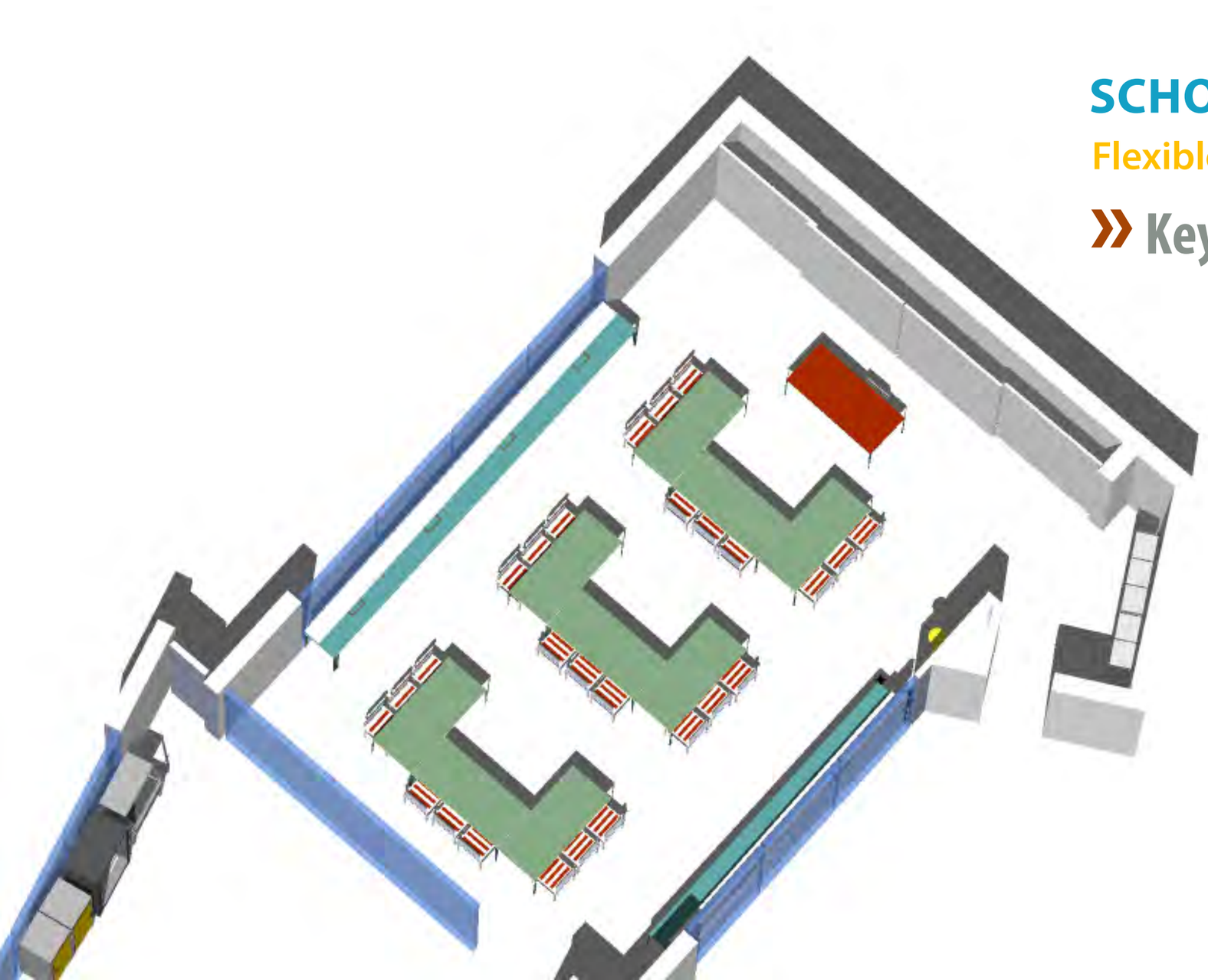

SCHOOLS' SCIENCE LABORATORIES

Flexible spaces for active learning

» Key features

PARQUESCOLAR

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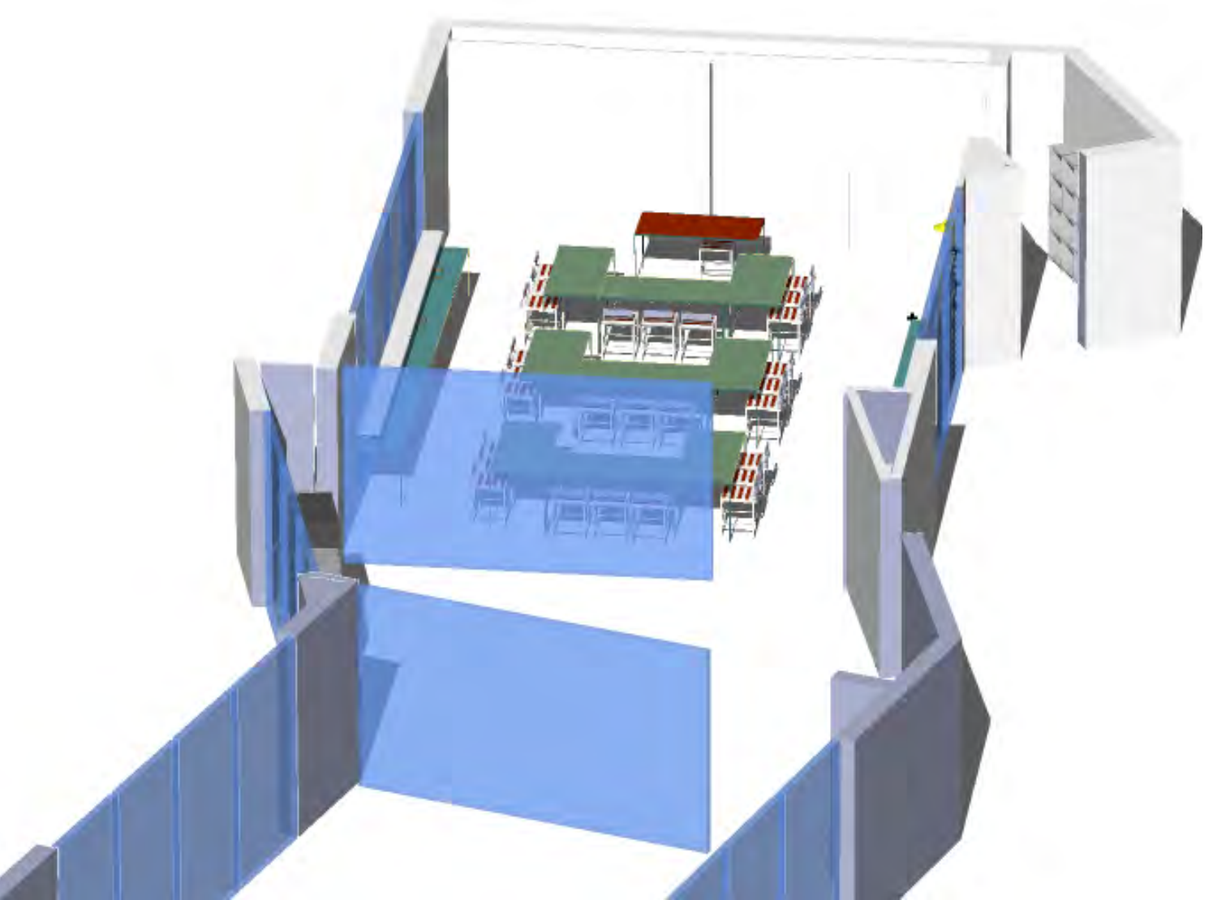
Lisbon, Portugal

Reference: Fernandes, J., Teodoro, V., Boavida, C. (2009). School's science laboratories: flexible spaces for active learning – key features. Lisbon, Portugal: Parque Escolar E.P.E.

INTRODUCTION

Flexible spaces for active learning



The current secondary school's building stock consists of a total of 477 schools built from the end of the XIX century, with 77% being built after 1970. This expansion period reflected the compulsory schooling policy change to nine years, recently increased to twelve years.

In 2007, the portuguese government created through Act 41/2007 of February 14, Parque Escolar E.P.E., responsible for the planning, management, development and execution of the secondary schools modernisation programme, reporting to the ministries of Education and Finance. This programme planned the intervention in 330 schools until 2015 and a total investiment of 940 million euros, 60% guaranteed by european financing (QREN, EIB, European Commission), state budget and local authorities. The remaining 40% will be guaranteed through bank financing (25%) and in asset recovery and development of business units (15%).

The modernization plan included four pilot interventions in Lisbon and Porto, completed at the beginning of the academic year 2008-2009, for refining the concepts and strategy of intervention. In these pilots was tested a new concept of spaces for teaching and learning Science, whose essential features are presented in this document.

The present state of secondary schools will also be addressed, together with a vision of scientific literacy and the educational goals of science education guiding the concept, some trends in the educational system, some examples of the concepts of Science learning spaces in other countries and the concept proposed for the national context, with the key elements and photographs of pilot interventions and new schools.

INDEX

THE CURRENT STATE

The everyday reality of schools

"Regular" Science classroom in ES Bocage, Setúbal

Central benches without water supplies, ES Passos Manuel, Lisbon.

Side benches with two electrical plugs, ES Monte da Caparica

There is lack of safety conditions in the portuguese secondary schools laboratories, besides the restraints in financial resources, audiovisual equipment and ICT, associated with an insufficient quantity of experimental equipment and conditions for their maintenance. These problems can contribute to teaching practices that avoid a more active involvement of students at a cognitive and psychomotor level through practical work. The lack of laboratories, coupled with their poor or low quality and the lack of technical support by trained staff (forf safety, maintenance and organization) can help accelerate the deterioration of the conditions for experimental work. Other aspects should be rethinked, including the number of students per class and the collaborative work of teachers in planning and preparing this type of work (Martins et al. 2002, p. 45).

The functional problems identified in schools' infrastructures put more obstacles to the implementation of experimental activities (Heitor et al., 2007).

Another aspect identified in the spaces for teaching and learning Science is the separation between the "regular" classroom, where work is mainly theoretical, and laboratories where the work is essentially practical, seeming to reflect a separation between the pure sciences and the applied sciences, or between "natural philosophy" and technology (Aikenhead, 2005).

Unlike the anglo-american model of science learning spaces, formalised in a single laboratory for all classes with daily activities of observation and / or experimentation, the portuguese previous model includes both "traditional" classrooms for lectures and laboratories for practical work, mostly for students in the final years of secondary education, with older schools also including amphitheatres for teacher-led demonstrations. This separation of spaces corresponds to a separation of teaching strategies, with the classroom devoted mainly to instruction and problem solving, and the laboratory to practical work, close to its origins in the university model of science teaching in the nineteenth century.

It is not inherent to spaces the teaching to be used, but the design may have a role to encourage and facilitate the implementation of a vision of the curriculum, pedagogy and assessment as of value for developing student's scientific literacy.

THE PRESENT

The everyday reality of schools

ø Amphitheathre room, with a demonstration bench for the teacher, ES Passos Manuel, Lisbon

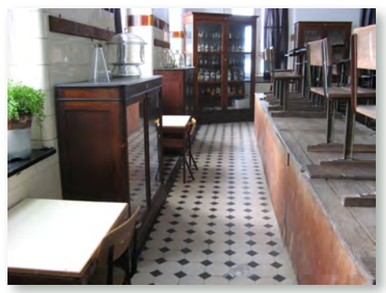
ø Teachers' unmovable bench with water supply, benches in wood for two students, ES Torres Vedras

ø Washing area, ES Rodrigues de Freitas, Porto

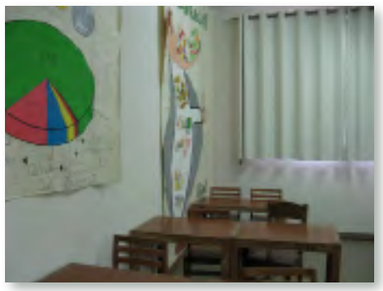
ø Central unmovable benches, height adjustable stools, fume cupboard and emergency shower, ES Romeu Correia, Feijó

ø Prep room, ES Gil Vicente, Lisbon

ø Laboratory with unmovable benches, ventilation, ES Passos Manuel, Lisbon



ø Floor in ceramics, walls with tiles, cupboards, chairs and tables in amphitheatre, ES Passos Manuel, Lisbon



ø Science classroom, ES Torres Vedras

ø Board and projection panel, ES Rodrigues de Freitas

Some identified issues

- ø Separation between "regular" classrooms and laboratories for the teaching and learning of Science
- ø Excessive partitioning, with underused spaces
- ø Lack of space for storage (equipment, chemicals, experiments for various lessons and classes, etc.).
- ø Reduced visibility between spaces
- ø Lack of equipment and infrastructure suitable for practical work (scientific equipment, electricity, water)
- ø Lack of adequate working space for teaching and non-teaching teams
- ø Lack of outdoor space in addition to laboratory space
- ø Lack of multi-purpose space suitable for informal activities related to Science for the community
- ø Lack of network (wired and wireless), computers and flexibility of projection and writing
- ø Problems of acoustics, ventilation and lighting
- ø Inconsistency of active safety equipment distribution and organisation
- ø Poor waste management
- ø Coatings unsuitable for the type of activities (floor, walls, benches)
- ø Work while standing hampered by the height of the benches
- ø Noisy seats and benches in room rearrangements
- ø Reduced areas and equipment for washing
- ø Reduced support equipment and decoration
- ø Lack of supporting spaces for display and discussion by students

TEACHING AND LEARNING SCIENCE

The vision that guides the concept

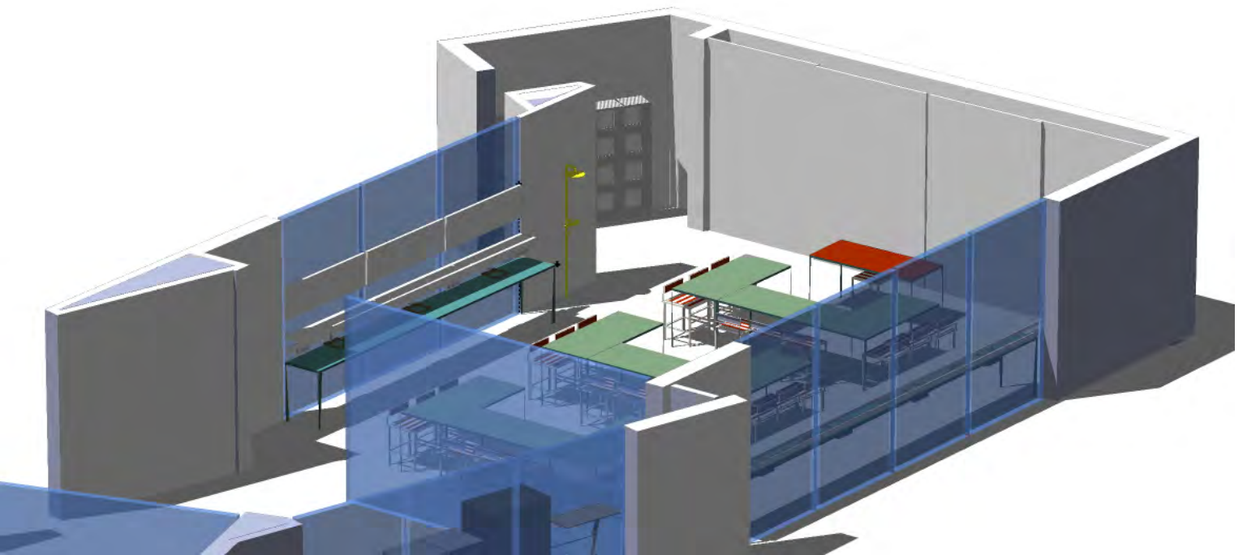
The proposed concept is based on a vision of science education that aims to:

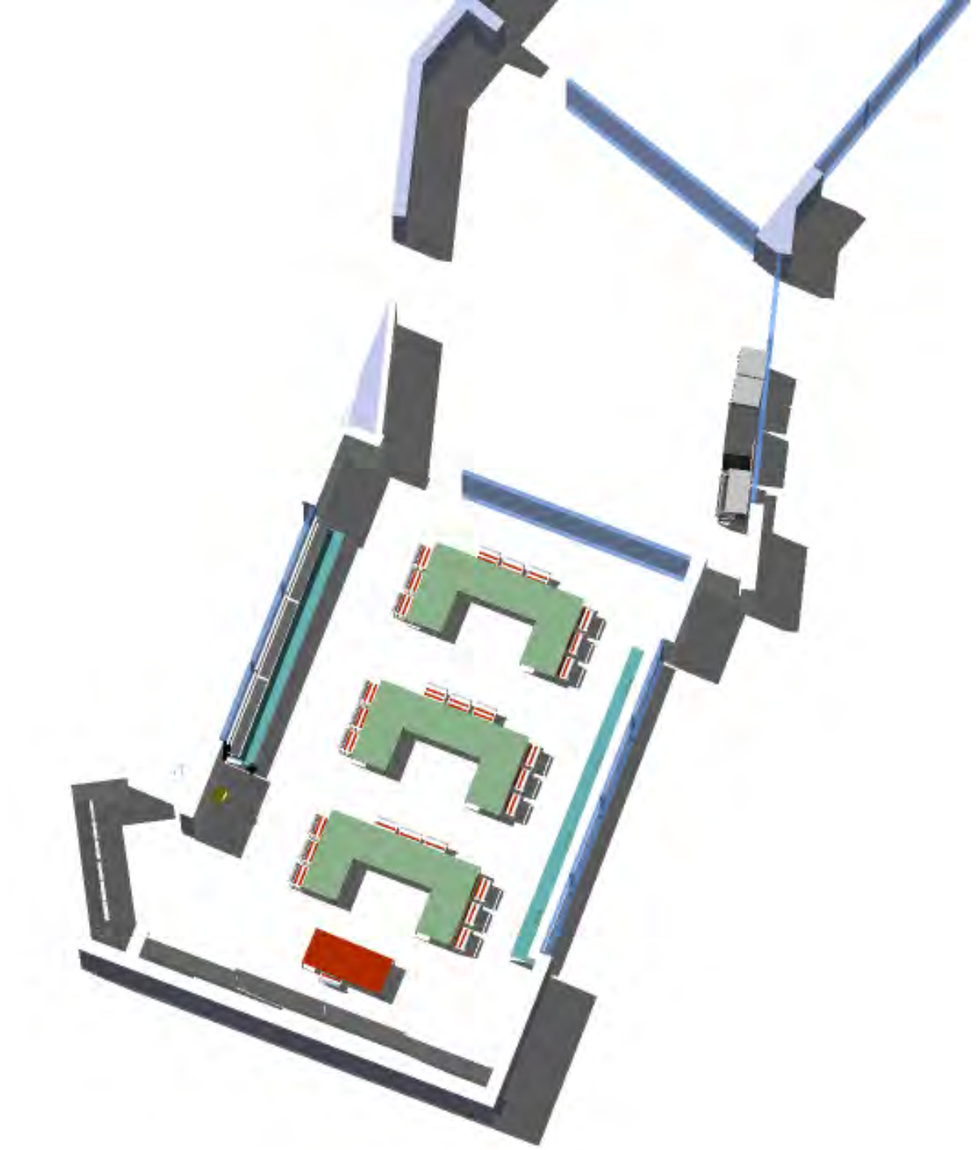
- make epistemic and human aspects of Western science more accessible and relevant to students, exploring the ways in which scientific knowledge is obtained, verified and refined, as well as the processes, values and implications of this knowledge;
- help students become better critical thinkers, creative problem solvers, and especially best decision-makers in their daily lives related to Western science and technology, with particular emphasis on the use of evidence, argument and dialogue;
- increase the capacity of students to communicate with techno-scienticic communities and with representatives of the media;
- increase the involvement of students in practices of social responsibility and citizenship, seeking social justice and socio-political action;
- increase the interest and sucess in learning of canonic content found in traditional curricula (Aikenhead, 2005, Osborne, 2007, Reiss, 2007).

To achieve this vision, it is considered necessary an active learning environment in which students work actively to build personal knowledge that is shared, actively explore Nature and test ideas and models, conduct long term investigations, get involved in conversations on natural phenomena, reflect and discuss impacts on Society and Nature, collect, analyse, create and share information not only on Science but also in a multidisciplinary and interdisciplinary perspective.

In addition to this, this learning environment is aligned with:

- "hands-on, minds-on, hearts-on" diverse teaching strategies (Sunal et al., 2007; Wagensberg, 2001; Rocard et al., 2007, Duschl et al., 2007) starting from students' previous knowledge (National Research Council, 2007);

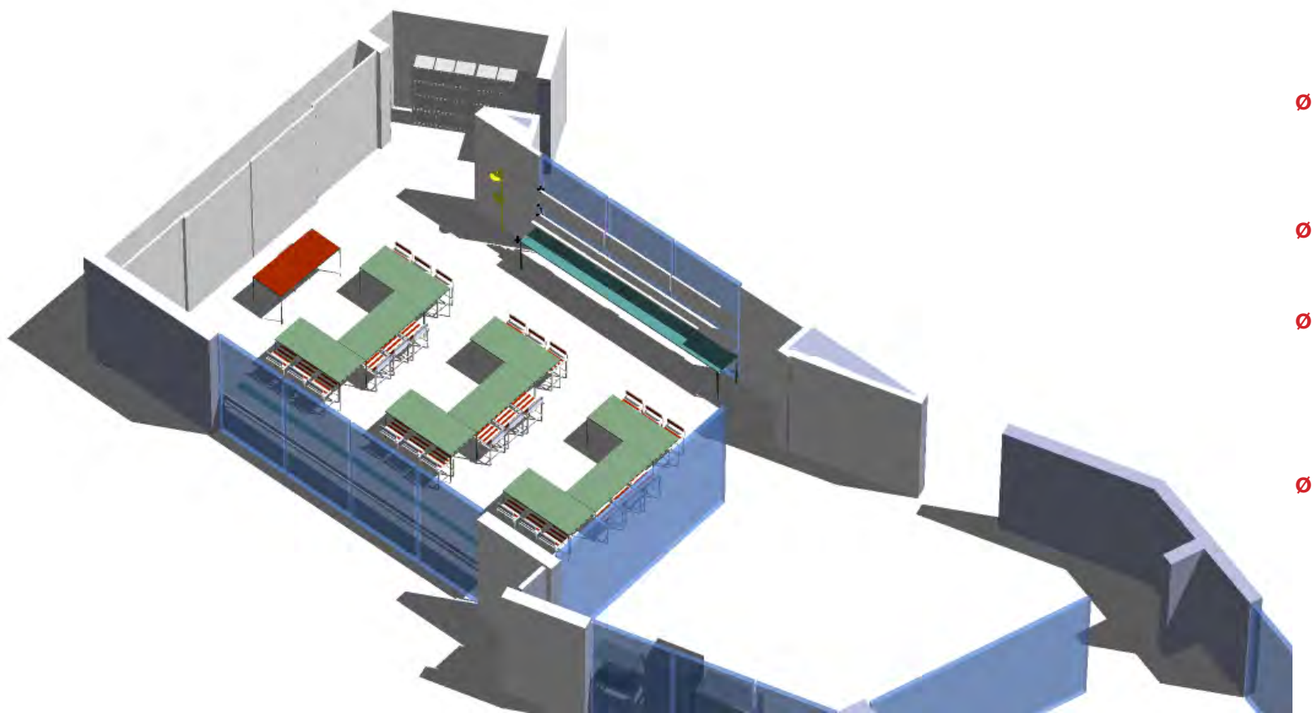




- a vision of the curriculum that seeks depth, consistency and is relevant to everyday life (Osborne, 2007; Millar & Osborne, 1998; Aikenhead, 2005);
- use of technology as a tool to "think with" and that can extend the sense of community, access to information, communication, collaboration, modeling and creation (Papert, 1980, Senge et al., 2005, Theodore, 2002, Michaels et al ., 2008);
- integrated assessment, aligned with the vision of the curriculum, including self-assessment, peer review and reflecting real life evaluation processes (Lombardi, 2007);
- a strong and transparent connection with the school and community, with sustained collaborations and finished products (multiple and competing) created by students and that can impact both. The learning also occurs outside the classroom and in informal environments (Lombardi, 2007; Tilling & Dillon, 2007, Osborne & Dillon, 2007);
- the timetables, spaces and access to tools are aligned with the vision of the curriculum and support the work of teachers and students (Beichner et al., 2007);
- ethnicity, language, culture, gender and socio-economic level are considered (Duschl et al., 2007).

TRENDS

Planning for the future



The trends identified with implications for the school in general and for school laboratories in particular are essentially the following:

- increased use by non-school communities;
- curriculum flexibility, reflected in a decentralized learning in space and time with students learning different topics (interdisciplinary) in different rhythms;
- learning by talents / aspirations and the emergence of specialist schools, at the secondary level;
- increased number of students in general, with laptops and other technological equipment in class;
- increase in the number of teachers per classroom, in co-teaching;
- increase in the supply of programmes and changing demands of students, many of whom are adults on a part-time basis;
- increased use of technology and the Web, with the barrier between physical space and online space becoming increasingly less distinct;
- increase in the variety of teaching strategies used in addition to independent projects for students and learning in real contexts, inside and outside school;
- increase in the length of lessons;
- mentoring, instruction and coaching to individual projects and small groups of students;
- evaluation based more on products, processes and effort rather than just paper and pencil tests;
- greater emphasis on documents and forms of digital work (including e-books, e-portfolios, digital notebooks, learning management systems and project management platforms, etc.)..

BENCHMARKING

3 reference projects

One of the methods used in developing a concept for the national context was examining international projects with interventions in the spaces for teaching and learning Science. In the following section is presented a brief summary of the characteristics of 3 of the most relevant projects, Scale-Up at the North Carolina State University, Laboratory 21 in Northern Ireland and Science Learning Centers, UK. Others, such as America's Lab Report or the Faraday Project in the UK were also analysed.

1 Scale-Up

In North Carolina State University, USA, the concept of Studio is proposed, in which:

- The front of the room is eliminated;
- There are round tables for 3 groups of 3 students each, with a diameter of 2 meters, with an area sufficient to experimental preparations;
- Each group of 3 students has access to a networked laptop, keeping the visual access to the teacher and allowing the students to put "lids down" when needed;
- The configuration space allows teachers to move easily between the tables;
- There are multiple areas of projection and a visualizer to display materials from the teacher or students' work;
- White board extended areas are provided, to support discussion groups, either fixed or mobile;
- It is provided access to laboratory equipment, stored in a support room (Beichner et al., 2007).

2 NEELB

The initiative Laboratory 21 in Northern Ireland proposes 3 laboratory concepts:

- Concept 1 - with the central axis with movable tables, allowing multiple configurations. The side benches have embedded computers;
- Concept 2 - all benches and tables are fixed and the central have computers embedded. The side benches have storage modules;
- Concept 3 - four sides benches and embedded computers built on the side axis. There are also two benches fully mobile allowing several rearrangements;
- Laboratories with dimensions of approximately 90m^2 for 24-26 students;
- Side benches with storage, with sliding doors;
- Teaching wall, a large dimension area of projection, writing and storage;
- 200x300mm water sinks and double gas outputs;
- Display and writing panels;
- Mobile fume cupboard;
- Adjustable seat and bench height for students with disabilities;
- Trays for storage in side storage and teaching wall;
- Separation between wet and dry area (NEELB, 2006).

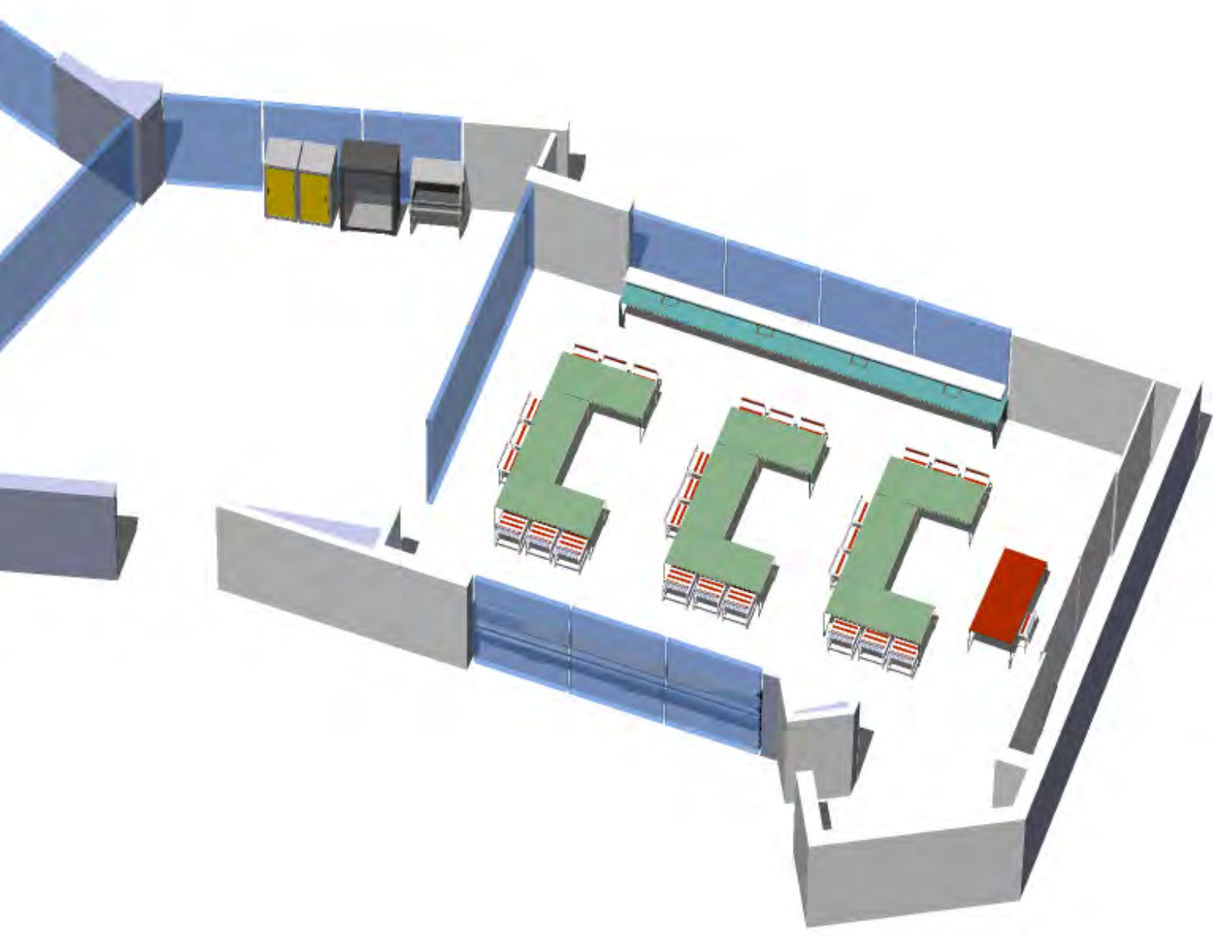
3 Science Learning Center (SLC)

The SLC emerged in 2004 as an enhancement of Science teachers and technicians training in the UK, providing the country with 10 specialised centers. The SLC's Institute of Education in London has the following general characteristics:

- Laboratories, support rooms, resource center, computer room and terrace with greenhouse;
- Specialized laboratories of rectangular shape, with areas exceeding> 100m^2 (Biology, Physics and Chemistry);
- Non-contiguous support rooms, with areas smaller than 20m^2, serving more than 1 laboratory;
- Laboratories suitable for 26 to 30 people;
- Natural light and visibility for the access corridor and through the doors;
- Supply of electrical power and connectivity through the floor (about 3 per lab, with 4 electrical plugs and 4 network plugs) and in the teacher area;
- Supply of gas and water service modules in the center of the laboratory, with electrical plugs. One of these modules is adjustable in height;
- Side benches with 2 fixed water sinks in the Biology lab. In the Chemistry lab there are 4 water sinks and a fixed washing module;
- Mobile benches with wheels adjustable in height, can be converted into fixed benches. Worktops in formica laminate;
- Mobile storage modules;
- Safety point with emergency electricity cut off, active safety equipment.

PROPOSING A CONCEPT FOR THE NATIONAL CONTEXT

Solutions adapted to the portuguese reality



The methods used in developing the concept for the Science learning spaces for the modernisation programme were:

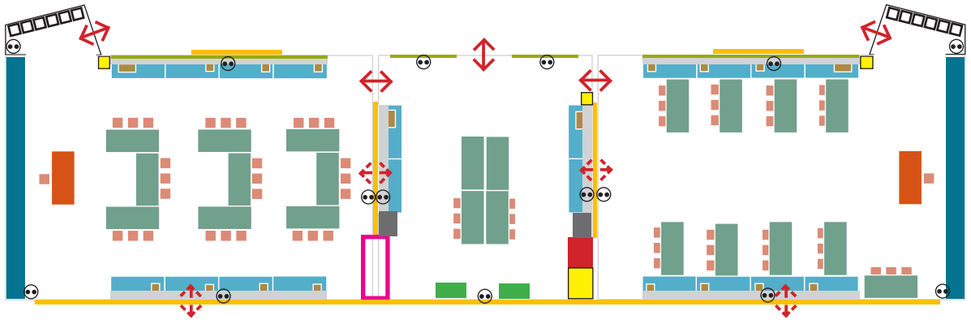
- **Analysis of the current situation (White Paper on Physics and Chemistry, Diagnosis of spaces for Experimental Sciences, visits and photos of schools);**
- **Visits to international schools and teacher training centers;**
- **Historical analysis of several existing laboratory concepts;**
- **Literature review on environment-behavior, design of spaces for learning, teaching and learning of science and technology in learning;**
- **Consultation of technical documentation from other countries on designing spaces for learning, in particular Science;**
- **Benchmarking of solutions adopted abroad;**
- **Visit to thematic exhibitions (eg BETT Show 2008, Building Schools Exhibition and Conference 2008, UK);**
- **Web and catalogue search for suppliers and market solutions;**
- **Consultations with teachers and students (of various levels of education and schools);**
- **Consultation with businesses (furniture, equipment, ICT, waste management);**
- **Consultations with researchers of the scientific areas related to Physics, Chemistry, Biology, Geology, Microbiology, Waste Management;**
- **Analysis of the curricula of secondary education of science and school textbooks (in particular the proposed activities);**
- **Analysis of inventories of equipment for schools;**
- **Review of the legislation;**
- **Definition of budget constraints, market and mass application to the national context;**
- **Prospective analysis;**

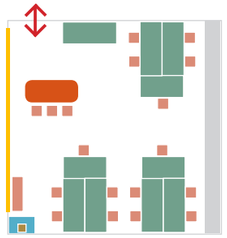
In the following pages, the key features of the concept are presented.

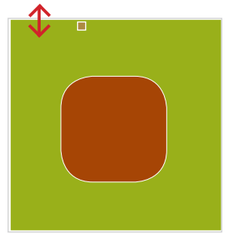
STRUCTURING UNITS

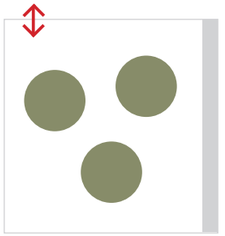
5 essential spaces

The proposed concept includes 5 essential spaces for the various activities related to the teaching and learning of Science, or more broadly, to school activities.









1 Pair of laboratories

- Minimum area of 80 m², ideally> 96m²
- Sides with fixed benches with a minimum of five water sinks, and electrical plugs and shelf on the entire length. One of the water sinks is a washing module. Transparency in common walls with prep. room and doors, facilitating visibility;
- Nine movable benches, allowing work while standing or sitting with groups of students, wit the same height of the side benches. Adjustable seats with back and feet support. One of the benches (the teachers' bench) is adapted for students in wheelchairs;
- Equipment whenever possible in kits, in transparent boxes, based on typical experiments, in non-breakable resistant materials.The fume cupboard is shared between the prep. room and one of the laboratories, and visible from all sides;
- Wireless internet access in all rooms for laptops for students, and wireless connection to projection from any computer. Hybrid computers with pen, one for the teacher, one per each group of 3 students. Visualizer/ Document camera, portable interactive whiteboard system and short throw projector or LED/LCD 65' screen behind the teaching wall;
- Electrical plugs around the entire perimeter allowing laptop and electrical equipment use;
- Areas of storage behind the teaching wall, under the side benches and in the prep. room, with transparent doors and removable transparent trays of various sizes;
- Safety point with active safety equipment (fire extinguisher, blanket, emergency shower)

2 Prep. room

- Minimum area of 20m², 40m² ideally;
- Transparency to the adjacent laboratories and in the doors;
- Side benches with storage modules;
- Shelves over side benches;
- Fume cupboard;
- Refrigerator;
- Storage of chemicals, flamable products and equipment with and without extraction;
- Safety point (first-aid kit, spill kit);
- Washing area with infrastructure for washing machine and electric shower/water heater;
- Electrical plugs in all the perimeter;
- 2 trolleys;

3 Office

- Minimum area of 49m²;
- Work benches with shelves, chairs with wheels. Bench for shared multimedia computer;
- Side table with computer, multi-purpose printer, wireless network;
- Mobile panel for artificial separation of spaces and writing;
- Electrical plugs;
- Klitchenette module, water supply;
- Transparent cabinet for documents;
- Meeting table.

4 Outdoors

- Water sink with 2 taps;
- Outdoor electrical plug;
- Wind turbine;
- Telescope;
- Weather Station;
- Solar panel;
- Plants' beds;
- Green roof;
- Rainwater collection;
- Greenhouse area;
- Mural or other decoration element, related to Science.

5 Multi-purpose area

- Water supply;
- Raised floor with electrical infrastructure or other solution to allow infrastructure in the central area;
- High benches with computers for free access;
- Round benches with a diameter of 2m for 9 people;
- Hanging system (gallery);
- Corridors with hanging system (gallery);
- Wireless network;
- Normal benches;
- Mural or other decoration element, connected to Science.

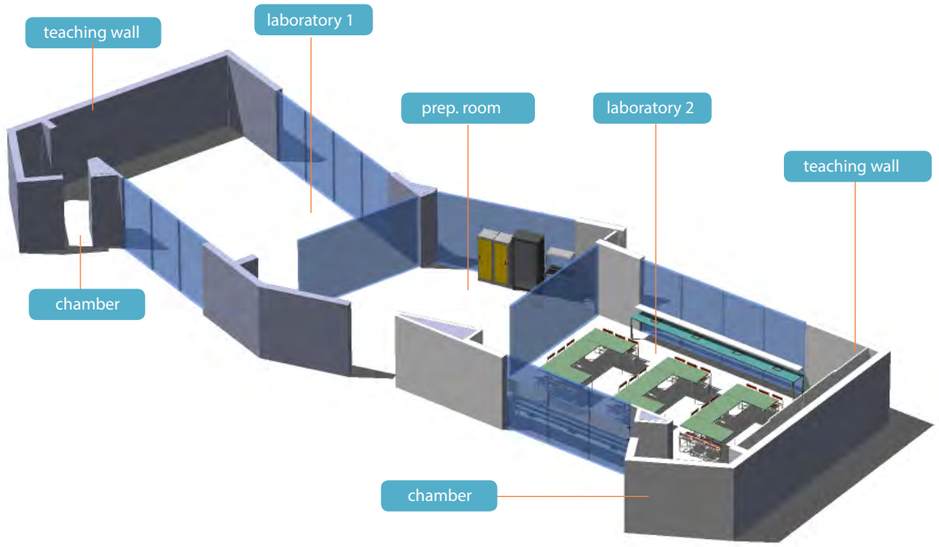
PAIR OF LABORATORIES AND PREP. ROOM

The essential space

The laboratories are presented in pairs, interspersed with a prep. room. These are atypical, and the school decides its distribution for the the various specialty areas. They are an hybrid of the "regular" classroom and laboratories in the previous model found in schools.

Some key features

1. **Flexibility: the space is adaptable to work in small groups to large groups, individually or to project-based work. The laboratory can be used for a single scientific or technological discipline or all Science related subjects, depending on the choices available in school.**
2. **Ease of access to scientific equipment, both in the laboratory or in prep. room, with good visibility allowing immediate location. Laboratories exist in pairs, with a common room between them, where shared equipment is placed (eg, fume cupboard, cabinet, chemicals, washing area, etc.)..**
3. **Transparency: glass wall between the three rooms, increasing the area of visibility and allowing for more visual control of students if necessary and to watch colleagues teach. Transparency also on the walls, doors and modules for storage under the side benches and teaching wall.**
4. **Extended areas of presentation, projection and support for discussion: Each lab. has a teaching wall, a white board with high sliding doors, filling the entire wall opposite the prep. room, with storage space on the inside. This can be used by the teacher or groups of students. The benches, spacious, are adequate for 3 or more students, with the same height of the side benches and with high stools with back and feet support, allowing work while standing.**
5. **Functionality: There are spaces provided for all storage needs, including bags and jackets (in the chamber and teaching wall) and larger equipment such as posters, maps, burettes and rock samples.**
6. **Safety: All rooms are built with the safety standards for laboratories and equipment and include active safety equipment, organized in a "help point".**
7. **Ubiquity of information and communication technologies: a tablet for each group of three students and the teacher, with wireless Internet connection and the possibility of projection from any of the tablets.**



1. 3D plan of the pair of laboratories

flexible

adaptable

sustainable

inclusive

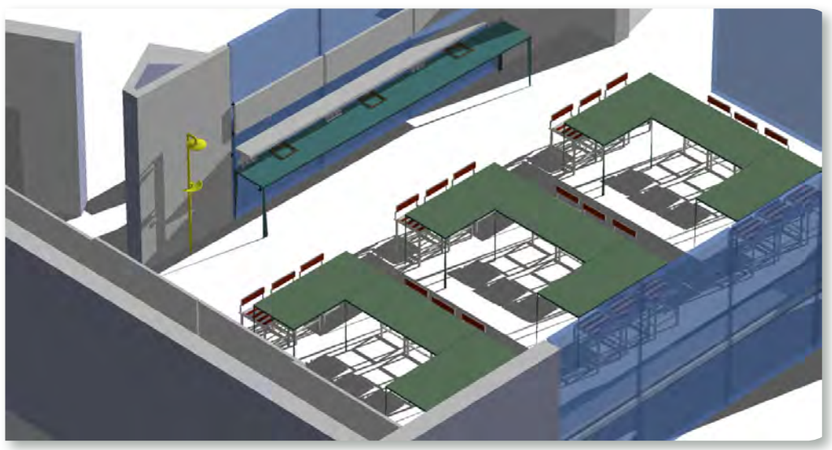
safe

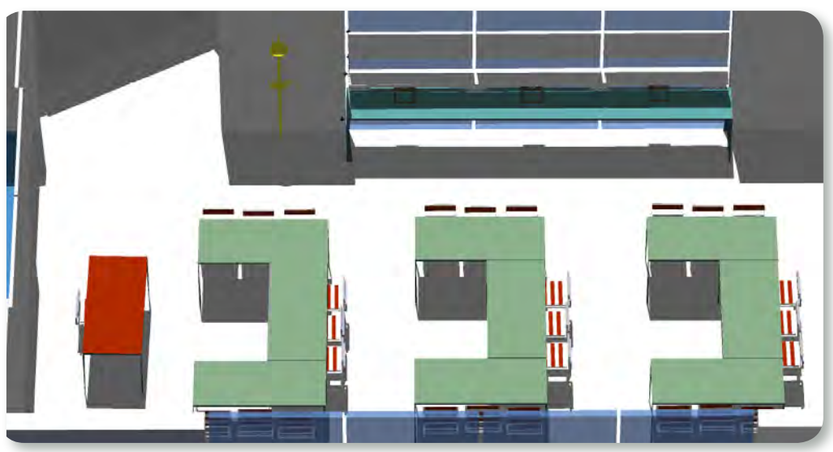
comfortable

scientific

natural

technological



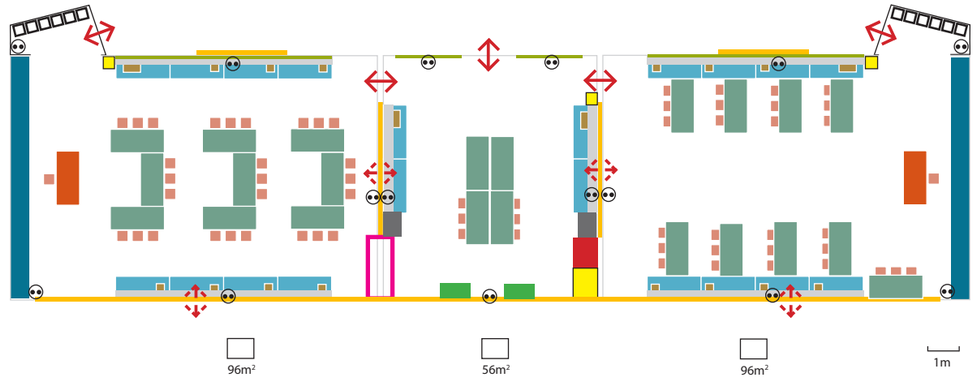


2. Details of the laboratoriess

SPACE USES

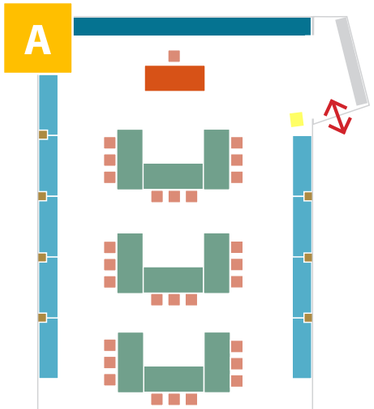
Different activities, different uses

Activities that can take place in the classroom, especially in a laboratory, are quite diverse, with access to scientific equipment and services increasing the possibilities. In this section are represented some of the possible configurations of the laboratory and the type of activities best suited to those configurations.



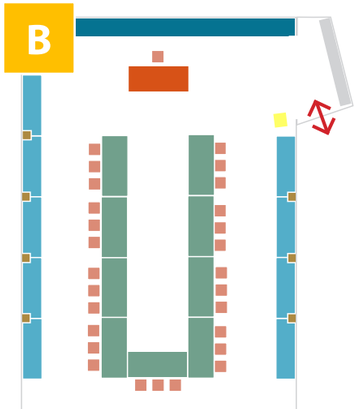
- Physical access
- Visual access
- Visibility
- Teaching wall
- Storage modules
- Electrical plugs
- Movable bench
- Side bench
- Teacher bench
- Stools
- Shelf
- Panel
- Water sink
- Washing module
- Help point
- Fume cupboard
- Cupboard
- Chemical storage
- Inflamable storage
- Trolley

A



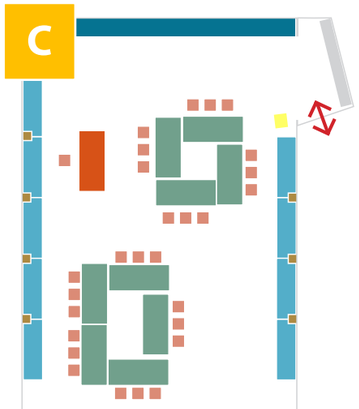
- Small groups in autonomous work
- Small groups with teacher guidance
- Instruction with group work
- Individual work

B



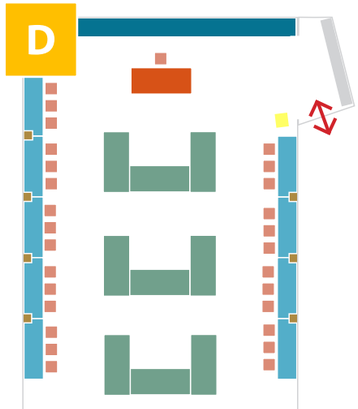
- Class work with teacher guidance
- Presentations and roleplay
- Instruction with group work

C



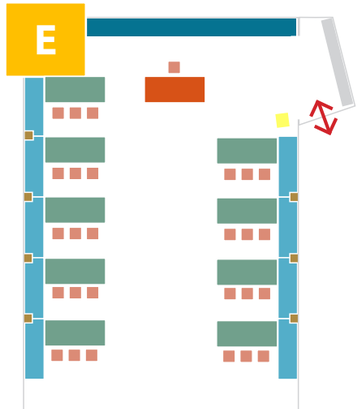
- Large groups work

D



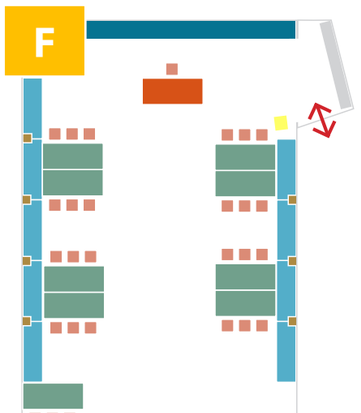
- Small groups in autonomous work
- Small groups with teacher guidance
- Instruction with teacher guidance

E



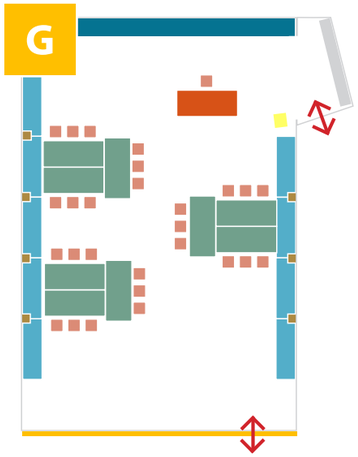
- Small groups in autonomous work
- Small groups with teacher guidance
- Instruction with group work

F



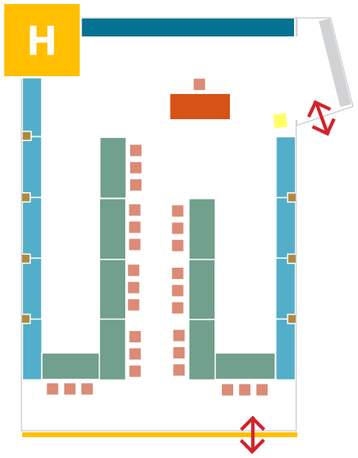
- Small or large groups in autonomous work

G



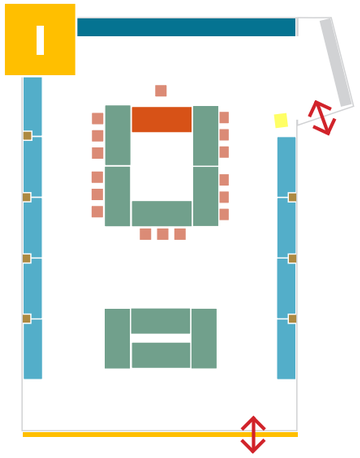
- Small or large groups in autonomous work

H



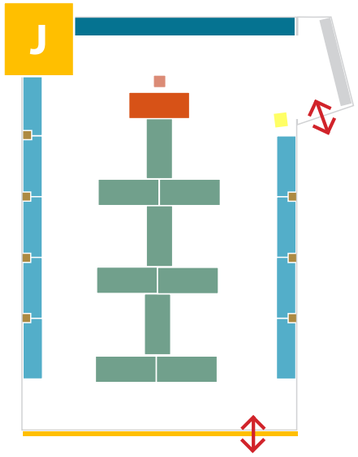
- Small or large groups in autonomous work

I



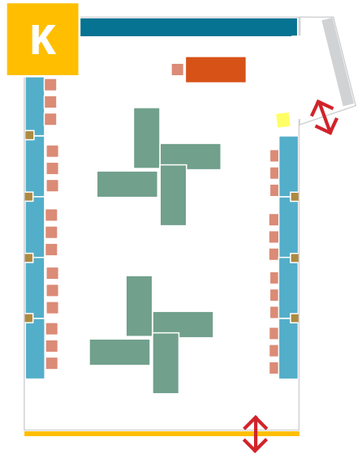
- Departmental meeting

J



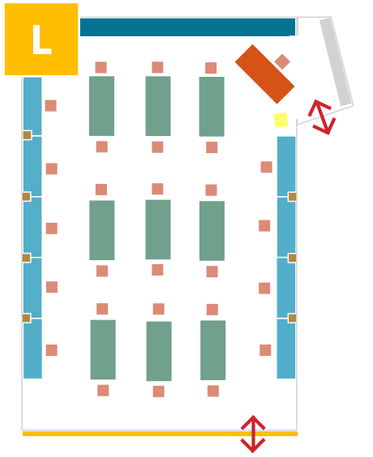
- Fair or exhibition
- Circus of activities

K



- Fair or exhibition
- Circus of activities

L



- Individual work
- Tests and exams
- Pairs work

LABORATORIOSESCOLARES.NET

Supporting website to the schools' laboratories

A key element of the concept is a website to support all users of the Science spaces. This is to ensure the continuity of the analysis and discussion of issues relating to new areas by providing resources and functions relevant to the day-to-day of school, which can be built by everyone.

http://laboratoriosescolares.net

/conceito
/reagentes
/sinaletica
/equipamento
/fornecedores
/reagentes
/pesquisa
/silogr
/residuos
/pogle
/rotulos
/manual
/virtual
/fotos
/wiki

labes

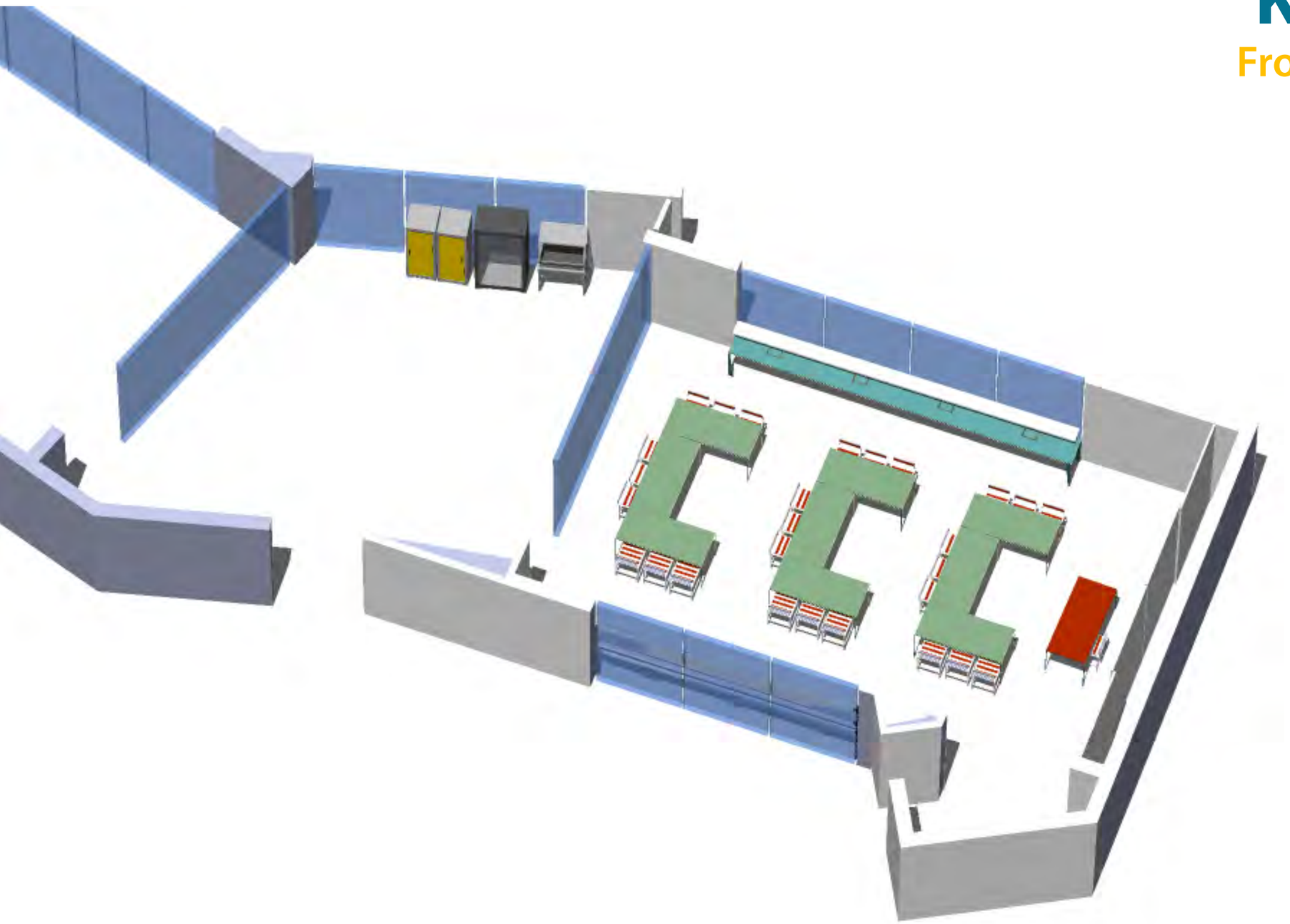
Some site functionalities

- Search for equipment suppliers
- Search for chemicals and MSDS
- Pictures of laboratory equipment and "real" spaces, former and present
- Guides for organization, storage, waste management
- Safety handbook
- Virtual Lab
- Template documents and images relevant to everyday
- Documents to support training (Ciências experimentais no secundário, Explorando - ensino experimental no 1.º ciclo)
- Search engine for online educational resources and in Portuguese relating to Science
- Digital museum of scientific equipment
- Forums
- Support for specialty pages with useful resources (simulations, software, suggested activities, examples of "real" schools)
- Template pages for department and subject
- Web TV with videos of activities in schools
- Publications related with the project (reports, articles on the concept, articles on the website, posters)

Possible future functionalities

Access to:

- State central shopping center with or without credit attribution to schools
- Digital inventories and laboratory notebooks
- Exchange system of equipments between schools
- Integration with educational resources repository
- Integration with GAVE's national exames questions database in the Moodle quiz format
- Support pages about several aspects of the curriculum, with questions, misconceptions, etc.
- Open MOOCs courses for teacher and technicians training
- Interaction/collaboration with teachers communities and associations



KEY FEATURES

From problems to solutions

The key features of the proposed concept of spaces for learning Science are presented in the following pages, organized by:

- Spaces
- Infra-structures
- Fixed furniture
- Movable furniture
- Equipments

KEY FEATURES

The essential of the concept

1

- Pair of laboratories with interspersed prep. room
- Transparency between all spaces
- Possibility of extending the spaces
- Minimum areas of 80m² and 20m², ideally 100m² e 40m²

- Minimum of 5 water sinks per lab. in side benches
- Size of 30x30x20cm
- Worktops resistant to main chemicals, fire and impact

2

- Technical pipeline along the side bench
- At least 24 electrical plugs in groups of 3 (50kW)
- 4 electrical plugs in the teacher area

- Washing area with retractable shower
- Drying support
- Infra-structure for washing machine and electrical shower/water heater

- Side benches 80 cm deep and height of 90 cm
- Worktops resistant to main chemicals, fire and impact
- Solution allows students to be facing the teacher during practical work using configurations E, F or G (p. 14)

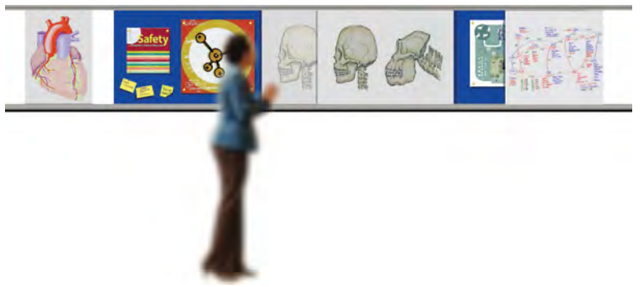
3

- Teaching wall occupying an entire wall
- Exhibition area on top, with transparency and storage modules on the inside. Area for burettes, maps, rock samples, posters and other large equipment
- Depth not inferior to 60cm

- Storage under side benches
- Transparent doors with transparent storage trays of several sizes
- The same key opens all the modules

4

- Shelf above side benches
- Minimum height of 130 cm
- Minimum width of 30 cm



5

- Exhibition and writing panels in one of the walls
- Sliding system that allows display of works

6

- Honeycombs in chamber for jackets and backpacks
- Minimum of 24 per lab.
- Honeycomb size of 40x40x60cm
- Hanger for laboratory coats

7

- Storage space in prep. room with transparency
- Maximum height of 140cm

8

- 9 movable benches for 3-4 students per lab.
- Rubber feet
- Worktops with 180x80x90cm

9

- Teacher's bench with wheels, height adjustable
- Worktop with 180x80x90cm

KEY FEATURES

The essential of the concept

10

- Stools with back and feet support
- Rubber feet

11

- 2 trolleys per prep room.
- With 3 levels, allowing storage of 9 trays with equipment

12

- Fume cupbard with transparency in all sides
- shared between prep. room and one of the labs

13

- Portable torch burners, refillable
- 10 per lab.

14

- Chemical and flamable storage with ventilation in prep. room

15

- Recipients for waste separation in prep room

16

- 10 tablets per lab., with wireless connection to projector
- Wireless internet access and visualizer

17

- Adapter for interactive white board or 65’ LCD touch screen behind teaching wall

18

- Projector with wire and wireless connection
- With extended projection area

19

- Help point in lab. with blanket, fire extinguisher and shower (from washing module)
- Help point in prep. room with above equipment and first-aid kit and spill kit

20

- Transparent trays in several sizes for equipment and kits of experiments

21

- Experiments kits
- Plastic material reusable whenever possible

- Electric shower in washing module in prep. room or water heater

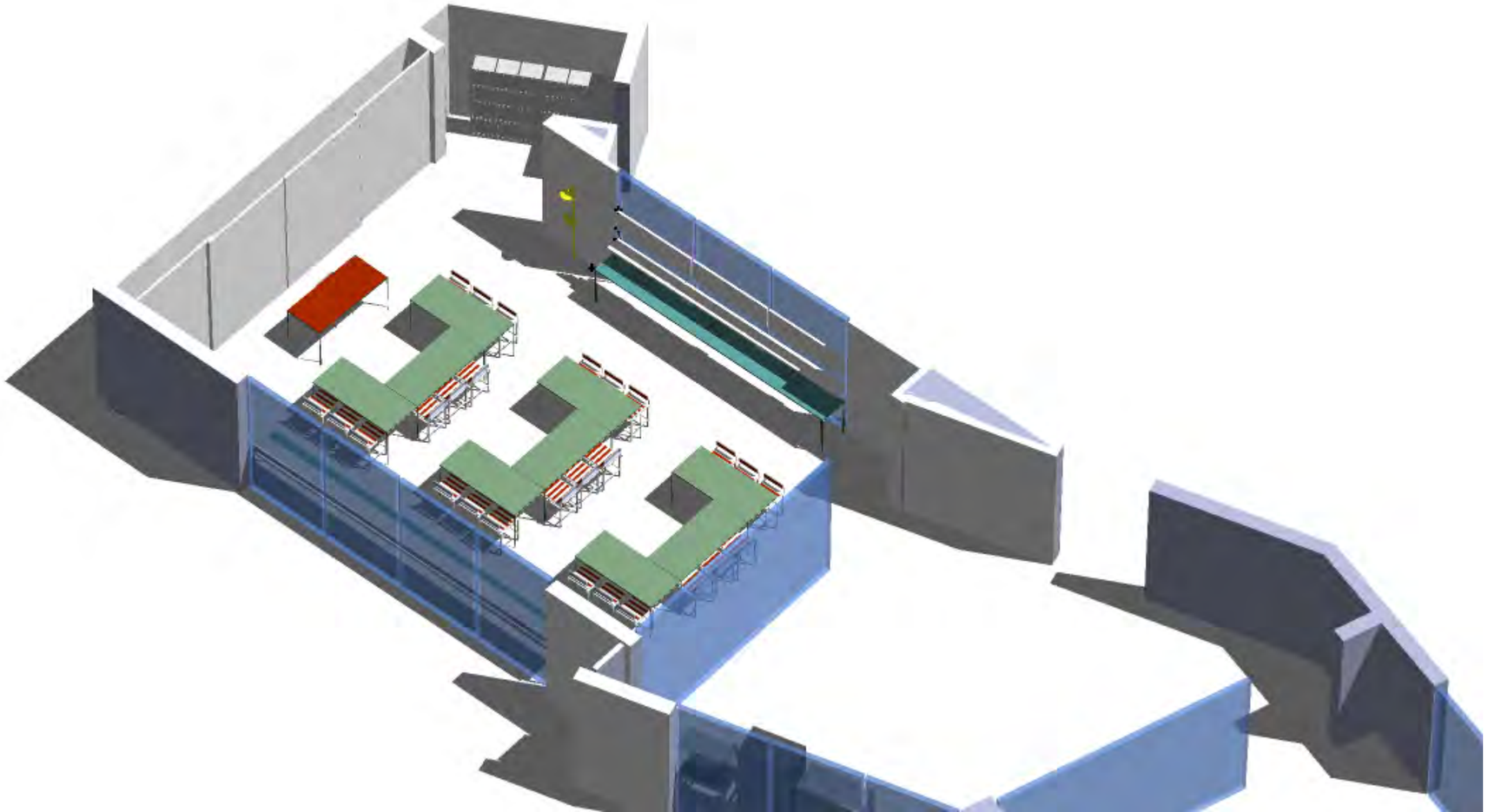
PHOTOS

Design experiences

Several elements of the proposed concept were tested in 4 pilot schools in the initial phase of the modernisation programme undertaken by Parque Escolar EPE. Completed in the academic year 2008-2009, these provided an opportunity to refine the intervention strategy and analyse the proposed solutions, improving the model to implement in the next phases of the project. The pilot intervention schools were:

- **ES Rodrigues de Freitas, Porto**
- **ES Soares dos Reis, Porto**
- **ES D. Dinis, Lisboa**
- **Pólo de Educação e Formação D. João de Castro, Lisboa**

The model woudl then to be optimised and applied to 115 schools in four phases. In the following pages some photos of the intervened schools are presented.



PHOTOS

ES Rodrigues de Freitas

ES Rodrigues de Freitas was the first concluded pilot. This school the first concept of teaching wall, improved in the following pilots. It was not possible to create prep. rooms with transparency due to the existing infra-structures.

ø Detail of teaching wall, with drawers for larger equipment

ø Teaching wall with sliding doors

ø Storage modules under side benches, with semi-transparent doors

ø Honeycombs and movable fume cupboards extraction behind the teaching wall

ø Emergency shower and side bench with shelf

ø Movable benches and height adjustable stools

ø Laboratory perspective

ø Water sink

ø Exhibition space

ø Electrical plugs

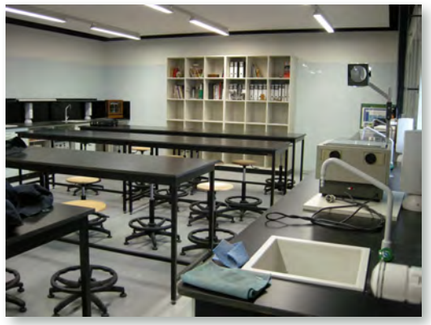
ø Washing module in prep. room with protection

ø Retractable emergency shower

PHOTOS

ES Soares dos Reis

ES Soares dos Reis has a laboratory pair with storage modules under side benches with transparency. An interactive whiteboard was installed over the sliding doors of the teaching wall.



- Movable and side benches
- Water sinks
- Honeycombs

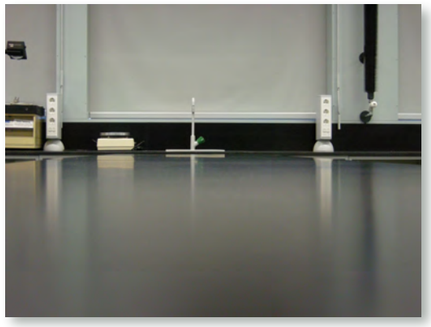
- Storage modules with transparency

- Blackouts
- Electrical plugs

- Interactive whiteboard in teaching wall

- Prep. room

- Detail of washing module



- Detall of side bench with electrical plugs and water sink

- Teaching wall

- Detail of connectivity module in teacher area

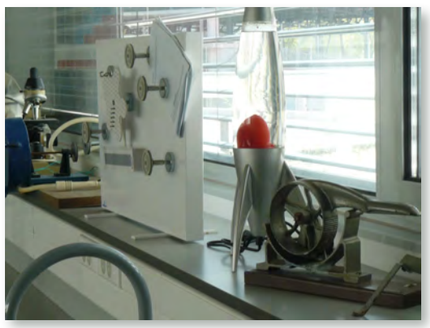
PHOTOS

ES D. Manuel I

ES D. Manuel I was concluded in stage 1. The laboratories have full transparency to the prep. rooms and good areas.

- Transparency to prep. room
- Side benches
- Movable benches

- Teaching wall



- Shelves
- Electrical plugs

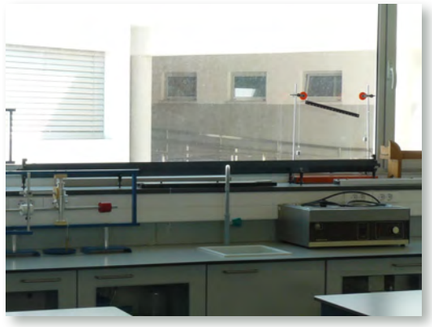
- Side benches with transparency

- Water sink
- Shelf

- Detail of access to laboratories

- Transparency to prep. room

- Teaching wall



- Side bench

PHOTOS

ES Pedro Nunes

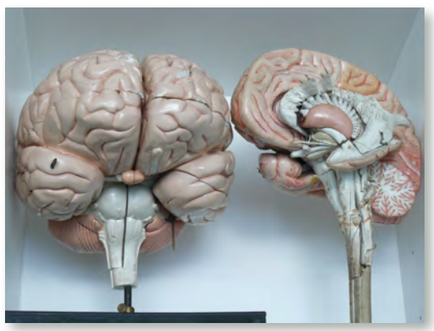
ES Pedro Nunes was concluded in stage 1. It is an historical school, built in the beginning of the XXth century.

Ø Access to laboratories

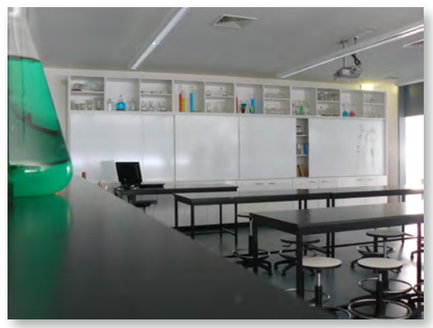
Ø Exhibition area above teaching wall

Ø Washing module

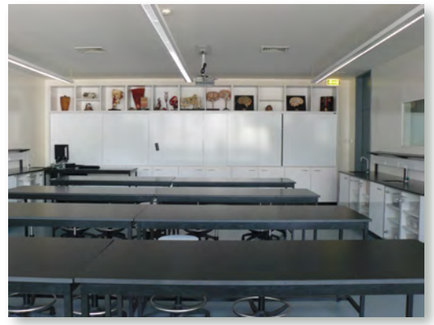
Ø Side benches with transparency



Ø Exhibition area above teaching wall

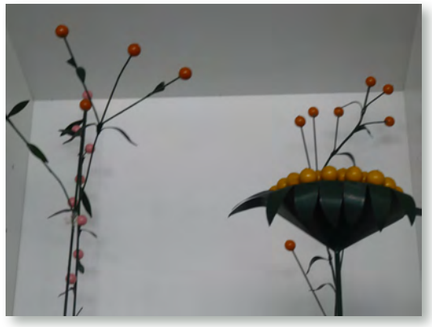


Ø Chemistry lab



Ø Biology lab

Ø Exhibition area above teaching wall



Ø Exhibition area above teaching wall

FINAL REMARKS

After the construction of the pilot schools, there was a period of analysis of the limitations of the various elements of the concept, with the participation of all stakeholders. In the next phase of the modernisation programme the lessons learned in this pilot phase are to be incorporated into other schools.

http://laboratoriosescolares.net/ is open to debate and all contributions are welcome. Learn more and participate!

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