental competences** established in the ECTS do you believe to have worked more and better throughout the course?:
a) capacity of analysis and synthesis
b) capacity or organization and planification
c) communicative capacities (oral and writing)
d) basic abilities in computer science
e) abilities of management of the information

6- Which of the following **personal and interpersonal competences** established in the ECTS do you believe to have worked more and better throughout the course?
a) ability to work autonomously building your own learning
b) Capacity of interpersonal communication (work in group)
c) Reflexive and critical attitude with respect to the subject
d) Commitment with the collaborative work
e) Capacity of analysis and synthesis in relation to the subject

7- Which of the following **sistemic competences** established in the ECTS do you believe to have worked more and better throughout the course?
a) capacity of learning/capacity of working autonomously
b) capacity to generate new ideas
c) capacity of adaptation to new situations
d) design and management of projects
e) research abilities

OPINION WITH RESPECT TO THE SUBJECT

For each of the five following statements, please indicate whether you

A) strongly agree
B) agree
C) are neutral
D) disagree
E) strongly disagree

8- The content and methodology of the subject seem to me interesting.
9- The tasks (contents and works) of the subject have seemed difficult for me.
10- I have learned new things I have never studied.
11- I have discovered and corrected erroneous ideas I had with respect to some topics.
12- My predisposition towards the subject has been favourable.
13- The corrections and commentaries of the teacher have been useful to me.
14- In comparison with similar subjects, this type of experience has helped me to better understand the subject.
15- To participate in the experience has helped me to better understand the subject.
16- I would like this experience to be repeated in other subjects.

17- The material placed in RedC@mpus about this subject has been very useful to me.
18- In comparison with traditional education, your opinion with respect to ECTS methodology followed in this subject has been:

A: favourable because the work of the student is better valued
B: unfavourable because it demands too many hours of dedication
C: Indifferent then you do not appreciate differences between both methodologies
D: more favourable to traditional education because it facilitates the understanding and assimilation of the contents on the part of the student
E: the desirable thing would be to conjugate both methodologies

19- In summary: my degree of satisfaction with respect to ECTS methodology followed in this course has been…
a) very high b) high c) indifferent d) low e) very low

For our purposes the main items are from 8 to 19

Conclusions

1- In 7 of the 12 items the answers are positive in more than 50% (very agree or agree) in the sense that the ECTS and ICTs methodology has increased their general valuation of the subject:
2- In item 18 we can observe that the favourable opinion about the ECTS-ICTS methodology reaches the level of 50% whereas the unfavourable one does not reach a 10%.
3- The percentage of students that are more favourable to the traditional teaching is only 5% and those favourable to a combination of both methodologies 18%.
4- In summary the degree of satisfaction with ECTS-ICT methodology is high or very high for a 65% of the students and low or very low for a 14% of them.
5- The use of a set of new computer science tools such as interactive periodic tables, animations, virtual experiments, simulations, applets and so on, contributes to develop the interest and motivation towards the process of learning chemistry.

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