

# **Production of Pedagogical Material and Chemistry Teachers' Formation.**

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## **INTRODUCTION**

The Chemical Education Area (AEQ) of Chemistry Institute (IQ), Federal University of Rio Grande do Sul (UFRGS), has been developing teaching, research and extension activities since its foundation, in 1989. These activities aim at combining actions for the enhancement of Chemistry teaching quality. In an attempt to contribute with the social commitment the university should keep with education, we directed our activities towards primary and secondary schools, as well as higher education institutions of Rio Grande do Sul state, and educational institutions of other Brazilian states and from neighbour countries such as Chile, Argentina and Uruguay.

Most of difficulties found when trying to develop a qualified Chemistry teaching are related to the contents inadequacy to students' cognitive development conditions and their distance from the students' interest, invariably linked to their daily life (Goulart, 1989; Herron, 1975).

Strategies for soothing problems of Chemistry teaching require necessarily the teacher's involvement, once he/she is the main articulator of the teaching and learning process. We also assume that any change for better scientific, social and political teaching methods qualification must undoubtedly go through teachers view, mainly of those from state schools, financially aided by the government (Schroeder, Del Pino, Salgado e Krüger, 1995).

Through the work with teachers and their reality within schools, AEQ has been triggering proposals that aim to restructure curricular and methodological bases of Chemistry teaching. This kind of action has been implemented, for example, through specialisation courses on Chemistry teaching, and extension courses.

AEQ proposals kernel is embedded in a pedagogical model of *building up education through Chemistry teaching*. However, we assume that in order to make this model feasible, a joint production of didactic material as an alternative for the traditional textbook is necessary, once these kind of books are inadequate to the proposals we have built. Moreover, they are not complete enough when used in traditional teaching methods.

Our didactic materials, different from the traditional ones in thematic and approach, use daily life topics as guidelines for Chemistry teaching. We believe “*a Chemistry in use is useful for the*

*student. It must be a daily-life-chemistry, characterised as an application of the chemical knowledge framed in the search for explanations that make easier the understanding of chemical phenomena present in several daily life situations”* (Chassot, Schroeder, Del Pino, Salgado e Krüger, 1993). We should then take into account that socio-historical construction of knowledge, students’ and community’s interests, as well as implicit knowledge the student has built in his lifetime are fundamental for the curricula construction.

Besides, the approach our material provides gives special treatment to reasoning development through the use of active methodologies derived from the constructivist conception of knowledge, which enable the development of activities that make the student build knowledge through planned actions with increasing difficulty (Osborne & Freyber, 191). Thus, teaching strategies associated to a differentiated content make possible the development of abilities that may help the student to formalise concepts, as well as to reach a wider learning level or a more refined reading of reality. For example, abilities such as measuring, observing, comparing and building representations may contribute towards the interpretation and analysis of other situations that involve more complex knowledge (Moraes & Ramos, 1988). For all this, it is important to guarantee a significant learning to the student, unlike traditional, which is mechanical (Novak, 1988).

Our production of didactic material is based on actions started at different periods of our history of contribution in the Chemistry teachers formation. We characterise this production in three different moments.

First materials were produced internally in AEQ with the aid of UFRGS Chemistry Licensure Course<sup>1</sup> students, who held research assistant scholarships. At that moment we started a continuous process of didactic material production. During this period we approached different Chemistry contents such as Waters (Lopes, Zago Neto and Krüger, 1996), Air Pollution (Del Pino, Ferreira and Krüger, 1996), Electrochemistry for Secondary Courses (Krüger and Soares, 1996), Modules for Radioactivity Teaching (Eichler, Calvete and Salgado, 1997), Working on Chemistry of Soaps and Detergents (Zago Neto and Del Pino, 1997).

We disseminated these proposals and distributed the material freely during teachers’ meetings, as well as used them in our own course, and in specialisation and extension courses. This has enabled a good involvement of teachers in the proposition and production of other didactic materials.

A second stage of production is related to the Specialisation Course on Chemistry Education, a post-graduation that requires a monograph as final work. Some works stressed the development of new proposals for the accomplishment of other curricular grids. This way, new didactic material

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<sup>1</sup> N.T. In Brazil, licensure and training to teach are granted at university level courses, in opposition to the so called bachelor courses, which in general focus on pure research.

was brought about: Chemistry, Health and Drugs (Vieira, 1996), Chemistry and Iron and Steel Metallurgy (Romeiro, 1996), and Pesticides Chemistry (Carraro, 1997).

Didactic material developed along these two first moments was also used in extension courses carried out by Education Boards (*DEs – Delegacias de Educação*) of the metropolitan area and countryside. The third moment of didactic material production resulted from this joint work.

A project arranged by UFRGS Extension Department, through the Integration School-University Nucleus (PROREXT/UFRGS, 1994), developed qualification courses on Chemistry teaching in some Rio Grande do Sul state towns, reaching a total of 125 teachers. At the end of these courses, teachers-students should present a final work, individually or in groups, that would qualify their teaching practice. This work could, for example, focus on a proposal for one Chemistry topic presentation or for a new curriculum development in their schools. Such courses originated 25 proposals of work that made up a reference collection for the production of new didactic materials. Some of these proposals show teachers' initiatives of a) reflecting about their teaching practice; b) looking for alternatives in order to change contents and teaching methods; c) composing new curriculum grids; or d) writing didactic material and use them with their students.

However, most of times the initiative did not result in good written works, because they lacked 1) justification and discussion of the reasons which led the teacher to choose a certain profile for his/her proposal, both in relation to topic and methodology; 2) description of the proposal development, for example, in the sequence of Chemistry contents, highlighting the contents specific of that topic, as well as the way they are related; 3) description of activities previewed for teachers and students (readings, exercises, experiences, graphics, tables, etc.); 4) results achieved with the proposal application; and/or 5) the curricular grids proposed or material applied.

These problems may be partially attributed to the lack of preparation and experience in the methodology and didactic material the method requires, as well as in taking part of curriculum elaboration processes. Besides, most of times teachers are compelled to undertake ready proposals and contents presented by the textbook.

This way, we understood that re-elaborating or restructuring some of these works would enlarge the availability of alternatives for classroom practice. They could be disseminated at teachers' meetings and used in several activities promoted by AEQ, such as the next editions of extension courses. This work of retaking the didactic material production was fostered by the *Fórum das Licenciaturas* project, promoted by UFRGS Undergraduates Department. This Forum aims at assembling all licensure courses in order to rethink the formation of future teachers and their insertion in primary and secondary teaching levels (PROGRAD/UFRGS, 1996). Thus, a circle that aims at improving the Chemistry teaching practice closes, and through it we will decrease the gap between teacher's eagerness to teach and students' real learning.

## METHODOLOGY

Firstly we analysed the proposals presented by teacher-students of the extension courses and, through a critical reading we selected proposals presented in Table 1. Selection was undertaken taking into account the following characteristics 1) a specific topic in Chemistry or curricular grids permeated or guided by a generator theme focused on the student's reality; 2) orientation for a Chemistry teaching that stresses understanding, reflection, criticism and judging, that is, the students' activity, and 3) authenticity and internal consistence (that is, not only a copy of loose and disconnected texts).

In a second phase we elaborated and applied surveys about each selected proposal. We sent 41 forms, one for each teacher-author of these 15 selected proposals. Such proceeding aimed at informing teachers about our project and asking for their collaboration for further details on their proposal, if that was the case. This aimed at integrating them in the material production.

Although teacher's participation in our project was not full, survey answers helped to choose two generator topics that were transformed into didactic material. They were "Milk" and "Natural Dyes for Wool Dyeing". The first was chosen due to the great amount of proposals on that topic, making evident its importance, and also because of the high quality of one work presented. The second was chosen due to its insertion in the main economic activity of that community (João Arregui, a rural community of Uruguaiana town, one of the greatest producers of wool in Brazil). Students in the last year of primary school developed tints and techniques for wool dyeing for the local co-operative. Craftsmen rewarded them showing spinning and weaving techniques. This way the student could associate the content with his/her local reality, and experienced the results of that study.

Table 1 – works presented at the end of qualification courses on Chemistry teaching

TITLE	TOWN	TOPICS
Chemical Additives	Lajeado	Kinds of Additives, composition; acids; characteristics
Alternative Method for Chemistry Teaching	Lajeado	Curricular program
What's rubbish after all?	Lajeado	rubbish production, garbage classification
Project of 8 <sup>th</sup> Grade <sup>2</sup> Sciences Teaching through the Production Process of a Cheese Industry	Não-Me-Toque	Pure substances and mixtures; separation processes; substances properties; acidity; chemical reaction; thermal energy; reactions speed; dilution;

<sup>2</sup> N.T. Last year of primary education. Students are in average 13 years old.

TITLE	TOWN	TOPICS
		combustion
Digestion Chemistry	Ronda Alta	Digestion mechanisms; digestive tract functioning; food break down; calories; carbohydrates, lipids, proteins, minerals and vitamins; feeding habits
Integration of 8 <sup>th</sup> degree Physics and Chemistry Contents	Chapada	Development of Chemistry and Physics contents through the process of spirits production
Food Additives	Santa Bárbara do Sul	Additives classification; characterisation; usage effects
Soap Preparation	Santa Maria	Saponification reactions; soap preparation
Bees	Faxinal do Soturno	Beehive social organisation; bees products and their action in the human organism; honey composition
Drinkable Water and Industry	Santa Maria	Water mineral composition; purification
Milk Study	Santa Maria	Milk composition and chemical analysis
Milk Chemical Analysis	Uruguaiana	Milk composition and chemical analysis
Obtaining Natural Dyes For Crude Wool Dyeing	Uruguaiana	Wool washing; dyeing process; dyes preparation
A proposal of Chemistry guidelines – First Year/Accountancy course	Três Coroas	Inorganic functions; pH; chemical reactions; reactions speed; organic composers
A proposal for Sciences teaching – 8 <sup>th</sup> degree	Sertão	Pure substances and mixtures; milk as a mixture; mixtures separation; substances preparation; pH; reactions; energy

The two topics chosen were expanded. Students of the Chemistry Licensure Course who participated in the *Fórum das Licenciaturas* helped to carry out this task, generating two new didactic materials Analysis and Identification of Milk Samples (Barbosa and Eichler, 1997) and Natural Dyes in Dyeing processes (Eichler, Pellenz, Barbosa, 1997). Later, we sent these materials to all teachers who had taken part in the project – the same who received the questionnaires – so that they made an appraisal, guided by a questionnaire composed of two sets of questions: one about the didactic material, its applicability to their school reality and the relation with contents the teacher is used to approaching in the classroom; the other about the proposal of material joint

production by teachers of different school levels. These questionnaires were later assessed, and this is the focus of this paper. In the next session, teachers' answers will conduct the report of these assessments.

## RESULTS AND DISCUSSION

Surveys evaluation aimed at checking teachers' position in relation to the material produced and their interest in going on with this integrated elaboration of new material. However, for different reasons, we verified that it is very difficult to integrate teachers in these actions. For example, there is a great rotation of personnel in teaching activity. During the project performance, 40% were dismissed, retired or moved to another town. Among those who continued teaching Chemistry, only 30% took part in the evaluation phase. The lack of time was the main reason for the small number of questionnaires answered. When contacted by phone teachers said: "*I am upset for not having answered the survey, but I did not have much time, I am teaching in the morning, afternoon and night*" and "*I would like to have answered it, but time has gone by and when I realised, deadline was over, so I ended not answering*".

In relation to applicability of the material to the school reality, 70% considered the issue about milk a generator topic integrated with the community and region economy: "*most of primary and secondary school students live in the rural area and sell milk, this way it is easier, because it is something that is part of their reality*". They also considered the proposed experiments help the student to recognise milk quality "*I myself perform many of the experiments mentioned because most of our students are farmers' sons and daughters and work with milk*" and mentioned the experiments are possible to perform in their school lab: "*milk treatment, formaldehyde, ammonia, caustic soda, or potassium ... it is easier to perform this kind of experiment with milk samples because it is a familiar product to all students and they are able to work with this topic ... besides, our lab has all substances and material required for this experiment*".

43% considered the generator topic *Wool and Natural Dyes* should be included in the school curricular grid. That is because this topic is related to students' daily life: "*this material is very useful in our work with students because in our town there are many craftsmen ... in relation to dyes, we can perform natural dying with vegetable specimen we have here*". Besides it is a Chemistry discipline topic: "*we associate the school Organic Chemistry content to this material*", as well as of other disciplines: "*I found this work interesting, I can work with it also in Biology classes, during vegetables study (dyes)*". Thus, the topic was considered integrator of different disciplines contents.

However, when they considered the material was not suitable to their pedagogic proposal, it was mainly because the topic was not connected to their reality: "*in our region our community almost*

*does not develop activities with those products. These topics would be far away from the students' reality".*

This way, justifications presented corroborate with one of our proposals. We understand didactic material should be differentiated according to its usefulness, and must be related to the particular social, economic and cultural characteristics of the school geopolitical reality. This is intensified in some especial cases. For example, on the one hand, a teacher who works in the urban area of Santa Maria asserts that the material is not inserted in their school reality because "*the school is central. Student's reality is turned to PEIES<sup>3</sup> entrance exam*". On the other hand, another teacher in the same town, but who works in the rural area, asserts the opposite "*most of the students live in the rural area, their families sell milk*".

Other data refer to the proposal of didactic material production by teachers of different school levels. We understood this integration could happen through topics proposals, and discussion about restructuring and applying these proposals, once such issues are directly linked to the teaching activity. We verified through the survey how teacher realises the importance of his/her participation in a project of this nature. Teachers' reports, for example, made evident that "*this integration among three school levels is important because a continuation of topics developed in primary school may be applied to other levels*". Thus, initiatives like these we developed were fully accepted by teachers, who considered they are integrators of teachers from different levels. They considered also that this integration is an important factor in the process of teachers continued formation because, as he realises the need of getting involved and the importance of participating he/she understands the work is "*great, because more than anyone, teachers have conditions of creating proposals and developing them with their students*". Besides, the teacher understands the relation of this kind of works with the improvement of the students' learning process because "*proposals like these are necessary for us to get a better improvement of the student's learning*" and "*I think it is great, because the teacher knows what interests students, the region, and schools*".

Finally, we verified that reflections of this kind make the teachers to criticise their formation course because "*the university should prepare professionals with more practice, more experience in their ideals, and not only throw theoretical contents on their heads*". The initial period of studies is a moment that requires understanding of a high number of information, in a short period of time. Therefore, practical application relation with daily school life and didactic transposition almost do not exist. This fact enhances the traditional teaching practice continuation: theoretical classes without the student's participation. So, when the individual undertakes the teacher's role, he/she

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<sup>3</sup> PEIES stands for Special program of Higher Education Entrance Exam. It is developed by Universidade Federal de Santa Maria and it is an alternative university entrance exam. The program consists of tests accomplished by the University, at the end of each high school year, focusing on topics the University selects.

does not feel able to perform a pedagogic autonomy, and do not believe him/herself authorised to perform the production of his/her curricular grid or didactic material. This way, we realise in teachers' talk the wish that "*the university promotes meetings and seminars with the three school levels, and creates a program of minimum contents to be developed in each level, resenting also experiences collected from participants*". That is, teachers delegate the university a role it is theirs, different from what we intend: that the teacher considers him/herself the main operator of the curriculum formation in their school. Partly, teachers justify their passiveness because of an inadequate formation, as one of them suggests "*first of all, I think this work should be applied to undergraduate students, because it is where teachers are formed. My course did not have this approach*". They also complain about the lack of opportunities to improve their abilities in school, as other teachers expressed "*to elaborate a reduced period for theoretical classes, leaving more time for teachers participating in courses, refining courses and even in joint projects with the university*" and "*keep the courses divided by Education Boards, assist teacher in school, supply an introduction to secondary school research activities*".

## **FINAL CONSIDERATIONS**

There are many different proposals turned to teachers formation. We consider this one presented here is feasible. However, in order to make it real it is necessary to perform projects in partnership with municipal and state education boards and with the university. Moreover, it is required that each part undertakes the commitment of opening more space for teachers within schools, in a way that actions proposed here will be significant in this context. For example, in the first two moments of material production, reported in this paper, we verified that good relations between professors and teachers took place. This way, we consider we reached the objectives of didactic material production as a strategy of teachers' formation because we could match the teacher-student's interest and availability with our proposals of continued formation courses.

However, when this partnership begins to require an institutional dependence, which is linked to governments policies of different geo-educational spheres, an adverse situation in the project development takes place, as reasons presented by teachers show clearly.

Thus, even undergoing this adverse situation, we consider the project provided good instruments for teachers to use in their professional activity and, in different levels, they were motivated to elaborate some kind of proposal that counted on the production of didactic material, focused on their school singular features. We understand that putting these works together makes possible to organise a library, which configures a collective product of work and reflection of the teaching

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N.T. In Brazil, high school is composed of three years. After that, the students who intend to enter a University course must go through an examination.

practice of different individuals acting within the education system. New information and communication technology allowed the free availability of these materials. For search and distribution, look at [www.iq.ufrgs.br/aeq](http://www.iq.ufrgs.br/aeq).

Note that our last period of didactic material production comprehended university teachers and primary and secondary ones. They produced proposals that went to the university, where undergraduate students worked on the conceptual and methodological adaptation of the topic proposed, developing a new application for them. This allowed the production of other didactic materials that were and still are used by other teachers and in new editions of teachers formation courses.

Eventually, we understand through the description presented that there are many stages involving the didactic material production, but all of them converge to the teacher's involvement in their professional qualification. Evolving in an increasing movement that aims at improving the teacher's work quality and, consequently, his/her students' formation.

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