ARTICULATED EXPERIENCES IN PILOT PLANT

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Abstract

Interdisciplinarity makes evident the links between the different assignments, reflecting an asserted scientific conception of the world, that shows how the phenomena does not exist in separated ways, and that when it is interrelated through the contain, an interpretation drawing is designed, interaction and dependency of the developed world. The accomplishment of an adequate relationship between the different assignments of a study plan, influences in the subsequent increase of teaching effectiveness, in quantitative as well as in qualitative terms, thus meaning a better formation of the students, which leads to a mayor qualification of the teacher. Furthermore, this constitutes a didactic condition and the challenge for the fulfillment of the scientific teaching character. The knowledge without links among them, break the conscious assimilation of knowledge and abilities. Based on the objective of the articulation between specific subjects of the Study Plan of the Chemical Engineering and to the effects of reinforcing the practical formation of the students with experiences at a pilot scale, the proposal to implement a summer course for the Chemical Engineering students with the fourth year approved is presented. These summer courses will consist in a series of Pilot Plant experiences, which are designed in such a way that the experimental results sum up information enabling an integrated project. At the same time it is intended that the student takes part in the discussion of the experience to be programmed, also when putting in operation the experimental equipment or equipments.

Introduction

We notice that in most of the cases we tend to "multidisciplinarity", which responds to the sum up organization form, the relationship between the different disciplines not clarified. See Figure 1.
Interdisciplinarity appears in some cases, which are different grades of interaction between two or more disciplines. See Figure 2.

We would like to reach transdisciplinarity, which is the mayor possible grade of interaction. See Figure 3.

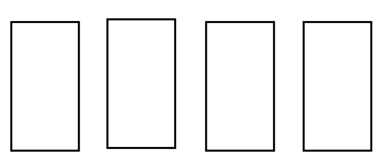

Figure 1. Multidisciplinarity Scheme

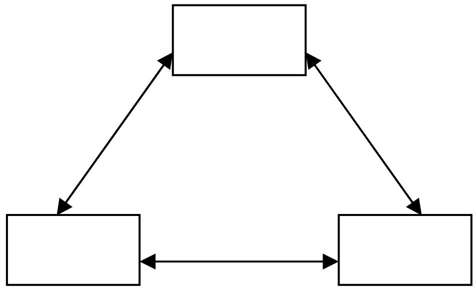

Figure 2. Interdisciplinarity Scheme

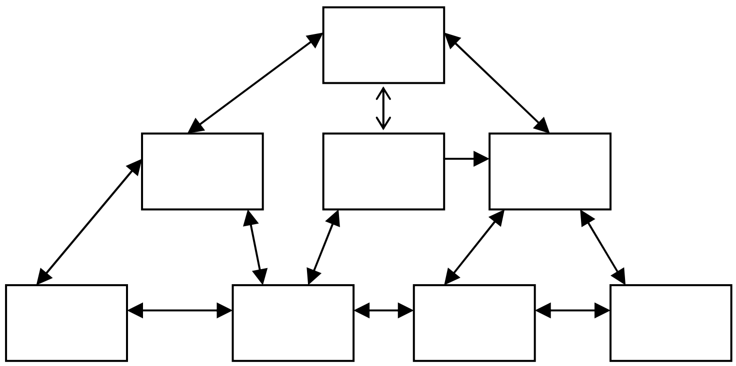

Figure 3. Transdisciplinarity Scheme

The Articulation

According to Tamayo and Tamayo (2004) interdisciplinarity is defined as the conjunction of linked disciplines among themselves with defined relationships, with the purpose that its activities do no happen in an isolated, disperse and fractioned way.

The evidence of links among the different assignments of the career which reflect an asserted scientific conception of the world, showing how the phenomena do not exist in separate ways and that by interrelationing through contains, and a draft of interpellation, interaction and dependency of the world's development is designed.

In order to reach an adequate relationship between the different study plan assignments influences the subsequent increase of effectiveness of the teaching in quantitative terms as well as in qualitative terms. That means an optimal preparation of the students, which requires a mayor qualification of the teacher. Knowledge without links among themselves, break the conscious assimilation of knowledge and abilities. Furthermore, this represents a didactic condition and the requirement for the accomplishment of the scientific character of teaching.

Krupskaia pointed out about this matter, "*if we want to transmit to the teaching staff the essence of the scientific conception of the world, we should not teach incoherent knowledge, but with its corresponding and determined relationship among them, only in this sense, we conceive a more integral character than this one*".

We understand under articulation the relationship between various assignments of different disciplines, without loosing the logical structure required for ordering the contents, warranting the development of specific abilities of the assignments from the professional and those that make up the personality of the student.

Articulation among the assignments should start from the general starting point of the interrelation or concatenation of all phenomena which are reflected in teaching through the contents and themes that are common to various assignments.

Theory of the Significant Apprenticeship

Ausubel states that the apprenticeship of the student depends on the previous cognitive structure related with the new information, “new structure”, should be understood as the conjunction of concepts, ideas which the individual person owns in a given area of knowledge, as well as its organization.

Ausubel resumes this fact in the epigraph of his book, as follows: “If I had to reduce the whole educational psychology into one single first step, I would enounce this one: The most important factor which influences the apprenticeship is that, what the student already knows. Find it out and teach consequently” (AUSUBEL; 1983).

Significant and Mechanical Apprenticeship

The most significant characteristic of apprenticeship is the fact that it produces interaction between the most relevant knowledge of the cognitive structure and new information (it is not a simple association), in such a way that these acquire a significance and are integrated to the cognitive structure in a non-arbitrary and substantial way, for the benefit of differentiation, evolution and stability of the pre-existing subsunsors (each time new information “is connected” with a relevant concept) and subsequently of the whole cognitive structure.

Contrary to the significant apprenticeship, the mechanical apprenticeship, is produced when adequate subsunsors do not exist in such a way that the new information is not properly saved, without interacting with existing knowledge, an example of which would be the simple learning of formulas in physics, this new information is incorporated to the cognitive structure in a literal, not proper way because it consists of purely arbitrary associations, [when], “the student shows lack of relevant and necessary knowledge to enable that the learning task might be potentially significant” (independent of potential significance that the task might have)… (Ausubel; 1983).

By way of illustration, in physics, if the system concepts of work, pressure, temperature and energy conservation do already exist in the cognitive structure of the student, these will serve as subsunsors for new knowledge, about thermodynamics, such as thermal machines, steam turbines, fusion reactors or simply the basic theory of the refrigerators; the process of new interaction with the already existing one produces a new modification of the subsunsors concept (work, energy conservation, etc.), this implies that subsunsors are wide, clear, stable or unstable concepts. All these depend on the way and frequency they are exposed to interaction with new information.

In the example given, the idea of energy conservation and mechanical work, will serve as “anchorage” for new information about thermal machines, but as soon as these new concepts are learnt in a significant way, they will grow and will modify the initial subsunsors, that is to say, the energy conservation and mechanical work concepts would develop to serve as subsunsors for concepts such as the second thermodynamic law and entropy.

Finally Ausubel does not state a distinction between significant and mechanical apprenticeship as a dichotomy, but as a “continuum”, and more, both apprenticeship types can incur concomitantly in the same learning task (Ausubel; 1983); for example, the simple memorization of formulas would situate in one end of this continuous (mechanical apprenticeship) and the learning of relations between concepts could situate on the other end (significant apprenticeship).

In brief, the significant apprenticeship is to develop abilities, allowing the student to work out knowledge in a concrete, functional form, affecting his profession’s duties accomplishing more productive and creative kinds of work. Furthermore, it means to gain that each developed action leads to a higher degree of skill of the contents, by means of transforming primary characteristics of said actions.

Theory Design

Problem

For Chemical Engineering students of 5th grade, at the National University of Salta`s Engineering Faculty. Is it possible to accomplish a significant apprenticeship upon the basis of Ausubel’s theory, by means of a change in the teaching methodology, which considers the links in the study assignment plan?

General Purpose

To institute a new teaching methodology, that contributes to improve the apprenticeship of the students.

Specific Purpose

To design and put in practice the experiences of the pilot plant which should consider the assignment links of the study plan.

Purpose of the Study

Teaching procedure – apprenticeship.

Action Field

- Significative Apprenticeship.
- Articulation among assignments.

According to the theoretical foundation, the analysis of the Object and the Objects of the investigation, we state following hypothesis.

Hypothesis

The application of practical Works which considers the links of the assignments in the study plan will contribute in the accomplishment of significant apprenticeship at the pilot plant.

Practical Articulation of Specific Subjects in Chemical Engineering

Based on the articulation purpose among specific subjects of the study plan in the Chemical Engineering Career and to the effects to reinforce practical formation of the students by means of multidisciplinary experiences, designed upon procedures at pilot scale, the proposal is presented to institute a summer course directed to the Chemical Engineer students, who have approved the 4th year.

During the institution of this summer course the student is expected to take part in the discussion of operational alternatives of the programmed procedure, putting in operation the experimental equipment and the analysis of obtained results.

This proposal is designed with the purpose of articulating subjects of the curricula, such as Organic Chemistry, Kinetic Chemistry, Physical Chemistry, Operations and Procedures, Auxiliary Services, Instrumentation and Control, Clean Production, etc., in such a way that the students use the knowledge granted and acquired during the whole career, with the final purpose of contributing to integrate concepts and practical formation.

During the course of the several assignments, the students carry out routine labor and pilot plant tests on specific themes of each one, knowing in separate ways the functioning and operation of most of the available equipment in the pilot plant. During the summer course the function of the plant will be integrated on a total basis, the students will have to apply their operational and functional knowledge of each one of the equipments and the procedure problematic as a whole.

Actions to follow

- Request the Chemical Engineering Career lectures for execution alternatives of new practical labor and/or pilot plant tasks.
- Analysis of the proposal of practical and/or pilot plant labor with the objective of acquiring data about:
    - Indispensable reactives
    - Indispensable equipment
    - Instrumental required
- Analysis of the feasibility of the experiences in an integrated way, within an admissible period of time.
- Adjustment and interrelation of the selected labor and pilot plant tests.

Available Equipment

In order of accomplishing lecture interrelation, the Engineering Faculty has the Pilot Plant II available, with the specific purpose of developing academic activities.

Several equipments is available, most of which at pilot scale see (Figure 4), and periphery laboratories are also available.

Following is the equipment available:

- Water softening system, 100 l/h.
- Steam tubular boiler, 100 kg/h, 7 kg/cm2
- Refrigeration system with 8 m3 storage depot, 200 l cooler hole.
- Cooling tower, forced fan, 15 TR.
- Stirred tank, 150 l, and ½ HP stirrers.

- Ultra high temperature sterilization system.
- 140 l heater for water tank.
- Liquid-gas absorption equipment.
- Liquid-liquid extraction system.
- Load loss rack.
- Air compressor.
- Jaw crusher, Blake model.
- Cone crusher, Symond model.
- Hammer mill.
- Mesh sieve.
- Rotative oven for calcination.

Laboratories of electrical installations, Automatic control, Electronic, Petro chemistry, Operations and Procedures, Clean production and Computer science teaching for procedure simulation.

Furthermore there is availability of a series of tools, working table and personal protection elements.

Figure 4 – Pilot Plant II equipment: Softener, Cooling tower, UHT, Absorption tower, Crusher

Articulation Examples

Obtention of precipitated Calcium Carbonate (PCC) from exhausted brine during the water softening phase.

The practice involves the interplay of four assignments for the development of labor, beginning with the operation of water softening using exchange resin. Once the resin is exhausted, the resin is regenerated of it with brine (12% in ClNa). A exhausted brine is unloading As a result of this operation (rich in Ca and Mg) to be fitted properly and then be ready

The proposal is to treat the effluent before its discharge into the environment, in order to recover the brine for reuse in the regeneration process of exchange resin and also to obtain viable by products marketing

The depleted brine is treated in a batch stirred tank reactor with appropriate reagents, such as Solvay Soda and Caustic Soda, so remove impurities differentially (Ca and Mg).

The suspension is then filtered, and each solid is drying properly

Involved chairs and objectives

The involved chairs in the development of practical and theoretical concepts to integrate them are the following:

- Auxiliary Services and Unit Operations I: Water Treatment (softening), pumps, agitation, filtration.
- Clean Production: treatment and disposal of effluents
- Operations and Processes: reactors design and design of dryers.
- Instrumentation and Process Control: design of instrumentation and control system of each of the integrated phases

Diagrams of the pilot plant practices

A diagram of the conventional process in water softening plants, by cation exchange resins, sodium cycle is presented in Figure 5.

In Figure 6 represents schematically the alternative process to develop in practice, with recovery of brine and obtaining products of commercial application

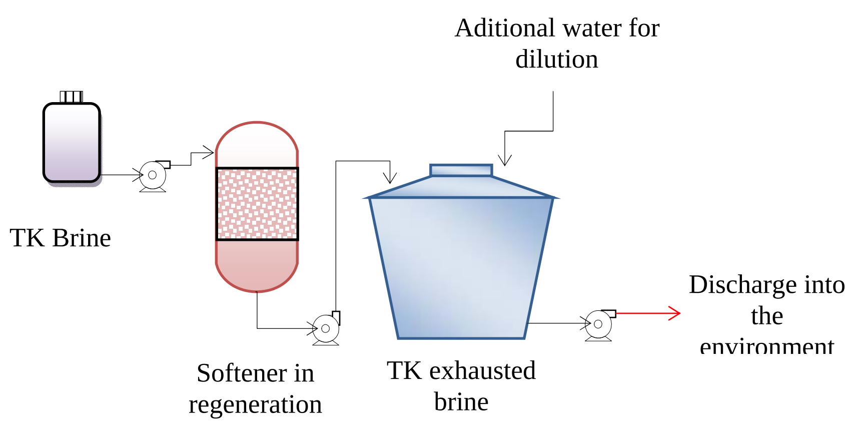

Figure 5. Conventional scheme for the regeneration operation of a cation exchange resins, sodium cycle

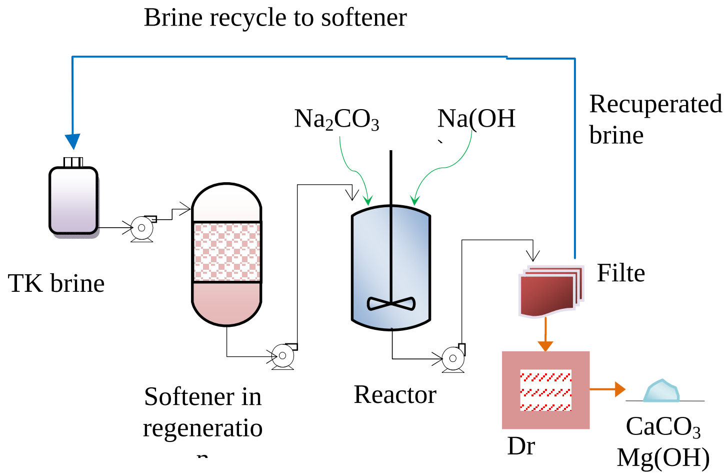

Figure 6. Scheme designed for the integrative practice, with recovery of brine and obtaining by products of commercial application

Saponification of ethyl acetate with caustic soda

This practice is to design a batch reactor to achieve a conversion determined from kinetic data of an irreversible and in non-homogeneous catalytic phase reaction.

The reaction of saponification is as follows:

$$CH_3COOCH_2CH_3 + NaOH \longrightarrow CH_3COONa + CH_3CH_2OH$$

Involved chairs and objectives

- Organic chemistry: a study of the reaction of saponification.
- Chemical Kinetics: determination of the kinetics of the reaction (laboratory scale)
- Operations and Processes: Design of a batch reactor to achieve a determined conversion from the kinetic data.
- Instrumentation and Control: defining the instrumentation for the measurement and control of operational variables.

The outline of the experience in the pilot plant can be observed in Figure 7.

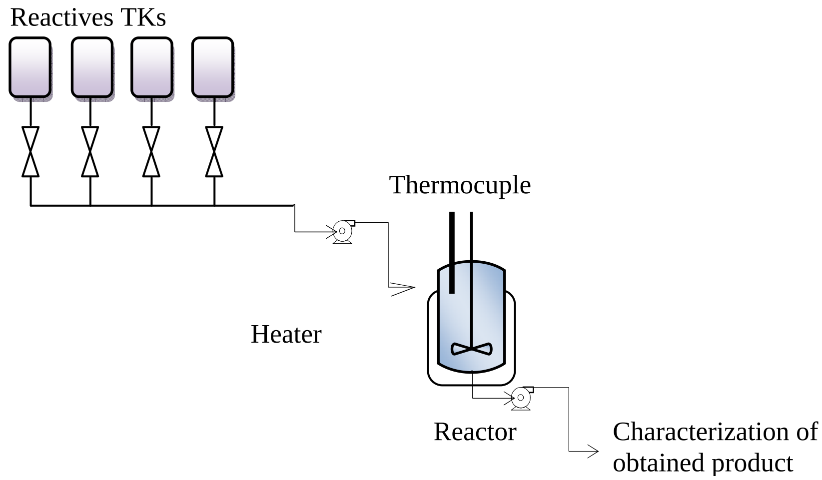

Figure 7. Outline of Practice for the saponification of ethyl acetate

Conclusions

For all these reasons, we believe that the realization of practical integrated in pilot plant for the career of Chemical Engineering, Faculty of Engineering will allow:

- Articulate specific areas of the career.
- Strengthening the basic knowledge by conducting a pilot scale integrated practices.
- Give more emphasis on practical training for students in the last year of the career.
- Increasing the participation of pupils in the programming of practical experience in order to generate critical discussions in the construction equipment and the analysis of results

References

1. Ausubel,Novak & Hanesian (1983), “Psicología Educativa: Un punto de vista cognoscitivo”, 2° Ed. Trillas México,
2. BetzDearbon, (1991), “Handbook of Industrial Water Conditioning”, 9th Ed.
3. Brown, G.G. (1956), “Operaciones básicas de la Ingeniería Química”, Manuel Marin Ed. Barcelona (España).
4. Carberry J., (1980), “Ingeniería de las reacciones químicas y catalíticas”, Mc Graw Hill.
5. Cunningham R. & J., Lombardi, (1972), “Fundamentos del diseño de reactores”, EUDEBA.
6. Debingh, K. G., et al, (1990), Introducción a la teoría de los reactores químicos; Limusa Noriega.
7. Durst, H. & G., Gokel, (1985), “Química Orgánica Experimental”, Editorial Reverté.
8. Froment & Bischoff, (1979), “Chemical Reactor Analisysis & Desing”, John Wiley & Sons.
9. Hardwood, L., (1999), “Experimental Organic Chemistry: Standard and Microescale”, 2º Ed., Blackwell Science.
10. Henley, E. et al, (1988), “Operaciones de separación por etapas de equilibrio en Ingeniería Química”; Reverté
11. King C., (1981), “Procesos de separación”, Reverté.
12. Levenspiel, O, (1974), “Ingeniería de las reacciones químicas”, Reverté.

13. Mc Cabe, W. & J., Smith, (1967), “Unitaries Operations of Chemical Engineering”. 2da.Ed., Mc. Graw-Hill Book Co, USA
14. Novak, J & B, Gowin, (1988), “Aprendiendo a Aprender”, Martínez Roca.Barcelona
15. Rase, H. , (1977), “Chemical Reactor Desing for Process Plants”, Vol I y II, John Wiley & Sons.
16. Richardson, J. & D.G. Peacock, (1971), “Chemical Engineering”, Primera Edición.
17. Scott Fogler, H., (2001), “Elementos de Ingeniería de las Reacciones Químicas”, 3º Ed. Pearson Educación, México.
18. Smith, J., (1981), “Ingeniería de la Cinética Química”, Continental, S.A., México, Segunda Edición
19. Tamayo y Tamayo, M., (2004), “Diccionario de Investigación Científica”, Editorial Limusa, México, Segunda Edición.
20. Vian Ortuño, A., (1996), “Introducción a la Química Industrial”, Reverte.
21. Wade, L., (1995), “Química Orgánica”, Prentice Hall.