

# “Teaching Science by Experimentation: *Hands-on* method”.

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**Abstract.** *The implementation of the method here described, was motivated by the lack of interest students showed towards school, as well as the difficulties they demonstrate in the learning process, most of the times associated to the absence of methods and study habits, as well as family background, which could hardly sustain any different attitude regarding school. These students showed the lack of previous knowledge that should be acquired in the previous years, namely in the preceding school year, were the syllabus was only accomplished in half of the planned.*

*During the school year of 2003/2004, some of the classes of the basic school (formed by students between 12 and 15 years of age) of Fermentões – Portugal, had Physical Chemistry lessons, in which the approach to the curriculum contents was made in a experimental way, where the objectives for every class were fulfilled, rising as conclusions that students formulated, as the outcome of their work.*

*This way, during the Physical Chemistry classes, the students were divided into small groups. In a first stage they followed the steps described in a lab protocol, using few materials that they had to choose, among a pre-selected group (the implementation of the activity was followed by the teacher, who also provided some help); in the end, after the students register the observations, they discussed the results and tried to reach a conclusion.*

*The great success of this method is related with the fact that possible wrong hypothesis could be tested right after their conception and in this way, by application of the scientific method, the expected conclusions were obtained.*

*Near the end of the class, in a few minutes, the teacher systematizes student's conclusions in a structured way, so students could establish them in a meaningful approach.*

*During the school year, the teacher's role got less important, and the students took the leading part in classroom action, performing their activities with a rising level of autonomy.*

*Concerning the evaluation, the results allow me to conclude that with this method, the students are capable to learn faster, in larger proportions, and in a meaningful way, because they show the*

*capacity to apply the abilities they learned during the classes to the every day situations.*

**Keywords.** Science Education, School, Hands-on experiments, scientific method, meaningful approach, learning autonomy.

## 1. Introduction.

During the school year of 2004/2005, in the Basic School of Fermentões, I chose a different set of teaching strategies, very different of the ones I used until then. The motives that led to this choice are described in this report, as well as its results.

## 2. Causes leading to the experimental method implementation

### 2.1. Social-economic situation of the school community

The Basic School of Fermentões is inserted on the outskirts of Guimarães City that has a population that derives mainly from families with meager economic resources, who also present serious dysfunctions regarding family structure (for instance unemployment, alcohol and/or drug abuse), which contributes to the lack of conditions for the students' learning process.

It is also important to mention that most of the families are composed, generally speaking, by four to five people and the students live with their parents.

The families are mainly derived from poor to median social-economic backgrounds. Most of the mothers are house or textile workers, while the fathers are mostly secondary sector laborers, mainly textile workers. Most of the parents in charge of the students' education possess a very low scholar degree, having only the initial school years. Most of the students have needed financial aid that is awarded by the government.

### 2.2. The students

While as the object of the teaching/learning process, the students, in an early stage, didn't show suitable conditions for the good developing

of this process; the main characteristics of our students are:

- lack of habits, methods and organization regarding work, which are not the desired by the students, in spite of the assisted study area efforts to help them to optimize these aspects;
- difficulties regarding writing and speaking, as well as reading and text interpretation;
- lack of previous knowledge, mainly regarding contents related to Mathematics;
- lack of scientific curiosity, as well as reduced critic/observation capabilities;
- general lack of motivation, resulting in interests other than school;
- lack of social, cultural and/or professional ambitions.

All the previous aspects are combined in a general lack of interest in the learning process, developed in the classroom. It is also important to mention that some students are under the 319/91 Law (students with special education needs).

As a result of a global analysis of the classes, we can conclude that they lack mainly participation, possess several difficulties regarding learning and concentration and have interests and motivations which do not regard school.

### 2.3. The Curricula: minimal objective accomplishment

For students with such difficulties, the accomplishment of the various curricular plans becomes hard. Frequently is not possible to introduce all the contents that are part of the National School Program for these school levels, making necessary to take certain choices. But, when the levels of unaccomplishment take larger proportions, the demand for new solutions becomes crucial.

When we arrived to this school, we saw that the teaching programs were given up to 50% of its total, which made our task even more challenging. Considering all these motives, a “hands on” teaching model was generated.

### 2.4. Method description

This way, during the Physical-Chemical Sciences classes, the students were separated into groups of two. In an early stage, they followed a protocol using the materials that were previously selected by the teacher (who followed the implementation of this protocol); at the end of the work, the students would register their

observations, as well as formulate theories regarding them.

The great success of this method is due to the fact that the wrong theories are suitable to be tested after their elaboration, being possible, this way, through the application of the Scientific Method, to reach the correct and expected ones.

At the end of the class the teacher would display the contents in a sequential and organized way, allowing the students to arrange them in a functional and meaningful way (such as a concepts map).

During the school year, the teacher’s role fell to a secondary place, where the student assumed the leading position, carrying the tasks with greater autonomy.

The results, regarding continuous evaluation, allow me to conclude that, in fact, the students managed to learn in a more significative way, as well as regarding the quantity of retained concepts (they became more capable of directing their learning and applying it in school and regular day situations).

### 2.5. Results

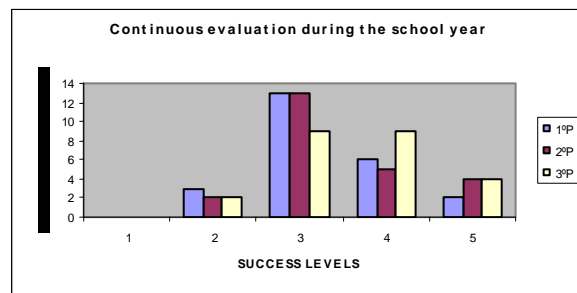
It was hard to mobilize the students, in the early stages of the process, making us wonder if this was the right approach.

Never the less, after about a month of experience, the students started to perform in class as intended: assuming the leading role.

We can conclude that, at the time of the preformed learning evaluations, the experimental practice showed itself useful, as the students demonstrated applying the acquired knowledge being made easily.

During the evaluation exams it was clear that the students became capable of fluently mobilize the acquired knowledge, where the experience allowed them a significative learning, having the contents became more than words, but objects with meaning and sense of fulfillment.

The chart bellow represents the evolution of the evaluation results during the school year.



Regarding the success of the learning process, as we could see in the previous chart, it is possible to conclude that, in addition of the decrease of scholar failure, we also managed to raise the scholar success to very satisfying levels.

## 2.6. Evaluation

A teaching strategy should only be preformed in a continuous manner if, through it, the number of retained knowledge by the students is effectively reached; any strategy should not be applied regardless of the final results.

An important factor for this strategy evaluation, besides the continued evaluation, was mainly the manner in which the students behave during class.

This behaviour doesn't result only from their discipline, but more important, their way of responding to the development of the classes: participation, curiosity, observations, conclusions, etc.

It is very satisfying having students who find important to participate, thrilled with what they observe and mainly with what they experiment; it is not needed to impose the activities, which are sufficiently appealing for themselves, in order to make the students more concentrated, becoming possible for them to carry out and reach their own conclusions.

It is our conclusion that the possibility of experimentation, confirmation of theories and mobilization of the acquired concepts are fundamental for an effective learning process and knowledge consolidation.

## 2.7. Conclusion

We consider that teaching by an experimental method is, in fact, a powerful ally in the task of forming, educating and transmitting contents and attitudes, like those that are present in the Science domains.

It seems unlikely to us that it's possible to perform such a noble task, specially near the minds of the youngest, if all the transmitted knowledge cannot find the support for the realization, experimentation and verification.

There is no greater satisfaction for a teacher than seeing the evolution of his students, their development as individuals capable of undertaking what we offer them to learn - for us, while teachers, we found in this way of performing our task, something extremely fulfilling, which drives the teacher to carry out his duty in a truly excited way, just like our students.

We recognize that this method of teaching requires a more exhaustive preparation of the classes, regarding the selection of materials, the learning of a conduct (relatively to laboratory work) by the students, creation of support materials used in class, etc. After a certain adaptation to this new method of teaching, regarding teachers and students, its application becomes natural, occurring a certain generalization of the process.

In order for the results to last and be noticed in the higher school levels, it is necessary that this kind of activity is preformed continuously, that it exceeds its character of exceptional, allowing the students to be capable of, in any given circumstances, to mobilize their experimentation conduct, interacting actively with the observations in the daily environment.

Referring to Piaget, to know an object is to be capable of acting on it.

## 8. Acknowledgement

This work enrolls in the frame of activities of the Hands-on Science network.

## 9. References

[1] Em Mortalidades, Gonçalves Óscar, Profedições Lda., Portugal, 1992.