

## DEVELOPMENT OF CONCEPT MAPS TO FACILITATE THERMODYNAMICS LEARNING WITHIN THE DEGREE IN CHEMISTRY

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In general, Chemistry is considered as a difficult subject for the students because its inherent concepts can be expressed at three different levels: Macroscopic, microscopic and representational (symbols, formula, etc.) (Johnstone, 1991). Thus, a significant assortment of problems in the learning of Chemistry has been well documented; from the most general ones related to the resolution of numerical exercises by the students (Pendley, Bertz & Novak, 1994) to other focused on particular topics of the Chemistry as Thermodynamics and Thermochemistry (Greenbowe & Meltzer, 2003), atomic structure, kinetics, etc. (Sirhan & Turk, 2007). Some of these topics concern the fundamental branch of Chemistry known as Physical Chemistry.

Thus, in order to facilitate the learning of the Physical Chemistry concepts within the context of the degree in Chemistry at University of Jaén (Spain), concept maps are being developed for the subject "Physical Chemistry I" that belongs to the second course (out of four) of the commented degree in Chemistry. This subject is devoted to Thermodynamics/Thermochemistry/Statistical Thermodynamics. It consists of ten lessons.

The present project involves two objectives. First, development of concept maps by the authors for the different lessons of the subject. Up to date, five concept maps have been built; the first of them intends to be a basic outline of Thermodynamics, the second gathers the fundamental concepts of Thermodynamics, the third is for the first Law of Thermodynamics, the fourth is devoted to Solutions and the fifth to Statistical Thermodynamics.

Second, implementation of the use of concept maps for "Physical Chemistry I" and its corresponding assessment. In this way, the program of the subject is divided in three blocks, one of them is taught/learned using the concept maps developed by the authors as experts; for the next block the students are organized in several groups and a concept map to be constructed is assigned to each one; the third block is formed by lessons for which neither the experts' maps nor students' ones are used. The exam of the subject as well as the numerical exercises conducted during the teaching period can be used as tools for the assessment. In addition, a test focused on the concept maps has been delivered to the students.

The analysis of the current data has still to be carefully accomplished. The authors are aware that more effort has to be done to get a matured implementation of concept mapping for the target subject. Nowadays, the evaluation of the maps built by the students provides some interesting results since it has been observed that one of them contains rather correct contact linkers between concepts and other one involves right concepts.

### References

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