Science, Technology and Society in Chemistry Learning

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Abstract. The aim of this investigation is the use of STS methodologies in Chemistry and emerges from the question: What's the degree of satisfaction and motivation of the students with an educational strategy centered in the resolution of problems related to the local environment and whose answers might be used in the scope of social politician decision making?

To answer the previous question this investigation developed different strategies of education learning with the following objectives:

- Evaluating the feasibility of a STS strategy of education in the current educative context;
- Evaluating the degree of satisfaction and motivation of the students to a STS strategy of education centered in problem-solving in real context;
- Evaluating the motivation and the performance of the students to a strategy of decision making based in previous investigations;
- Evaluating student's conceptual changes about description and characterization of Science and Technology and its Inter-relations with the Society.
- Contributing to the use and development of STS educational strategies in Chemistry teaching.

In this Work the methodology adopted is action-research and qualitative investigation.

The study took place in Chemistry class with 10^{th} degree students. When STS strategy was implemented, a common subject allowed the students to formulate several problem questions. Afterwards the students conceived, planned and executed the activities that could lead to answers to the questions they had placed. Finally the students used the results of their investigations in a decision-making episode designed to this specific situation.

All the activities developed in this work and student's conceptual and attitudinal changes were diagnosed and evaluated through diverse questionnaires, interviews and direct observation.

With this study we concluded that the students positively addict to this kind of STS strategies and are able to verbalize and clarified their personal views of Science, Technology and Society.

It is thought that this research will be able to contribute to the use and development of strategies in STS education, including decision-making episodes in Chemistry teaching.

Keywords. Decision-making episodes, science, technology and society education.

1. Introduction

Formation for the citizenship in a global world, influenced by Science and the Technology and influencing these, it passes necessarily for the education of sciences that we made in our schools. It seems us, thus, of great importance, to develop strategies that promote the participation responsible in a world where great part of the decisions involves scientific and technological questions (Yager, 1990; Fensham, 1992; Fourezetal, 1994; Jenkins, 1994; between many others).

A person with scientific and technologic literacy is, second different authors (Solomon, et al, 1995; Millar, 1996; Martins, 1999, among others) one that is capable, in a conscientious form, to present a critical position in relation to subjects that involve science, technology and society and to understand that the relationship between science, technology and society involves moral, ethical, social and ambient aspects.

This critical position requires, among other learning, the construction of images adjusted on science and the scientific work, as well as of experiences of conflict that promotes the necessity to take wised decisions.

It seems us, therefore, pertinent to place the question of how to implement CTS education in education of sciences, with sight to reach the goals and purposes behind related. What strategies can we use in our lessons to educate for science?

Despite innumerable works of diverse authors who point and strengthen CTS or CTSA education in Portugal, its implementation has not been easy. As it relates Martins (2002), exist some constraints

as diversity of meanings CTS, the organization of the education system and the purposes of the education in sciences in the some levels of education, the obstacles recurrent of the practical models and of formation of science teachers, the pertaining to school programs and the way as professors face them and, still, the school resources that translate visions of education and learning without a CTS orientation.

This situation took us to question about the viability of a work plan based on CTS Education where, without relinquishing the conceptual domain, could promote the development of citizenship abilities.

It is in this thematic framing that is developed this study. The component of Chemistry, in Chemical and Physical Sciences in 10th year class, was worked using diversified strategies, inside of which was presented a thematic project, "Water in Faial", from which the students had enunciated some problem-questions that had considered important for themselves, had designed activities in the attempt to find their answers, had developed those activities and had been citizens to an episode of decision-making. We intend to inquire the adhesion of the students to this type of strategies, as well as its viability about the level of difficulty, the management of time and the level of adequacy to the curricula goals.

Having in account the global context previously presented, relatively to importance and to the necessity of the education in science, on science and for science, we can specify the central problem of this study through the following question:

- **Which is the degree of satisfaction and adhesion of the students on an educational strategy centred in the resolution of problem-questions about their local place and whose answers, for found them, harness and facilitate the taking of social and political decisions?**

In agreement with the central question previously presented, for which we intend to find possible answers, they had been defined, for this study, the following goals:

1) To evaluate the one viability strategy of CTS education in the actual educative context;

2) To evaluate the degree of adhesion and satisfaction of the students to a strategy of CTS education centred in problem-questions on real context;

3) To evaluate the adhesion and the performance of the students to a strategy of taking of decision based for its investigative paths;

4) To evaluate the conceptual changes in the students in what concerns to the description and characterization of Science, of Technology and of its Inter-relations with the Society.

5) To contribute for the use and the development of CTS strategies in education, nominated of taking decisions.

Having in account the central question and the goals of the study, a inquiry-share plan was adopted on the basis of the following hypotheses:

1) The students involved in a CTS strategy of education will present attitudes more favourable in relation to Chemistry and to its learning.

2) The students involved in a CTS strategy of education will present a more structured vision of Science and Technology, as well as of its inter-relations with the Society.

3) The students involved in a CTS strategy of education will get better argumentation capabilities with a strategy of decision-making.

2. Methodology

2.1. Drawing and description of the study

This work was developed in Chemical and Physical Sciences class with a group of 10th year at the Secondary School Dr. Manuel de Arriaga, during the school year of 2002/2003.

The delineation of the action was made on the basis of the methodologies of the action-investigation processes. Thus, after diagnosed the problem, it were designed the strategies and was proceeded to their implementation. These phases had been succeeded in spiral, since new problems appeared that demanded new plans and other strategies.

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Implementation of the strategies and development of the activities

Soon in the presentation lesson when we talk on the works to develop in scope of Chemical and Physical Sciences class, was related to the students that we would like to them to consider a subject of inquiry related with its experiences or with the local context and that it hugged subjects of chemistry.

Before initiating this passage to them had been presented transparencies and a Power Point with a summary of the phases about how to plan a project (Milk, 1989) and propose the analysis and discussion of the presented documents.

The subject proposal that we present was the "Water in Faial". The students had divided themselves in six groups of work, according with their preferences and had started to place questions

that they liked to see answered. The work of group in this first phase was to delineate the excellent questions for each group, and to try to formulate them in a specific form.

In this phase they had initiated one work of planning their action, supported with documents, since contact to establish, research information, eventual laboratory work, asking for available resources, etc.

After the research of relevant information had been appearing some questions as: how to prepare a solution? What means concentration of a solution and how can we know it? What is a titration? What happens in a titration? How to use a burette? How to use a water analysis kit? What advantages and disadvantages have its use? How do we must proceed to collect the samples? Which are the characteristics of domestic water for consumption? Withes norms and legislation exist for domestic water for consumption? What it means VMR and VMA? What consequences for the public health and the environment if that norms and rules are not accomplished?, between many others.

These questions had been used as excuse for the exploration and discussion of the contents considered in official curricula and to search other information in agreement with students interests.

However, we made a meeting with their parents where it was explained to them what kind of work we are doing and that we wanted to share our work with them. A date was combined of presentation of the works with the parents, in agreement, also, with its availabilities.

The work was developed using varied activities and with diverse degrees of complexity, nominated, rank of hypotheses, drawing and/or accomplishment of practical activities, resource the diverse techniques to determine the concentration of ions, bibliographical consultations, planning and implementation of interviews, formal and informal contacts with local entities, research in the internet, consultation of norms of legislation and water analysis, etc.

Two extraction water holes were visited, the samples collected in these holes were analysed and other samples were collected in the taps of some points of the island.

They had been made diverse research in the internet on the consequences of the constitution of the canalizations to be, in its majority, of asbestos-cement and lead.

It was tried to establish contact with the responsible ones for the fish industry, situated in the Bay of Port Pim, to the exit of the city of the Horta, but these had prevented any contact.

After finding answers for its questions or to have concluded that they needed another one type of technical resources to get a reply, the students had initiated one process of writing of report of the developed work.

At this time, students had initiated the preparation for the presentation of its works to the parents. For this, they had made their presentation in Power Point to the parents, people in charge of education, professors and other people for invited them. The presentation elapsed in after-labor schedule and all the students had participated in the verbal presentation.

Finally it was presented to them an episode of making-decision elaborated from the problems diagnosed in result of their work. At this time, the groups of decision-making had been constituted by the teacher to be heterogeneous, with elements proceeding from different work groups with different questions so each one can gave complementary elements, arguments, information and experiences about their work.

In the end of these sessions of discussion and confrontation of ideas, all the group debated and made lists of possible consequences of each option; at this point they set a sequence of actions to the resolution of the problems of their local community.

Later, we invite the school community and three representatives of the Mayors Office: the Councilman at Entire Time and a Civil Engineer (both responsible for "waters") and one Engineer of the Environment. The students had proceeded, again, to presentation of the works and had requested to the invited people that tried to take the proposal decisions in the episode for them presented.

They had, thus, the chance to collate its decisions with the options of the three guests, who also they diverge between themselves. This process generated some debate and confrontation of ideas.

2.2. The sample

In this study, as already it was related, we use only one group of 10^{th} year. Although we have appealed to another group in the same year to compare their answers on the questionnaire of “Attitudes to Chemistry as Science and the Learning of Chemistry”, we do not possess given enough to characterize in accordance with same items that the work group.

As already it was related, the twenty one students who constitute the involved group in this work are all ages between the 14 and 17 years, being that the majority of the students (61,9%) had 15 years what

it means great homogeneity in terms of ages. These students were all boys in the Secondary Courses Predominantly Guided for the Continuation of Studies in Sciences.

2.2. The instruments

In agreement with the goals defined for this study, had been elaborated diverse instruments. We make, in this section, one brief description of the diverse ones.

To the long of this study they had been gotten elements of qualitative nature through the content analysis questions of descriptive reply, and quantitative nature through questionnaires.

The diverse instruments had been presented in the some phases of the process, as to follow if it indicates.

1. Questionnaire in the beginning of the school year

In the beginning of the school year, it was considered that each student filled a fiche of biographical register with some data staffs and with questions opened on its attitudes to discipline of Chemical and Physical Sciences (CFQ) and its conceptions of Science and Technology.

With this questionnaire, it was intended, for besides collecting personal data of each student, inventorying the conceptions they had, to the entrance of secondary education, on science, technology, chemistry, the education of chemistry, among others.

2. Questionnaire of Attitudes to Chemistry as Science and the Learning of Chemistry

The questionnaire of Attitudes was elaborated with the goal to try to evaluate the Attitudes of the students in relation to Chemistry as Science and to its Learning.

Since we intend to evaluate attitudes in relation to science, Chemistry as science in particular, and in relation to the learning of Chemistry, matters to clarify which dimensions, of predominantly affective nature, involved.

Some authors (Germann, 1998; Giddings, Hofstein & Lunetta, 1991; Sundberg, Dini & Li, 1994; Gogolin & Swartz, 1992) had used or suggested instruments multidimensional to measure different dimensions in the attitudes in relation to science.

Having in account it disciplines it, education subject and the developed strategies, we opted to elaborate one questionnaire to measure diverse dimensions. The questionnaire was composed for 25 items, all Likert type, with five reply options varying of *I disagree Totally* to *I agree Totally*. The majority of items were adapted of other instruments already existing (Araújo, 1995; Sundberg, Dini & Li, 1994; Gogolin & Swartz, 1992; Cardoso, 1998). The 25 items had been chosen in order to give indications on 5 attitudinal dimensions.

The dimensions of the questionnaire were grouped as follow:

A Sub-scale - Interest for Chemistry as science - it corresponds to interest of the students for subjects, programs, activities of Chemistry inside the school context and on professions related to Chemistry;

B Sub-Scale - Appreciation of the value of Chemistry in the society - disclosed by the attributed importance to Chemistry in understanding of the world and in the utility of its knowledge in people's life;

C Sub-Scale - Interest in relation to the learning of Chemistry - it corresponds to the interest and motivation of students in relation to the subjects, activities and time in the lessons of Chemistry and appraise for the tasks developed in the lessons - disclosed by interest of the student for the activities developed proposals and in the context of classroom.;

D Sub-Scale - Interest in relation to the laboratory work in Chemistry - it corresponds to the interest and motivation of students in relation to the laboratory work developed in Chemistry lessons.

E Sub-Scale - Judgment of the student on the personal capacity in learning Chemistry - what students feel in relation to its proper capacity in understanding the subjects treated in Chemistry lessons.

This questionnaire was applied first in one Another Group of 10th year (AG) and, then, in the Work Group (WG), to detect difficulties of understanding and to compare with our Work Group.

3. Questionnaire of Attitudes to our Chemistry Lessons

This questionnaire was elaborated in function of the developed work. The goal of this questionnaire was to know the students opinions about the utility or appraise for the developed tasks, concretely, during this work. Also we intended to diagnosis which the difficulties and the opinion of the students on the work of research and the episode of decision-making. In these two last questions, it was used same methodology that in the questionnaire related in point 2

4. The episode of decision-making

The episode of decision-making was conceived from the collection of concrete data gotten by the students in development of its work and other data for gotten us, next to Regional Secretariat of

Tourism, the Regional Secretariat of Economical Activities, of elements of the Environment Department of the City and of the Department of Oceanography and Fisheries of the University of the Azores.

This episode was made with the same orientation that Shal(1995).

2.2. Methods of data handling

The central body of this study seats in picture of the qualitative paradigm. Some of the instruments used can be treated quantitatively, but without statistical relevance, given the small dimension of the sample.

As indicating, in the questionnaires "Attitudes to Chemistry and its Learning" and "Attitudes to our Chemistry Lessons" the values were arrange of 1 to 5 for each reply, of the following form:

- items where the agreement corresponds the considered attitude more positive, had been quoted of 1, 2, 3, 4 and 5, respectively for the answers *I disagree Totally, I disagree, I do not agree nor disagree, I agree, and I agree Totally;*

- items where the agreement corresponds the considered attitude less positive, had been quoted in inverse way (of 5, for the answers *I disagree Totally* , up to 1, for the answers of *I agree Totally*).

For the purpose of treatment of the data, to get the quotation in each item, we determined the average value in each item e in the global scale.

In these two questionnaires we will use the following classification already used by Araújo (1995):

Classification of attitudes	Average Score
Predominantly positive attitude	**>3,5 and <5**
Ambiguous attitude	**> 2,5 and <3,5**
Negative attitude	**1 and <2,5**

Table 1. Classification of attitudes

The questionnaires with opened answers, like the "Questionnaire Integrated in the Fiche of Biographical Register" implemented in the beginning of the school year and the "Questions of Revision and Reflection about the Episode of Decision- Making", had been treated from prominence of words or key ideas.

These two questionnaires were useful to compare the definitions of science and technology and its relations with the society,that the students had to the entrance of Secondary education and after the development of this work.

3. Results – analysis and a discussion

3.1. Results gotten through the diverse instruments of work

1. Analysis of questions presented in the integrated beginning of the school year in the register fiche biographical

In relation to the concept that students have of science and of technology, the following questions had been placed:

"**Try to define your concept of Science"**

In the answers to this question students had shown that they never had thought to much on this subject, at least, they never had attempted to define, for writing, their concept(s) of science. Comparatively with a study made with students of 8th year (Carvalhinho, Gomes, 2001), the reply had been very similar.

"**Try to define your concept of Technology"**

To this question, the answers had been divided in two groups:

- Technology depends on science contributing, also, for its development;

- Technology is associated to equipments.

Also here, they had shown difficulties to state their concepts.

We also collect the information that Chemical and Physical Sciences classes, such as Science, are useful to understand and to study the world around us.

2. Analysis and discussion of the answers to the questions of revision and reflection of the episode of decision-making

To the question **"Considering work developed during the Chemical and Physical Sciences lessons, tell the importance, in your opinion, of the knowledge that the common citizen must to have on these subjects."**, the students had answered, over all, *it is important to know and understand science and to be able to give opinion.*

They had still related that it was important: *To act in political decisions (...to) grow our quality of life (...to) have conscience, to be informed, to know, to be informed, to change attitudes, to have knowledge, to participate asset e conscientiously in the subjects day to day, to know what is the quality of water we drink, to be along with everything, to know what one becomes, to be the forward or against the decisions, to be alert, to have knowledge, to know.*

It appears, thus, new data, almost all the students had related that the importance of the chemistry

knowledge for the common citizen it is that thus it can give opinions.

In relation to the question **"In your opinion, how the knowledge can become the citizens more participative in the decisions that affect the populations?"**, they had answered, over all, *that more knowledge implies greater ability to argue and greater capacity of intervention in public decisions.*.

They had also related that the citizens: *(can) to save and not to pollute the water, they can complain, they can to disclose itself, to act in the life politics, they are felt more active, more knowledge implies greater to be able of argument, to make propagandas, more intervention in the decisions, to question the responsible ones, to demand that they improve, to be active, not to allow that if it constructs without being duly inspected.*

Almost all the students assumed, in this phase, that the knowledge promotes the development of interventions and argument abilities.

In relation to the question **" Present some considerations about science: its characteristics, its methods and others that you find important,** they presented the following considerations:

- *the mental, bred level happens for the Man, to decide problems, it subjects to the change, requires tests, analysis of the tests with conscience, it happens due to curiosity and dissatisfaction of the being human being, mental, dynamic activity, change, studies the things, contributes to the development, answers the questions, is based on facts, studies them, it compares them, it evolves, it helps to decide problems, it is an orientation of the thought, to understand the environment, use experiences, to think about the future of everything, curiosity is the base of science, experiences and very study, to know what we are, different areas, everything can be influenced by science, scientific knowledge is not absolute.*

- Over all, *it happens in the mind human being and is subjects the change*

Almost all the students had assumed one to character much more dynamic and humanist in its definitions of science and it appears, for the first time, a reference the values that can condition work in science.

In relation to the proposal **"Present, of summarized form, a technology definition: its characteristics, its methods and others that you find important.,**

- *physical and material resources, it serves to help the Man to reach its goals, forms to increase its physical potential, aid in the development of science, ways, processes of electronically aid in the performance of tasks, machines, things, a way of to work.*

- Over all, *devices to increase the human potential*

Although they continue to relate the technology only with material resources, the used language is more careful and they relate that the technology is related with devices that they allow increasing the human potential.

In that it says respect to the proposal "**Present a small text with possible relations between science, technology and the society.**", they had related, over all, *science is helped for the technology to benefit the society* and they made, still, the following commentaries:

Is necessary the science to the technology go more beyond in things that go to be inserted in the society,

Science is an assistant of technology that is made use to help the society in the resolution of problems and in the infrastructure creation.

The relation between science, technology and society always appear that we speak of ethical problems, or either, questions as the case of the cloning, abortion, etc. In these problems it is the science that made those existence or resolution, is the technology who develop them and create and, finally, it is the society that condemns them, criticizes or supports. Therefore, it is science and the technology that makes to evolve the world and tries to discover the extremities, but it is the society that has an important and difficult paper to define the ways.

In this last reply, it appears, for the first time, the society as regulating the science and of technology.

They presented a positive image of science and continue to consider that science and the technology depends one on the other for its development.

3. Questionnaire of attitudes face to the work developed our Chemical and Physical Sciences class

The activities that students liked more to develop were *field exits* and *laboratory work* . It is was not a surprise because therefore these contexts of learning are less frequent in their lessons and are, simultaneously, more informal.

But what they liked doesn't correspond to what they considered more useful as a student. The activities more related by them were "*the teacher purposed research work ", "the teacher did exercises on the board "* and " *they did exits field to collect samples and/or information ".*

It is interesting to verify that the students had considered of bigger utility the activities where the process was more centered in the teacher, what

denotes, still, few habits of autonomous learning and little security on their individual work.

They liked too "*they had been argued in group the problems to investigate ", "activities had been developed laboratory to investigate the constitution of the collected samples "* and "*teacher explained subjects from de books"*.

What they considered more useful for its personal formation was *"contact with local entities for collect information "*and *"discussion, using valid arguments, to find the best final decision "* (in the episode of decision-making) e *"discussion, in group, of the problems to investigate"*.

Making a final rocking, considered activities more useful they had been, of followed *"the exit field to collect samples and/or information "* e *"the teacher purposed research work "* to follow it appears " *the teacher did exercises on the board "*. These two last ones had been considered useful as, but they had not been much appreciated.

The activities "*contact with local entities for collect information ", "discussion, using valid arguments, to find the best final decision* "also had been considered useful.

The considered activities less useful and that less they had liked they had been "*the students did exercises on its places"* and *"the teacher explained subjects of the book"*.

It is interesting that the work group considered more difficult "*to design the activities "* and to follow , as well as *"to present possible consequences in the episode of decision-making "* of that *"to understand concepts ","defense of the arguments in the work of decision-making ",* he was not considered difficult, therefore, in this phase, the students already had made one listing of the positive and negative consequences.

In accordance with the data that they had been being collected to the long one of the study, these students never had developed works of this type and as, to develop them, it was necessary great capacity of organization, work and initiative, some had considered them difficult. We verify, also, in elapsing of the process, that the phases that had excited those greater difficulties had been the planning of activities and the writing based and organized of the report of the work.

4. Answers to questionnaires of attitudes to Chemistry as science and the education of Chemistry

To get some comparative information we applied this questionnaire to another group in the same school level. This group was the only one we have and we consider important to relate that its options were Chemistry Laboratorial Techniques and Biological Laboratorial Techniques, and our group options were Education Sports and Chemistry Laboratorial Techniques.

Of followed, we present table in table 2 the results that translates the score average to the 5 attitudinal dimensions evaluated through the questionnaire of attitudes face to Chemistry as science and to learning of Chemistry in the Working Group (**WG**) and in Another Group (**AG**) and the Difference between these two **V**alues (**DV**). Table 2 shows the predominance of attitudes (positive, ambiguous or negative) of each one of the groups in each dimension using the same criterion that Araújo (1995), related in section xxx of this study.

Sub-scale/ Dimension	**Work Group (WG)**	**Another Group (AG)**	**Difference between Values (DV)**
A - Interest for Chemistry as science	**3,81**	**3,15**	**0,66**
B - Appreciation of the value of Chemistry in the society		**3,60**	**0,47**
C - Interest/motivation to the learning of Chemistry and to the activities developed in Chemistry lessons	**3,82**	**3,24**	**0,58**
D - Interest/motivation in work Laboratory	**4,43**	**4,50**	**-0,07**
E - Judgment of the student on the personal capacity in the learning of Chemistry	**3,64**	**2,88**	**0,76**

Table 2. Predominance of attitudes in the 5 dimensions

In the Work Group (WG) all the dimensions present predominantly positive attitudes on the part of the students.

In Another Group (AG) only corresponding dimensions to sub-scales B and D present attitudes predominantly positive and in the other sub-scales they present attitudes ambiguous.

From the analysis of these data we cannot guarantee that the attitudes of the WG had modified after development of the works for considered us, but the collected elements to leave of the other

instruments of work, nominated, the interviews, they point in this direction.

3.2. Discussion of the results

Comparing the elements collected in the questionnaire implemented in the beginning of the school year in the fiche of biographical register with answers given for the students in the revision fiche and reflection of the episode of decision-making, we can weave the following considerations:

a. In the end of the intervention they had related that chemistry provides knowledge that the citizens allow to be able to give based opinions and that it provides greater argument capacity to them intervention.

b. To the entrance of secondary education, these students, they presented naïve and very poor conceptions of science in a social context and without human values. In the end of this intervention they had assumed definitions much more dynamic and humanist of science and, in some cases they put values in scientific decisions.

c. Although they continue to relate the technology only with material resources, the language that they had used was more careful and they related that the technology is related with devices that allow increasing human potential.

d. In the end of the intervention they relate, for the first time, society as regulating of science and the technology.

e. They continue to present, of a general form, one very positive conception of science.

In that it says respect to attitudes face to the lessons of Chemistry, are interesting to verify that the students they had considered of bigger utility the activities where the process was more centered teacher, what it denotes, still, lack of security and habits of autonomous learning, or the more comfortable and less laborious fact of being not to have that to carry out the processes.

In relation to the attitudes face to Chemistry as science and to the learning of Chemistry, we consider that the works developed with the students, even so devotion e has demanded them sufficiently persistence, had also increased them the auto concept in the processes of teach-learning in Chemistry.

4. Conclusions

It is main intention of this study to find reply for the question enunciated in the beginning of this work: **Which is the degree of satisfaction and adhesion of the students on an educational strategy centred in the resolution of problem-questions about their local place and whose answers, for found them, harness and facilitate the taking of social and political decisions?**

Being conscientious of the meaning and implications of science as social construction e considering that the two great goals of CTS education are:

- The analysis and demystification of the social paper of science and the accessible technology to become them understandable and interesting to the citizens;
- The social learning of the public participation in the decisions related with technical and scientific subjects.

To find an answer to our central question, we implemented strategies and methodologies of work that, even so, were not strangers; we had never used in a consistent and based form. In this direction, we had that to define them, to characterize, to design and to apply and, thus, our study could contribute to reach a more general goal - *To contribute for the use and development of strategies of CTS education, using of decision-making episodes, in the education on Chemical and Physical Sciences.*

They are presented of followed the conclusions of the study, having in account the hypotheses and goals previously defined:

C_1 -Relatively *to the viability of a strategy of CTS education in the current educative context,* evaluated only for the difficulties of implementation of these strategies adjusting them it the programs in vigor and to the material and human resources existing, we verify that it is necessary a bigger involvement and investment of the teacher and, even so they are reasonable in the related context, create great difficulties in the management of the time.

C_2 -In relation *to degree of adhesion and satisfaction of the students to a strategy of centered CTS education in problem-questions in real context,* we feel, during of the process some distinct moments. First some students had shown some reticence e a certain discomfort for having to take initiatives and design its proper activities, but when we start to advance in the processes of inquiry in the land, to discover new problems and to collect information unexpected, the enthusiasm was generalized. These appreciations that we make here confirmed by the results gotten in the questionnaire of attitudes in relation to the lessons of Chemical and Physical Sciences.

C_3 -In that it says respect *to the adhesion and the performance of the students to a strategy of taking of decision based on their investigative works,* the

students demonstrated great involvement in discussions in decision-making process, therefore being the heterogeneous groups of decision, or either with elements proceeding from different work groups, all wanted to share the information that they had collected and they wanted to know what the others "had discovered". These considerations on its adhesion to the process can also be confirmed through the results gotten in the questionnaire of attitudes in relation to the lessons of Chemical and Physical Sciences.

C_4 -In that it says *respect to the conceptual changes in the students in whom it says respect to description e characterization of Science, the Technology and its Inter-relations with Society*, we verify that their conceptions of science and relation between science, technology and society had become less naive, more dynamic and flexible, but we consider that it is not only in a period of few months of work that modifies and integrates so complex conceptions and relations.

C_5 -In relation to our hypothesis that *the students involved in a strategy of CTS education will present more favorable attitudes to Chemistry and its learning in Chemical and Physical Sciences class, in the set of the attitudinal dimensions*, this study took us to conclude that this hypothesis was verified, but we present many limitations, given here the differences between the groups and the lack of data relatively to our group of work before intervention. Any form, the results that we got in the questionnaire of attitudes to Chemistry as science and the learning of Chemistry can lead us to confirm our hypothesis.

C_6 -The hypothesis of that *the students involved in a strategy of CTS education will present greater capacity of argumentation in a strategy of decision-making*, was not confirmed, even so we noticed a significant difference in the answers of students given in the revision fiche and reflection of the episode of decision-making. They proper had related many times that knowing the subjects and discussing them can take them intervention citizens and bring to them a bigger capacity of argument.

In summary, with the results of this study, we conclude that the degree of satisfaction and adhesion of the students to a strategy of education centered in the resolution of problem-questions about local issues and whose answers, found for them by they work, was very good.

The particular context where our study was carried through, the very small sample, the access lack the groups equivalents for comparison of results, the short period of time where it elapsed, the characteristics of the instruments, are examples of some of the aspects that constitute limitations of this work.

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