Learning Based on Problems (ABP), Impact of RAEE: A Case Study

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Abstract*—Using a case of research as a methodological tool, applied in the research lab with students of the ninth semester of the academic program of chemical engineering (IQ) of the Faculty of chemical sciences and engineering (FCQeI) of the Autonomous University of the State of Morelos (UAEM), analyzed competition to students include scientific concepts acquired, where education is a human process more than verify that cognitive skills according to the approach [1], are developed during the resolution of the case. The results showed that students managed to explain the concepts involved, reflected on his own work and realized what had to be improved. For that, students employed higher order cognitive skills, such as explain, investigate, conclude, argue, make decisions and cognitive skills of low order, such as describing, enunciating, memorize and reproduce.*

***Keywords*—Study Case, Investigative Research, Skills and Cognitive Skills.**

I. INTRODUCTION

Paulo Freire mentions that: the liberating education, analyzing, can no longer be the Act of depositing, narrate, transfer or transmit "knowledge" and values to learners, mere patients, as the "Bank" education does, but be a Knower Act [2].

The goal is to challenge students to a new vision of the world and become the main protagonists of their learning, through the development of projects that respond to current problems, change their own reality and paradigms based on a critical analysis. However, [3] indicates that the cognoscente Act can be made through the action Dialogic between educator and learner, through problems that allow further reflection, a greater disclosure of reality and understanding of the existential situation, in which the student is central.

Science, technology and society (CTS), movement can also provide the car change and critical thinking, [4], for its part numbers to: critical science education is to make an approach to end questioning models and values scientific and technological development of our society. That represents, not to accept technology as a superior knowledge, whose decisions are limited. On the other hand, the hope is that students can participate in democratic decisions about science and technology, questioning the dominant ideology of technological development [1].

The CTS with a humanistic emphasis carried out the rescue of the conception of Paulo Freire in education, citing this as a human process. In this sense, [2], [3], [4], [5], have been discussed and expanded the ideology of CTS in the perspective of Freire. Along with this [6], notes that this expansion of the movement, seeks to reduce the extremes between rich and poor in the current globalization process, facilitating the debate on issues relating to technological exclusion.

The case of research, it is assumed as a method of learning that facilitates the process of dialogue between teacher and pupil, allowing the students to exercise a critical analysis of a situation or specific exclusion. This can occur naturally in two points: first to the teacher, who acts as a mediator of the students, guiding them in the identification, search for information about the possible solutions and encouraging reflection on the decisions taken and the possible consequences[5]; and second in the students, who come out of passivity and the oppression of information and begin to reflect on their own social and human conditions according to the proposed case.

Case study-based methodology offers students an independence of learning, because it allows to exploit scientific knowledge sometimes distinct and complex. It is a method that arose from based learning problems (Problem Based Learning), originated in the school of Medicine of University of McMaster, Canada, 35 years ago, with the aim of improving the training of health care professionals[7].

The resolution of the cases can be done in various ways: through records and information; using the relations

between the scientific, social, political, humanistic, environmental expertise, etc.; and in experimental form, in this case, the teacher can use case study, so that students develop skills of research, handling and communication of data [8]. On the other hand, the research provides a teaching for small research, together with the scientific concepts involved, procedures and actions to be taken by the students[9].

Laboratory practices approach to the methodology of case studies. According to [10], in a review of the literature concerning the activities of laboratory research method involves questions of planning, experimental productions, collection and interpretation of data and presentation of results. These skills and abilities are that students come out of mere passive recipients and executors of prompt instructions. This, along with the capability of making decisions and the relationship with the social, environmental aspects and humanists, lead to better learning by students.

ZOLLER says that the type of situation influence the manifestation of cognitive skills and characterize them in two basic levels: cognitive abilities under order (LOCS), for example, know / recall or apply knowledge and algorithms in family situations and cognitive abilities of higher order (HOCS) as investigate, analyze and solve problems, make decisions, think critically, evaluate different situations, formulate hypotheses.

With this, Zoller[11], said that only with activities where the learning process is built in conjunction and not deposited in the heads of the students, it is possible to promote the development of higher order cognitive skills. If teachers continue to develop traditional methodologies, students will continue to only manifesting cognitive skills of low order.

The work aims to analyze the influence of a case study by means of experimental research activities in an upper year students learning and verify which cognitive abilities are developed by students to solve it. In addition, find out how resolutions are related to issues involved in the proposal of STS education humanist.

II. METHODOLOGY

The pesquisa intervention is intended to investigate collective actions, and these actions as they relate to qualitative differences of each individual. In this perspective, the intervention that can be made of various forms, assuming a character partneranalytics[12], where he meets teaching humanist advocating by Paulo Freire.

In this context, intervention is articulated to the investigation in order to reformulate the knowledge acquired, either through the duality theory/practice or subject/object relationship. This reformulation must be mediated conflicts and differences between students and teacher and between students and activity among students, teacher and activity, to allow for changes and adjustments in the formation of subjects.

Based on the perspective of the pesquisaintervention was planned activity and developed. The methodology of case study, where students presented a resolution founded on the chemical concepts worked in the experimental activity was used as a mode of research. The interventions took place through debates and discussions during the activity and subsequent to the activity, with the aim of promoting a strong interaction between Professor and investigated object, promoting the reformulation of the initial reading of the knowledge developed by the students.

Activity was developed in the laboratory of IQ research, with students from the ninth semester of the academic program of IQ, of the FCQeI of the UAEM. The participants were divided into groups of four students. Classes had lasted four hours and worked was leaching acid and basic, for the extraction of metals contained in the WEEE.

The following study was developed for the activity of case:

Location of WEEE. Case study. Situation of class.

Beginning of a class segment.

Teacher: Good day, we are going to start the class,... young people are going to give the class home... Please... I came across the news that each year, about 300 thousand tons of e-waste generated in Mexico and I wonder, what the final disposal of this waste is. I know that here at the University comes a company and all takes it; I also know that this company is responsible for broken computers in its parts and most sold them, but they don't know what to do with the WEEE, then. What is the final disposition of these wastes? and I immediately thought that the study of this subject is an opportunity to begin from two angles; the first with a Green idea and the second recovery of valuable metals by means of specific components of separation processes and metals present in computer equipment at the end of its useful life.

And then, I would like to propose as a challenge to design a script of the practice of the laboratory to carry out this idea. What do you think? (Silence)

Student 1: hear well

Student 2: what metals can have e-waste?

Professor: Gold, silver, copper.

Astonishment and laughter from students.

Professor: how about?

Several students: interesting

Professor: you think if we put together the work plan?
Teacher: what is your opinion?
Several students: If you have to do it.
Teacher: Then let's go to form teams of four members, after each team will devote to find in reliable sources required and relevant information that allows us to write the screenplay for the practice and each week we will be reviewing the progress of each team. Finally we will make a plenary to incorporate all the ideas and weapons final attack. What seems to them?

The initial research concerned with concepts leaching acid and basic, specifically, reactions with metals such as Au, Ag, Cu, Al, Fe, content on the computer (TCI) printed circuit boards. The case is baseless with regard aspects socio and the approach to CTS. However, for the solve this, the students read aloud the case and Professor Start a prior discussion to heal some doubts. He stressed that for the preparation of reports, students must submit a solution for the proposed case and that there is no restriction in the structure of the script, and that all observations in the experiment, should tell them, as well as the chemical concepts involved.

Discussion and findings

Conformity classification of [13], the case used in the experimental activity is structured type, it explicitly shows the problem to be resolved. However, under the experimental research approach, the case can be considered also as a case of several problems. This reclassification is justified by the tasks and procedures that students had to develop during the experimental activity, to achieve results that allowed the same resolution.

For the analysis of the data was read from all reports, extracting information and fragments of their own to make the analysis of the results and discussion. As described in the methodology, we considered two reparse points: at first the research process of the students, together with the CTS approach humanist; the second time was considered the manifestation of cognitive skills by the students.

The problem of the analysis regarding the extraction of metals by means of solutions acidic and basic, to develop reports, students should explain all involved chemical concepts to the topic, as well as addressing the apprentice these explanations, and detail the experimental procedures.

Table 1. Comparison between the results of the reports of each group in relation to the process of learning and contribution CTS humanist.

TEAM	Process of Learning	Contribution CTS humanist
1	1. He correctly explained the meaning of leaching processes. 2. He correctly explained the meaning of basic and acid leaching. 3. Explained procedures, reagents used and the system to use mounts. 4. He presented photos of the system. 5. He presented macroscopic evidence and some correct chemical equations.	1. You redirect from the beginning all the explanation for the apprentice. 2. He noted the benefits and disadvantages of leaching. 3. I am a contextualization of the subject. 4. He concluded the results indicating the apprentice.
2	1. He correctly explained the meaning of leaching processes. 2. It properly explained the meaning of the basic and acid leaching. 3. Explained procedures, reagents used and the system assemblies. 4. Presented macroscopic evidence and some correct chemical equations. 5. Discussed between the two methods of leaching efficiency.	1. You redirect all explanation for the apprentice. 2. He noted the benefits and disadvantages of the extraction of metals for leaching. 3. I make contextualization of the subject. 4. He concluded the results indicating the apprentice.
3	1. He correctly explained the meaning of leaching processes. 2. Explained procedures, reagents used and the system assemblies. 3. Presented the evidence and correct chemical equations.	1. You redirect from the beginning all the explanation for the apprentice. 2. He concluded the results indicating the apprentice.

4	1. He correctly explained the meaning of leaching processes. 2. Explained procedures, reagents used and the system assemblies. 3. Presented the evidence and correct chemical equations.	

Table.2: Main HOCS and LOCS developed by students during the resolution of the case.

TEAM	CATEGORY		
	A	B	C
1	HOCS: think critically, investigate and apply the knowledge. LOCS: describe and know, remember concepts	HOCS: reflect, analyze, investigate, argue, think critically, and explain. LOCS: compare and correlate State.	HOCS: conclude, make decisions, think critically and make value judgments. LOCS: remember and repeat concepts.
2	HOCS: explain, reflect and investigate. LOCS: describe and learn / remember concepts.	HOCS: reflect, analyze, investigate, argue, think critically, and explain. LOCS: compare and correlate	HOCS: conclusion and decisions. LOCS: remember and repeat concepts.
3	HOCS: not LOCS: describe and learn to remember concepts.	HOCS: reflect, analyze, investigate, argue, think critically, and explain. LOCS: compare and correlate State.	HOCS: conclusion and decisions. LOCS: remember and repeat concepts.
4	HOCS: explain and inferred. LOCS: describe and learn to remember concepts.	HOCS: reflect, analyze, investigate, argue, think critically, and explain. LOCS: compare and correlate State.	HOCS: conclusion and decisions. LOCS: remember and repeat concepts.

III. CONCLUSIONS

No doubt the use of case studies in the teaching of chemistry can contribute greatly to the process of learning for students of all levels. This methodology may include issues of a different nature, as for example, the scientific and scientific, approaches CTS humanistic and cognitive skills.

From the analysis of the reports submitted on the case, is may suggest that the students managed to mix human conditions and personal values, with the scientific concepts related to the activity. The importance given in the treatment the trainee indicates the idea of Freire[14] that education should be a human process. Perhaps this was not the priority for students, but for the solution of the case, these issues should be present in the reports. In addition, relations with the technical applications demonstrate the learning process developed during the resolution of the case, especially when the students explained the concepts involved.

He was also observed in the resolutions of the case, which students have developed several different cognitive skills. In certain situations the skills were of low order, as describe methodological procedures and materials used, remember the related concepts and leaching techniques employed, making decisions that were not a reflection on the results.

When explored the chemical concepts involved in the experiment for research, students were able to develop higher order cognitive skills, as for example, to think critically, inferring, and reflect on outcomes, contextualized, apply and evaluate different situations connections. Above all, students were able to relate the three axes of most of the explanations (macroscopic, submicroscopic, symbolic) chemistry, using causal relationships and scientific terms to build a broad, solid and critical learning.

Many of these considerations were influenced by the approach of experimental research, since students were developing specific skills, such as unfold the procedure for analysis, mounting devices, observe the phenomenological changes, analyze the data, to produce an informative report

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