



Red Mud: toxic waste of aluminum refining. An experience of cooperative learning in the "Inorganic Chemistry" subject from the Bachelor in Industrial Chemical Engineering.

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Introduction

"Inorganic Chemistry" is a first year Specific Technology Subject that is given in the second fourth-month period of the Bachelor in Industrial Chemical Engineering. In the EEES context, this subject has been designed paying special attention to embody active teaching and learning methodologies [1]. Among them the use of the press as an information source able to motivate students and the cooperative learning have been profusely employed to help reaching the main transversal competences aimed in this subject: analytical and synthetic capacity, oral communication skills, criticism ability and acquisition of interpersonal skills.

Cooperative learning is a successful teaching strategy in which small teams, use a variety of learning activities to improve their understanding of a subject. Each member of a team is responsible not only for learning what is taught but also for helping teammates learn, thus creating an atmosphere of achievement. Since the establishment of its basic principles [2] it has been a well documented tool widely employed to promote the acquisitions of the skills above mentioned. [3, 4]

We present here our cooperative learning experience working with informal groups about the disaster that buried three Hungarian villages in caustic red sludge in October 2010, killing three people and injuring 123. It was a world-wide new and event with almost unprecedented environmental consequences.

Detailed Course Schedule and Syllabus

Abbreviations:
BS: Basic Subject, CI: Industrial Engineering Subject, B: Specific Technology Subject
Subject (Specific), C1: First semester, C2: Second semester, A: Annual

FIRST YEAR

Code	Subject	Type	ECTS	Dpt.
509101001	Mathematics I	BS	A 12	DMAE
509101002	Physics I	BS	C1 6	DFA
509101003	General Chemistry	BS	C1 6	DIMOC
509101004	Applied Computing	BS	C1 6	TIC
509101005	Industrial Drawing	BS	C1 6	DEO
509101006	Physics II	BS	C2 6	DFA
509101007	Physical Chemistry	B	C2 6	DATE
509101008	Inorganic Chemistry	B	C2 6	DIMOC
509101009	Organic Chemistry	B	C2 6	DIGA



Methodology

Before the two hours session, students must individually read the news as it was published in two well known national newspapers [5]. The main aspects of aluminum chemistry have also been revised at class. To start with, groups are formed (4 x 6 people) in the a classroom with computer facilities and then the whole class establish the main aspects and consequences of the new, using discussion and brainstorming techniques. Then the teacher helps to order the ideas and assigns the following subjects for a detailed study in each group:

1. Obtención industrial del aluminio. (Aluminum industrial production process)
2. Composición del barro rojo. (Red mud composition)
3. Carácter corrosivo. Riesgos para la salud. (Toxicity and health risks)
4. Otras catástrofes ambientales similares. (Related environmental catastrophes)

In order to obtain additional information students must look at web pages of the companies (MAL Magyar Aluminium) [6] and ALCOA, [7] main world producer with several factories in Spain. The teacher supervises the work in order to get the basic elements of cooperative groups being practiced: positive interdependence, individual demanding, face to face interaction, interpersonal skills and group analysis. Then the group's work is explained to the class by a spokesman during a maximum time of ten minutes. Finally, individual evaluation by means of the attached test is performed. Students must also answer an anonymous Critical Incidents Questionnaire about the activity.

TEST "RED MUD: TOXIC WASTE IN ALUMINUM REFINING"

- 1.- Indica la impureza más habitual del mineral bauxita.
What is the most common impurity in bauxite?
- 2.- Describe el comportamiento ácido-base del óxido de aluminio.
Describe the acid-base behavior of Al₂O₃.
- 3.- Describe, utilizando reacciones químicas, el proceso industrial de purificación del mineral bauxita.
Describe with the chemical reactions involved the industrial procedure of bauxite purification.
- 4.- Describe, utilizando reacciones químicas, el proceso industrial de obtención del aluminio metálico a partir de óxido de aluminio.
Describe with the chemical reactions involved the industrial procedure to obtain Al from Al₂O₃.
- 5.- Explica cómo disolverías en agua una muestra de Al₂O₃.
How would you dissolve a sample of Al₂O₃ in water?
- 6.- Explica por qué es rentable económicamente el reciclado del aluminio.
Explain why it is profitable recycling aluminum.
- 7.- ¿A qué propiedades debe el Al su uso tan extendido?
What are the aluminum properties that confer it a widespread use?
- 8.- Indica, a tu juicio, cuál es el componente más peligroso que contiene el lodo rojo estudiado.
Which component of the red mud is the more dangerous?
- 9.- Indica la composición aproximada del lodo rojo.
What is the composition of the red mud waste?
- 10.- En "El Mundo" se afirma que el pH del vertido es de 14, ¿cuál es entonces su carácter y fortaleza ácido-base?
"El Mundo" says that the waste has a pH = 14. What is then its acid-base character and strength?
- 11.- ¿Qué se pretende conseguir al regar el vertido con un compuesto aglutinante?
What is pursued irrigating the waste with a binder compound?
- 12.- ¿Cuáles son los principales productos que se fabrican en MAL Magyar Aluminium?
What are the main compounds produced in MAL Magyar Aluminium?
- 13.- Cita algunas ciudades españolas en las que se encuentran factorías de la multinacional ALCOA y los productos que se fabrican en ellas.
Could you write some ALCOA factories in Spain and its products?
- 14.- Haz una breve reflexión sobre la rentabilidad económica y medioambiental de reciclar/reutilizar el lodo rojo.
What do you think about the economic/environmental profitability of recycling the red mud?
- 15.- Cita otras catástrofes medioambientales similares ocurridas en España o en otros países indicando el tipo de vertido.
Point out other environmental catastrophes indicating the kind of waste?

Conclusions

The use of news from the press provides a connection between theory and reality, at the time that demands an effort of reading with understanding. Searching at the web pages of international companies, scientific publications and foreigner universities allows an approach to technical English at the time that make clear the big contrast between these sources of information and no-specialized press. As a whole it gives a practical and applied dimension to the subject that favor the motivation and positive attitude of students. The results of the test revealed that students knew the basic information, although also showed their difficulties to distinguish between relevant and superfluous information.

VALUATION BY STUDENTS: Critical Incidents Questionnaire
Students considered as a very positive experience the application of "Inorganic Chemistry" contents to approach a real case. Environmental implications of the Hungarian disaster gave additional value to this practical example.

As aspects to improve most of the students pointed out the shortness of a two hours session to develop the activity and the likely benefits of displaying the presentations elaborated by them in the Virtual Classroom in order to have a more calm analysis of the conclusions.

References

- [1] Propuestas para la renovación de las metodologías educativas en la universidad, Consejo de Coordinación Universitaria, MEC, 2006.
- [2] Johnson, D. W.; Johnson, R. T.; Smith, K. A. (1998) Active learning: Cooperation in the college classroom. M. N. Edina: Interaction Book Co.
- [3] Cuseo J. B.: (1996) Cooperative learning: A pedagogy for Addressing Contemporary Challenges and Critical Issues in Higher Education. New Forums Press.
- [4] Borá, J.; Domingo, J.; Valero, M.: (2007) Técnicas de Aprendizaje Cooperativo. Taller de Formación en la Universidad Politécnica de Cartagena.
- [5] a) www.elpais.com / artículo / sociedad / Hay / zonas / lodo / podran / ser / recuperadas / elpepicoc / 2010103elpepicoc_5 (Res. b) www.elmundo.es/elmundosalud/2010/10/06/pietsana/1286390790.html
- [6] http://english.mal.hu/Engine.aspx
- [7] http://www.alcoa.com/spain/es/info_page/home.asp