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SMEC  
SAILS  
Conference  
2014

Dublin City  
University  
Ireland

*Why teachers should want to  
follow our curriculum design?*

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- Evaluation Study – Curriculum
- External Evaluation – Science teaching
- Teachers' Education Programme – SAILS

# *An evaluation study*

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The main objective of this study was to understand how teachers interpret and implement the science curriculum and how students experience it.

# Curriculum Evaluation

- Adequacy to the international recommendations for science education
- Interpretation and implementation
  - integration in textbooks
  - implementation in schools
- Effects on student learning

# Strategies

- Adequacy to the international recommendations
- Comparison with international recommendations and with a set of reference curricula
- Criteria for curriculum selection
  - students results in PISA

# Strategies

- Interpretation and implementation of science curriculum
  - Analysis of teaching strategies
    - Teachers' perspective
    - Students' perspective
  - Analysis of textbooks

# Strategies

- Effects on student learning
  - Analysis of Portuguese PISA results
    - Competencies evaluated
    - Students' errors
  - Analysis of 9<sup>th</sup> grade students' competencies

## Interpretation and implementation of science curriculum

- Analysis of teaching strategies
  - Teachers' perspective
  - Students' perspective
- Analysis of textbooks



# Teachers and students' perspectives

- Three studies:

- A survey study

It involved a representative sample of Natural Sciences' teachers (NS) (n=394), Chemistry and physics' teachers (CP) (n=395) and 9th grade students (n=5079)

- Data was collected by inquiry through a questionnaire, applied to a representative sample of students and of science teachers from all over the country.

- Multiple case study

- It involved 7 cases, aimed at deeply knowing some schools and its relation to the enactment and experience of the curriculum

- Analysis of text-books (those more frequently used) with the goal to study the alignment of the proposed learning activities with the curriculum.

## Results concerning teachers perspectives

		NS Teachers	CF Teachers
Type and frequency of activities developed inside the classroom	Never or occasionally use of investigative activities	90%	94%
	Never or occasionally use of experimental work	93%	79%
	Never or occasionally use of decision-making activities	61%	60%
Type and frequency of actions required from the students inside the classroom (related with an inquiry environment)	Planning an investigation rarely required	95%	94%
	Conduct experiments rarely required	95%	86%
	Discuss socio-scientific issues rarely required	89%	85%
Type and frequency of resources used in the classroom	The text-book	89%	85%

## Results concerning teachers perspectives

### *Difficulties related to the implementation of the curriculum*

Lack of students' perceived relevancy of the science themes explored

Students disinterest with science classes

Students' behavioral problems

Lack of adequate knowledge and of transversal competencies (such as written and reading interpretation)

Difficulties related with managing a perceived extensive curriculum

## Results concerning teachers perspectives

*Pointed difficulties justify their teaching practices, which are characterized by:*

- Closed tasks mostly centred on teacher
- Tasks demanding low cognitive operations; e.g. teachers present all the information in a very simplified, ended form, expecting from the students the reproduction of the information provided,
- Low challenging tasks (as they do not require complex competencies)

# Difficulties associated to *students'*

## *characteristics* justify teachers' practices

- “I try that they have a written support. So I write a lot on the blackboard and I transform the information provided on the textbooks into schemes (...). For instance, **I draw a scheme on the blackboard about certain information and I write down the corresponding page of their textbooks.** After that they open their textbooks. I just want to contextualize them, to guide them. In this way, they know where they can find the information that I will provide them during the lesson. Usually I illustrate what I am saying with lots of images, in order to enrich what I am saying”.
- “In what concerns experimental work... Usually **I write down an experimental procedure that students should follow.** I also give them a template of the written report that they have to deliver after the activity is over. They can adapt the template to the activities”.

# Difficulties associated to *curriculum*

## *management* justify teachers' practices

- “There are two exhibitions that I would like to assist with my students of 9th grade. However, **I don't know if I will have time for it.** Let's see. One is passing on the Electricity Museum, and as I will start teaching electricity on the 3<sup>rd</sup> term I thought that it could be interesting. (...). It could be important to enhance students' curiosity with science and with explanations related with everyday phenomena. But, will I have time for that? **I am so delayed with curriculum.**”
- “Teaching science by means of experimental activities is almost impossible. My students are not adequate for that. And the extension of the curriculum does not allow that. **In order for me to accomplish the program, I can not develop that kind of teaching**”.

# More relevant issues

- Inquiry based activities are not part of teachers' practices
- Text-books and exercises books are the most frequently used resource
- STS is not deeply explored
- Teaching practices centred on the teachers
- Assessment does not include research competencies (planifications, interpretation of experiences, graphics building, etc.)
- Most pointed difficulties: curriculum extension and students characteristics.
  - These difficulties justify the maintenance of routine practices.

## Synthesis

### This Project aims at:

- identifying reasons for low scientific literacy levels among Portuguese students at the end of compulsory education
- presenting recommendations for improving science education

### Tasks 1 & 3

Portuguese curriculum aligned with international recommendations and selected curricula

1. Students
  - interested in sciences, although...
  - don't develop complex competencies (great differences between "bad" and "good" students)
  - perceive traditional teaching
2. Teachers
  - Although they know curricular documents, they don't follow the orientations due to several contextual and circumstantial (national tests, teachers evaluation) constraints

Considering teachers as "curricular transformers"

- How can we create in teachers the will to appropriate and transform the curriculum?
- How can we reconstruct the curriculum as a tool that can easily be appropriated by the teachers?

### Task 2

Although students seemed to present basic substantive knowledge, they do not mobilize it for explaining and solving problems

Pisa: when we exclude from the overall sample unsuccessful students the results improve significantly (above OECD average)

### Task 4. Teachers practices

- Not aligned with curricular orientations
- Text book as the main resource

### Task 6. Text books

The text-books analysis showed that most proposed activities focuses only on factual knowledge, scarcely exploring students' understanding about the processes of science

### Task 5. Students perceptions

- Congruent with teachers' perspective
- Vision of science as interesting, useful and relevant



# Conclusion

Having in mind that **one important focus** of the curriculum reorganization was the **development of inquiry learning environments**, it is important to **support teachers** in defining strategies that explicitly address important questions regarding **inquiry activities' structure, and inquiry activities' design, development and assessment.**

# Experimental Teaching of Science Programme

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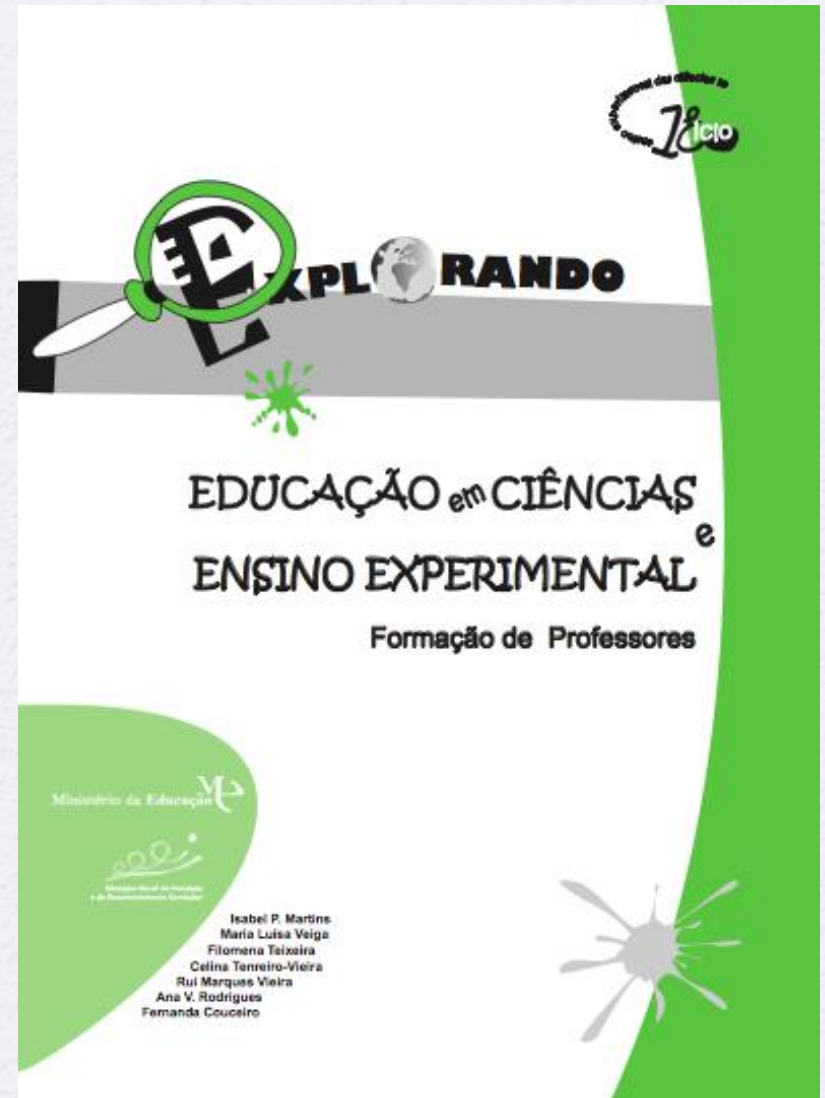
An external evaluation

# Experimental teaching of sciences

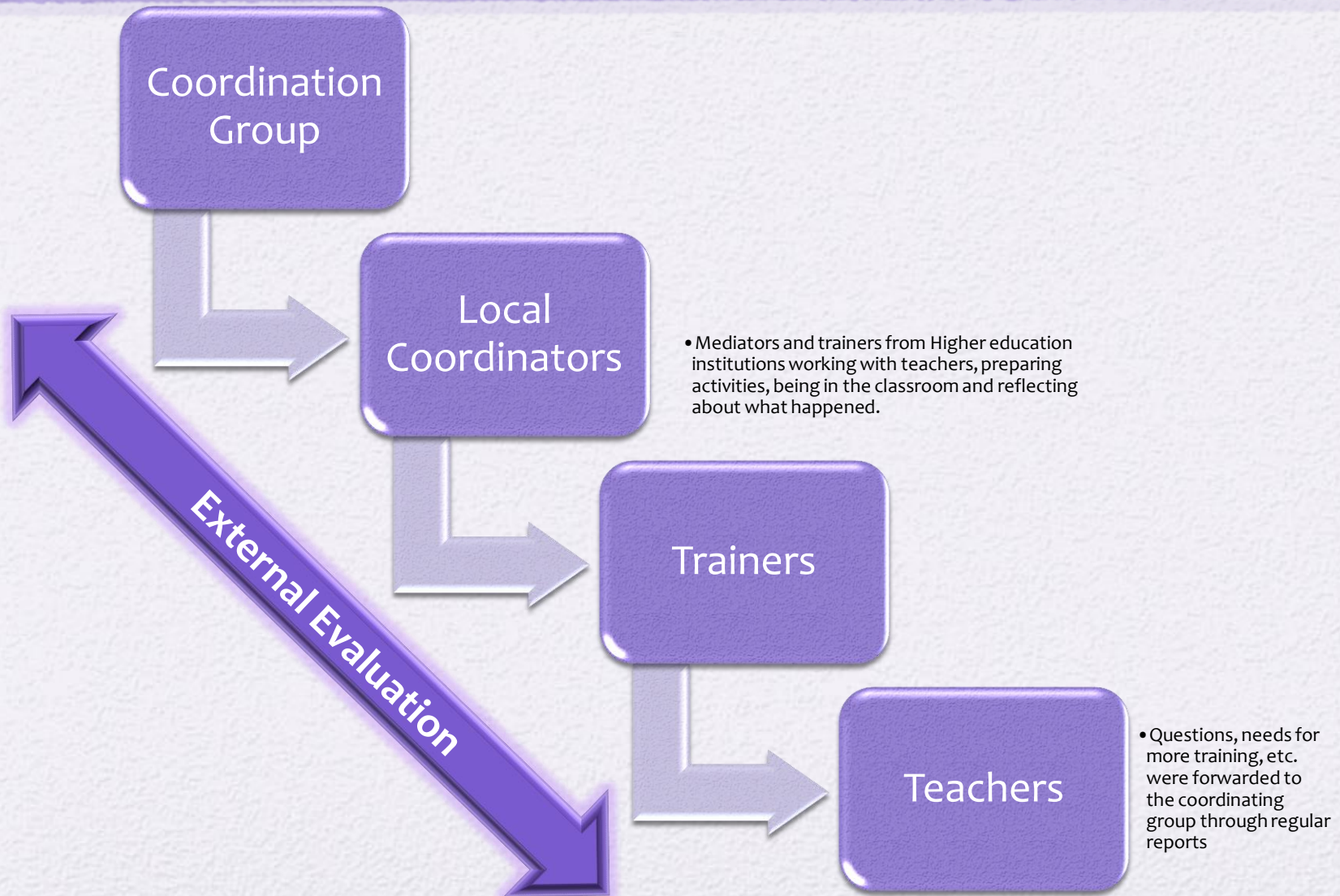
Primary School

In-service teachers

Teachers education programme



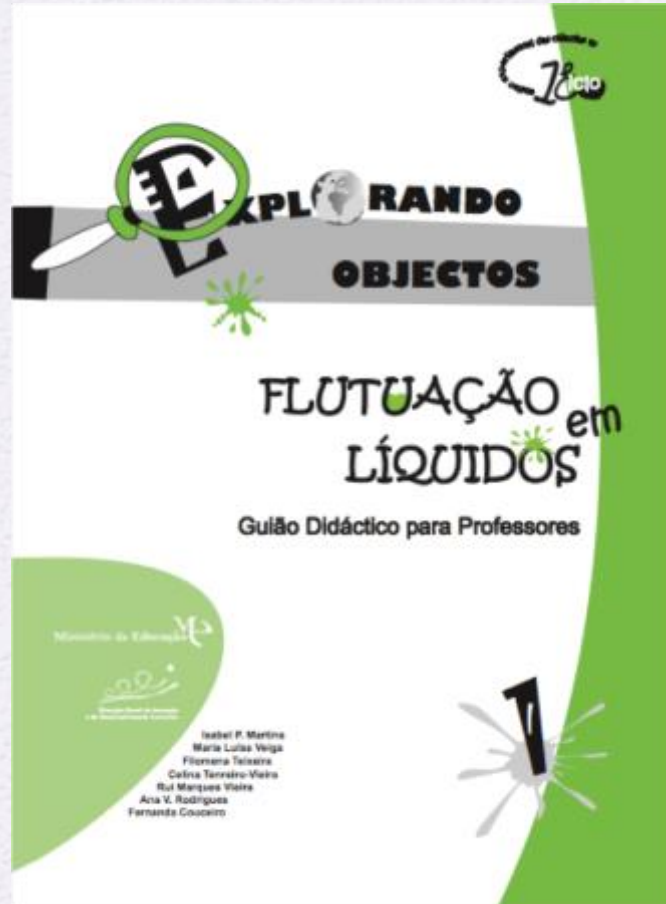
# Teachers education programme



# Training Purposes

- (i) Value training as a process of teacher development
- (ii) Integrate theory and practice
- (iii) Develop training in the context of a changing process
- (iv) Articulate teachers training and school organizational development

# Teacher didactic guide



- Exploring Objects: Floating in liquids
- Exploring Materials: Dissolution in liquid
- Exploring Plants: Seeds, germination and growth
- Exploring Light: Shadows and images
- Exploring Materials and Objects: Electrical phenomena
- Exploring Transformations: Changing states of matter

# Teacher didactic guide structure



- Curriculum framework
- Activities Purpose
- Conceptual framework
- Activities
- Resources
- Learning outcomes
- Suggestions for learning assessment
- References
- Attachment: Students' note book

# External Evaluation

Criteria	Data collection
Relevance	Questionnaires
Effectiveness	Observation
Efficiency	Analysis of documents
Durability	Interviews



# Conclusion – *impact on teachers*

□ From data collected emerges a strong consensual idea that points to a positive impact on teachers:

□ Attitudes

□ Professional knowledge

□ Teaching practices

# Conclusion – *impact on teachers*

- ❑ “I used to do what is in text-book, all very superficially; [...] I increased my knowledge [...], using appropriate strategies [...] From now on, I have knowledge and tools to implement in the classroom experimental lessons in a more rich and rigorous way”.
- ❑ “ It was very enriching because I learned a lot, not only new concepts, but also how to plan the subjects, present it to students, build materials and to develop activities in classroom”.
- ❑ “[...] students learned to work in groups, understand the meaning of the word predict [...] I succeed to stimulate curiosity and a feeling of admiration, enthusiasm and interest in experimental activities”.

# Conclusion – *impact on teachers*

- ❑ Some trainers identify further changes in teachers' practices:
  - ❑ Student-centered methodologies
  - ❑ Work group
  - ❑ Focus on skills development
  - ❑ Conceptual change
  - ❑ Development of reflection capacity
  
- ❑ “From now on I’m not the same professional, grew up in my understanding about the relevance of the experimental science teaching in the classroom”.
  
- ❑ “Allowed the development of a more critical and reflective attitude about their performance in the classroom [...]”.



Community of  
Practice (CoP)

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&

Teachers Education  
Programme



- Community of Practice

&

- Teachers Education Programme



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# Featuring

**12 countries involved** - Ireland (coordinator); Belgium; Denmark; Germany; Greece; Hungary; Poland; Portugal; Slovakia; Sweden; Turkey and United Kingdom.

**Support Teachers** – Lower and upper secondary

**Context** - Inquiry Based Science Education (IBSE) | Strategies and frameworks for assessment of IBSE skills and competencies

**How to** - Teachers Education Programme

**2013** – 25 hours | 24 teachers

**2014** – 32 hours | 19 in-service teachers

Face to face sessions

Collaborative work under the CoP

Individual work

## Goals -2013 |2014

- ◆ To discuss and take ownership of the Inquiry concept;
- ◆ To share experiences focused on developing tasks centred on Inquiry;
- ◆ To discuss assessment perspectives (diagnostic, formative and summative);
- ◆ To share experienced assessment strategies of Inquiry tasks;
- ◆ To share difficulties encountered in either the development or assessment of Inquiry tasks.

# Teachers Education Programme 2013

## Objectives

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- Understand how do teachers position with regard to IBSE
- Identify teachers expectations and perceptions regarding their involvement in the CoP

## Methodology

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- Qualitative approach
- 24 teachers were involved
- **DATA COLLECTION**
  - 2 questionnaires
  - Teachers individual written reflection

# Teachers' perception

## Potentialities

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- Development by students of a very large range of Inquiry skills
- A way to make classroom lessons more attractive both for teacher and for students

## Constraints

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- Time management in different moments: construction and planning, implementation and reflection on the process
- Students assessment in this learning environment



# Teachers' perception

## Previous teachers' perception

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- Groups sharing knowledge
- Contributes to improve practice
- Facilitates knowledge (re)construction
- Opportunity for professional development
- Values teaching profession

## Teachers' perception after TEP

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- The CoP was useful in the workshop context
- Reveal considerable potential
- Resources were very helpful
- It is intuitive
- Some felt difficulties to use it

# Conclusion

- **INQUIRY** – Lack of knowledge and teaching experience
- **CoP** – Provides a place to share resources, strategies, learning experiences, and a collaborative workspace, creating the opportunity for reflection and knowledge construction

# Challenges

- **INQUIRY** – Empower teachers with a set of strategies that enable them to effectively assess students outcome in IBSE context
- **CoP** – Promote the development of the CoP as a tool for knowledge construction that combines teachers practice and educational research

# CURRICULUM TEACHERS

“teacher learning and

development is a complex process that brings together a host of different elements and

is marked by an equally

important set of factors ... that at the centre of the process,

teachers continue to be both

the subjects and objects of learning and development”

# STUDENTS LEARNING

# INQUIRY ASSESSMENT

# RESOURCES TRAINING

# ENVIRONMENT

# SCHOOL CLASSROOM

Avalos (2001, p.17)

What makes a teacher  
a good teacher?

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7 principles  
Teacher Education  
Programmes

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Korthagen, Loughran and Russell (2006)

- ① Learning about teaching involves continuously conflicting and competing demands
- ② Learning about teaching requires a view of knowledge as a subject to be created rather than as a created subject
- ③ Learning about teaching requires a shift in focus from the curriculum to the learner
- ④ Learning about teaching is enhanced through (student) teacher research
- ⑤ Learning about teaching requires an emphasis on those learning to teach working closely with their peers
- ⑥ Learning about teaching requires meaningful relationships between schools, universities and student teachers
- ⑦ Learning about teaching is enhanced when the teaching and learning approaches advocated in the program are modelled by the teacher educators in their own practice.

# Professional development focus on student's learning

- Collaboration as a powerful strategy
- Continuous reflective and transformative activity at school level
- Researching teachers' own practice
- Practice-oriented



- Reflection
- Collaboration
- Teachers as co-researchers
- Lesson studies
- Build a bridge between theory and practice
- Professional learning communities

Avalos (2011); Smith (2011); Vescio, Ross and Adams (2008)

# The school we want

## Creative

### *With teachers*

Enthusiasts [by the profession]

Knowledgeable [of the subjects they teach]

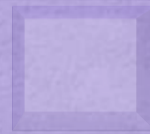
Cosmopolitan [establishing bridges between subjects]

Creative [creating several learning environments, interdisciplinary]

Courageous [without fear of breaking the routine and experience challenges]

Valued [by society and by themselves]

*Thank you*



It was a third-year class, with 19 students arranged in 4 groups. On each tabletop there was the material for the experimental activity: lamps, batteries, electrical wires. They work on the theme "exploring electricity: electrical circuits", under the training programme in Experimental Teaching of Sciences.

The proposal task was: planning and executing an experimental activity concerning obstacles to the passage of electrical current (the knots in electric wires). The students had already conducted other electricity tasks.

After the groups have formulated and presented their problems the teacher encouraged them to formulate predictions:

T – "This is not a test, is not to know if it is right or wrong. This is for you to give your honest opinion about what you think that is going to happen."

The teacher created a context (a scenario):

T – "My mom was vacuuming the living room and I was sitting watching TV; when I lifted the couch to vacuum underneath I saw that the couch foot was on the TV wire, but it kept working. "

T – "What are we going to plan?"

S1 – "If the lamp lights turns on."

T – "What?"

S2 – "What we're going to do."

S3 – "Our experience."

Prior the experience accomplishment, the teacher reminded what is an electric circuit and made connections to Math (geometric shapes) and to Geography (earth globe, North pole and South pole). The work was done in small groups that sometimes have shown some difficulties in the discussion and negotiation of ideas. Several problems were formulated:

" Does the knot let the electrical current go through it?"

"Does the lamp lights with the knot too tight or slight tight?"

"Does the tight knot let the electrical current go through?"

"And if there are a lot of knots?"

Each group only tested one of the conditions: a group with wire without knots (control group), one group with a very tight knot, another one with a wide knot and, finally, a group with a multiple knots wire. The records were made in a table given to students in the script. They performed the experiment and observed that all the lamps were lighted.

The first general idea for the conclusion was:

"even with knots the electrical current always across the wire".

There were no divergent opinions, or unsuccessful experiences. Some students verified that the results do not confirmed their forecasts and they tried to erase them. The teacher returned to the TV example and used analogies and metaphors to explain how the electric current works:

T – "There are no prisons for electricity. It always passes through."

S1 – "Only if we cut the wire."

T – "That's true, but if we don't cut it, always passes through."

S2 – "Can I ask you a question?"

T – (playfully and accomplice) – "Don't make me tough questions!"

S2 – "You said that electricity couldn't be arrested?"

T – " It is true, even if the police come it cannot be arrested."



S2 – " If we can't arrest electricity, how the electricity gets stuck in a battery?"



We think we have the class prepared and, suddenly, it becomes the opposite of what we have planned. The other day, in the experimental determination of soil humidity, something strange happened.

The students weighed the Petris' dishes, and then they put the soil inside and next put them in the stove.

After a couple of days, they weighed the dishes with the soil, and did the same eight days later. The results were totally unexpected, because the dishes were supposed to be lighter but they were heavier than before.

The students and I were frustrated, because we thought we would have predictable results and now we had the opposite to deal with.

We wrote down the results on the board and tried to interpret them. I told the students:

“This was unexpected, I’m just as frustrated as you are, but this is what happens sometimes to scientists.

In science, things are not as simple as you probably thought. Now, we have to try to find explanations for what happened”.

So we tried to find these explanations.

One of the hypotheses was an error in weighing, but it was strange that all the student groups had made the same mistake.

We checked in school and found that the stove was disconnected during the night and weekends. We also found some material other classes had put inside to dry, and because of that our own dishes had received the humidity of the other material.

They realised this could be the explanation and repeated the experiment, this time controlling the stove.

Now the results were as we expected, except for one of the groups where the calculations were wrong.

For me, it was a great experience as a teacher. The results were wrong but we actually thought together and discussed what was happening.

In another class, everything was so correct that it wasn't much fun. That discussion in the former class was fantastic and the students benefited from it. Changing the idea they had that in science everything is right and simple was important for them as students.

What disturbed me most was their question after the wrong results:

“Why did we do this experiment if the results are wrong?”

In their minds we only do scientific experiments to confirm what we already know.

After this episode, I feel they think differently about science.

(Maria, in Galvão, 2002)



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