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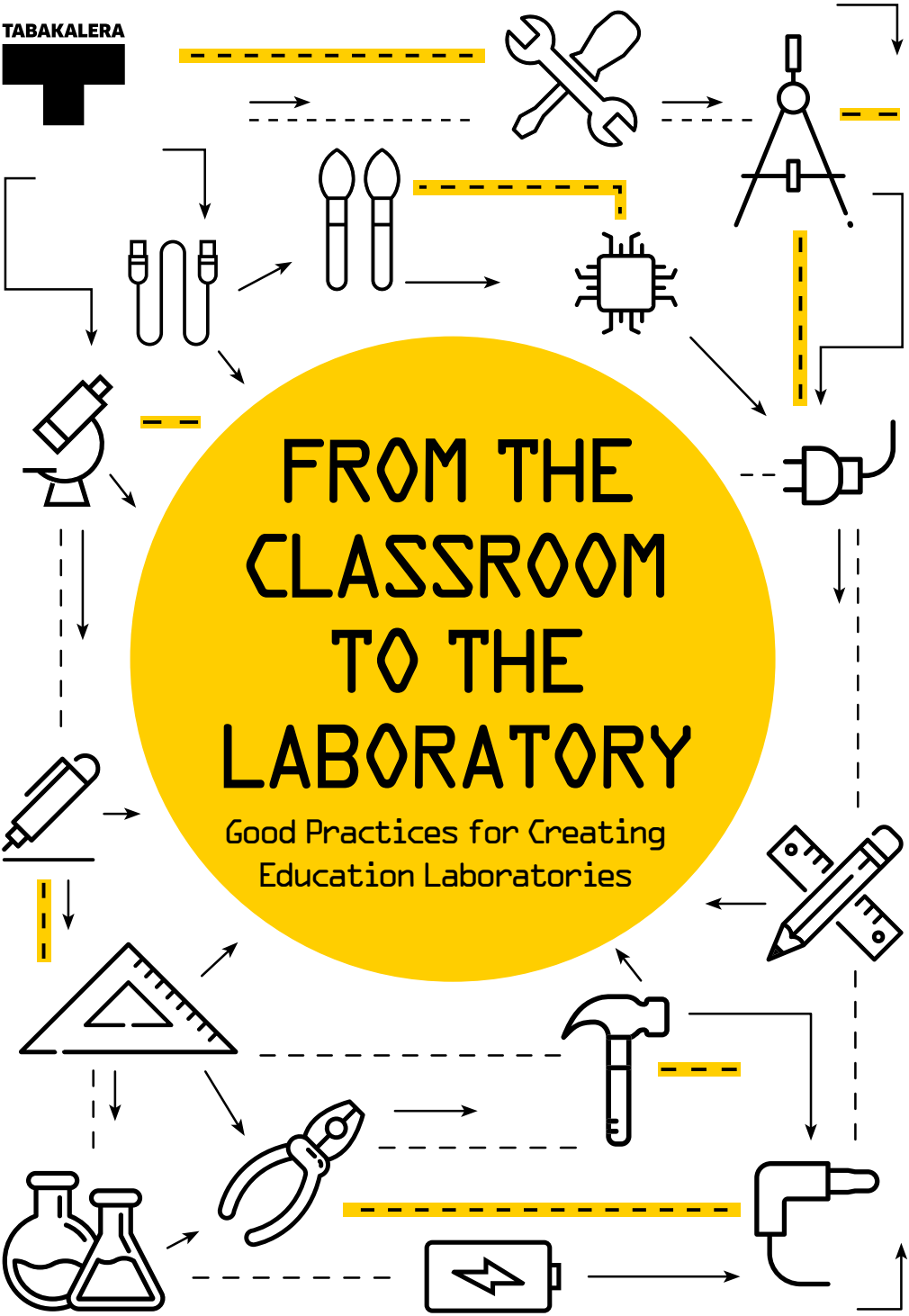

FROM THE CLASSROOM TO THE LABORATORY

Good Practices for Creating Education Laboratories

Donostia / San Sebastian

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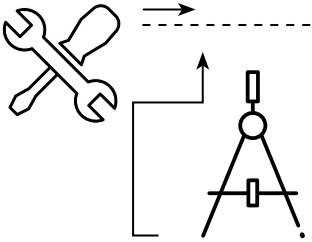
INTRO-DUCTION



This publication is the result of the reflection process carried out by the *STEAM*[1] *task force on Education Laboratories*. The task force has been meeting since November 2015 in Hirikilabs.

This task force was launched to address the concern shared around the 'packaging' of laboratories by an industry which sees the education system as a market without considering the *hows*, *whys* and *what fors* of humanity's use of technology, particularly in educational settings.

Task force members have used their own practice and experience to build open educational environments based on creativity, discovery and hybridisation between disciplinary fields and diverse forms of creating and sharing knowledge.

The first phase, called ***Meeting and Contrast***, which took place between November 2015 and February 2016, established the fundamentals of the process, mapped out various initiatives and defined key ideas for its approach. These include the notion that technology is viewed differently within the education sector than outside it. Laboratories only exist in schools because of the efforts of a small proportion of teachers who remove technology from its isolation.

In addition, there is clearly a gap for turning laboratories into spaces for creation, where the equipment (which may or may not exist) is a resource, and where technology is viewed in a wider sense as a connection between disciplines and as a space for experimentation and inclusion. The laboratory takes on a wider definition, going beyond the space itself to the practices and philosophies it encompasses.

[1] *STEAM // Science Technology Engineering Arts Mathematics*

The task force decided to cast their net wide and seek input and feedback with individuals who could contribute different experiences and approaches. This led to the second phase of the process, called ***Learning and Dissemination***, which was implemented between March and June 2016.

A series of important meetings were held with the dual aim of learning about and disseminating practices which were interesting to the process. These meetings sought to raise awareness of the 'laboratory' phenomenon within the education sector. Highly valuable contributions were made by Margarita Padilla, Danel Solabarrieta, Jokin Lacalle, Jabi Luengo and Paola Guimerans, and ideas and experiences were explored around communities, gender, methodologies and STEAM education.

September 2016 saw the start of the third phase of the work process, which gathered recommendations of good practices for establishing education laboratories and which are set out in this publication. Susanna Tesconi facilitated this part of the process and decided to frame the reflection around the following narrative building blocks:

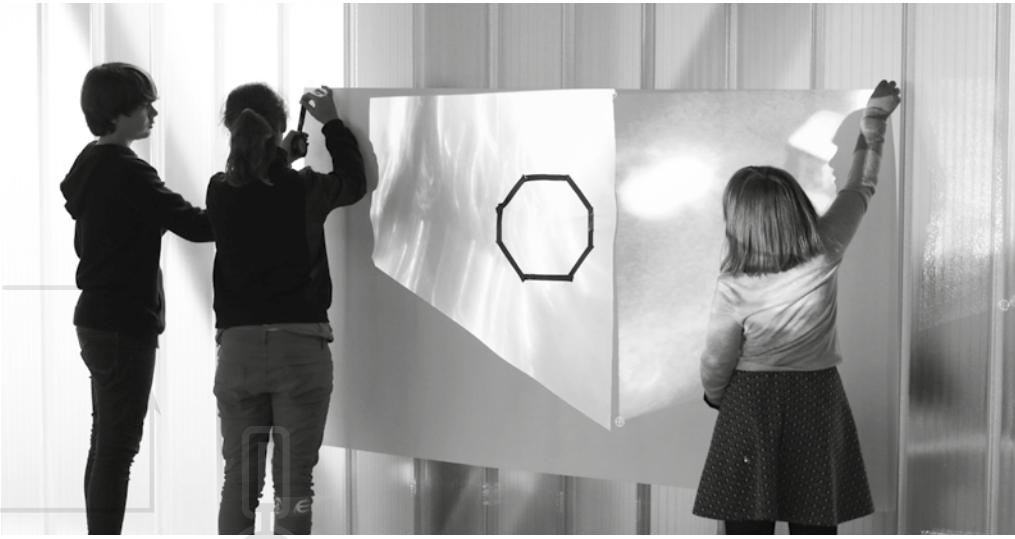
Narrative building blocks:

Spaces for learning and creation

Ways of doing and working

Situational changes: methodology and organisation

Each block is built upon conceptual maps and the reflection/discussion generated in the group about the approaches set out. The publication unfolds around the same blocks, and explores them starting from a collection of existing ideas about the design of educational spaces, the role of teaching professionals, teaching styles and the critical and creative uses of technology as pedagogical strategies.

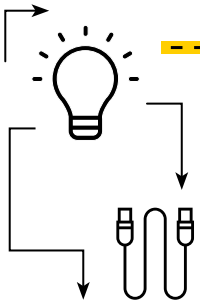


#1 CON-CEPTS / IDEAS

The teacher as a space designer

Generating knowledge through the co-design of learning environments: the education laboratory

The maker movement and STEAM environments through active education



This section gathers key ideas about the design of education spaces, teaching and critical uses of technology, all of which constitute the theoretical basis of the reflection process.

Approaches to education reflect a society's historically and politically determined outlook. **There are no neutral positions**, nor those which are distanced from specific intentions and visions. For that reason, it is important from the outset to share the theoretical and idealogical basis upon which the collective reflection process has taken place.

THE TEACHER AS A DESIGNER OF ENVIRONMENTS

DESIGN LEARNING

We live at a time when information is more available than ever. ICTs and the almost ubiquitous connectivity enabled by the profusion of devices such as mobile phones, tablets and computers, and the powerful actions of movements which democratise technology, put us in direct and rapid contact with an immense network of knowledge, some of which is open and freely accessible.

Information and knowledge is no longer imparted exclusively through traditional channels like teaching. As indicated by Goodyear and Dimitriadis (2013), this is why we need to redefine the role of our educators and how we create and organise knowledge.

Their view aligns with that of King (1993), who sought to change how we view teachers (rather than a *'Sage on the Stage', they are a 'Guide on the Side'*[2]), and tries to overcome this view by casting the teacher as a designer of learning environments. As **designers**, teachers have access to useful tools for identifying their students' educational needs and for supporting their students to learn and take advantage of the knowledge available to them.

The teacher continues to provide access to information and knowledge, but is also capable of designing and activating environments where the student can explore, investigate, analyse, synthesise and build shared knowledge from the huge variety of cognitive and technological resources around them.

Design learning is based on the idea that education is not just about transmitting information to a passive receptacle but about **integrating the student's motivation with the construction of cognition**, and triggering cognitive abilities which enable students to learn autonomously (Laurillard, 2013).

Education is conceived as an act of design, such as a problem-solving activity that leads to the creation of something that didn't exist before (Ertmer, Parisio & Wardak, 2013).

[2] *From Sage on the Stage to Guide on the Side.*

Mor and Craft (2012) define *design learning* as the creative and intentional act of conceiving new practices, planning activities, and seeking resources and tools for reaching new educational goals within a specific context. The teacher in their vision acts based on their knowledge of the field, a pedagogical approach, technology and practical experience, and in doing so generates new practices within these fields and supports the students as they work towards their goals.

The design idea upon which this vision is based comes from analyses by Cross (2001), Latour (2008) and Schön (1992). That is, the idea of ***design as a discipline that is at once science and art***. Schön in particular sees the educator, and other professionals, as a designer who creates devices and methods for solving problems, but places the emphasis more on the process of identifying the problem than on the steps necessary for solving it.

Design in this vision is simultaneously a creative practice and a research process. It can be applied to complex contexts where the most optimistic and nuanced analytical techniques fail. For Shön, design is not limited to applying scientific knowledge to problem solving within a set context. Rather, it extends to the creative potential of the professionals involved, and places more value on their tacit knowledge. **Based on this logic, teaching professionals are like practical researchers in a constant dialogue with the scientific community.** On one hand, they base their actions on scientific theory, and on the other, they nourish the scientific community with the knowledge they generate.

THE TEACHER AS A DESIGNER OF ENVIRONMENTS

DESIGN LEARNING

The analyses by Latour (2008) and Mor, Craft and Hernandez-Leo (2013) generated a list of *design learning* characteristics which helps us to better understand what it's about:

- A **process** through which teaching professionals meet educational goals in a specific context.
- An **art form**: a technical ability and a creative practice.
- A **science**: a theory-based critical and reflective inquiry.
- A practice **guided by ethics** that identifies needs and proposes improvement strategies.
- A practice geared towards **change**.
- A practice of **repeating** processes to adapt and improve them.
- A practice that alternates between defining the problem and solving it.
- A humble yet powerful practice that considers contextual limitations and those of the people involved.

As stated by Dalziel et. al. (2016) and Koper (2006), *design learning* is about developing a descriptive framework for gathering and representing teaching and learning practices and exploring how this framework could support educators to adopt new strategies. It's about representing the teaching and learning processes that take place in the classroom and from there identifying all supportive actions taken by learners and teachers alike.

Another feature of *design learning* is the emphasis it places on sharing practices among teaching professionals. *Design learning* is therefore a methodology that supports teachers to make decisions on the design of activities and interventions, and is an opportunity for peers to generate knowledge and training exercises together.

GENERATING KNOWLEDGE THROUGH THE CO-DESIGN OF LEARNING ENVIRONMENTS: THE EDUCATION LABORATORY

Researchers agree on the need for institutions to step away from the course-based training model (which focuses on one specific tool) towards one which provides more learning opportunities (Riera & Prats, 2008; Stein, Smith & Silver, 1999).

The technical reasoning behind a teacher training model focused on developing technical skills and acquiring technological knowledge only goes so far in addressing the challenges faced by professionals who sometimes use indeterminate practices within complex settings.

> *When we talk about a teacher, we're referring to someone immersed in the complex world of the classroom to the extent that they understand it both critically and vitally. They are affectively and cognitively involved in its unclear exchanges, in analysing messages and interaction networks, in questioning their own beliefs and approaches, in proposing and experimenting with alternatives and in the ongoing reconstruction of the school world.*
>
> *(Schön, 1992, p.89)*

GENERATING KNOWLEDGE THROUGH THE CO-DESIGN OF LEARNING ENVIRONMENTS: THE EDUCATION LABORATORY

Professional training based on technical reasoning belongs to a hierarchy that views professional development as the process for resolving instrumental problems via the application of specialist scientific knowledge. According to Schön (1998), ranking professional knowledge in this way causes a separation between research and professional practice, among other consequences. Researchers provide the knowledge for diagnosing and solving problems, and professionals feed their problematic or successful experiences back into the system as evidence for the research.

The alternative to the model we've just described is teacher training based on reflection in action and developing critical reasoning. It opens up a line of research, and is a more effective alternative for solving problems in the classroom (Schön, 1992; Carr & Kemmis, 1988).

Teacher training is viewed as an 'innovation area'; a space for experimentation and education where experiential learning, research and organisational creation of knowledge lead to improvements (Fernández Rodríguez, 2009).

Design processes provide the teacher with opportunities to reflect on the curriculum and environments, based on the knowledge, beliefs and learning objectives that they set for students (Parke & Coble, 1997). Interaction with other teachers, experts and researchers can deepen their reflections (Borko , 2004) and radically improve their learning Ball & Cohen, 1996; Parke & Coble, 1997), and improves the quality and validity of the devices developed (Penuel, Fishman, Yamaguchi & Gallagher, 2007).

Training on STEAM and *making* is a constant and ongoing process. Technologies and action plans evolve continuously based on contributions from the community and scientific advances. For that reason, the implementation of creative technology practices requires tools for generating continuous training processes based on self-training, collective cognition building and access to technology and educational resources in person or remotely.

In that sense, the laboratory **should operate as both a repository of material and digital resources and as a multidisciplinary and intersubjective space where knowledge is built through social interaction, self-management, self-training, research and informal learning, and through participation in expanded educational communities.**

The resulting knowledge is ***situated and distributed***. That is, knowledge is created in the context within which it is used, and is distributed among individuals, groups, spaces and symbolic contexts. Selection is based on the principle that working in teams and networks leads to a more effective use of knowledge and lends it greater quality and depth. It also draws on the idea that **the layout of the space plays a vital educational role;** the organisation of the space can help generate positive interactions between individuals and lead to creative practices.

The laboratory is therefore a space where students can experiment, where teachers can develop and exchange practices, and where peers can jointly develop training processes. It's more than a fitted-out physical space. It's a place which facilitates meeting, knowledge creation and the development of strategies and tools.

THE MAKER MOVEMENT AND STEAM ENVIRONMENTS THROUGH ACTIVE TEACHING

Initiatives such as the *maker movement* which seek to democratise technology, the profusion of digital manufacturing spaces and citizen science programmes, and the growth in interest in the STEAM approach, are all affecting education practices and how knowledge is generated.

Looked at from an education perspective, these powerful stimuli for acquiring scientific knowledge can open new links between them and generate dynamics with varying levels of inclusion and freedom. STEAM training – in the sense of acquiring technical abilities – could be seen as a response to the demands of the labour market: an opportunity to train future workers in the fields of science, design technology and engineering.

Alternatively, if we view STEAM, DIY, *and maker-centred activities* etc. as an opportunity to generate education practices based on inquiry and cooperation, we put ourselves in a completely different place and **use the *hype* to salvage and update all those active and critical pedagogies which, despite having existed for centuries, have never been implemented on a significant scale within the formal education system**.

This second approach requires an understanding that purpose of STEAM or *maker-centred* learning environments **is not limited to training professionals but is about inspiring people and strengthening their commitment to learning.** It's about collaborative use of interdisciplinary inquiry tools and the creation of shared knowledge, encouraging people to develop as creators of knowledge, and driving a change in educational relationships towards a more fluid exchange between experts and learners.

Furthermore, as Blikstein (2016) highlighted, **the education community takes on the role of guide in these change processes** when it comes to implementing STEAM laboratories, makerspaces and fablabs in educational settings. Without an approach that places learning and freedom at its heart alongside critical, creative, multi/interdisciplinary and reflective knowledge of the technical competencies demanded by the market, STEAM environments will fail to generate profound change in our education system and will be just another example of its subordination to the market.

#2

SPACES FOR LEARNING AND CREATION

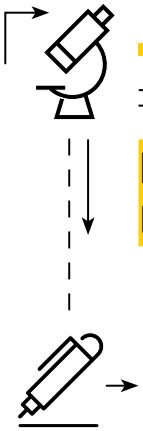
Laboratories: why and what for?

What do we want to achieve with laboratories in education?

What's the methodology?

What's the learning objective?

What organisational changes are we looking for?



LABORATORIES: WHY AND WHAT FOR?

The ideas, visions and intentions set out in the above section constitute a breeding ground for educational actions that encourage the establishment of education laboratories: education and creation spaces, and environments where experimentation, relationships, doing and broad learning have a place.

Why do we need laboratories?

A laboratory provides more opportunities to learn things that aren't taught. With the right guide, we can learn the same thing as taught using the traditional methodology but in a more active way.

Unfortunately, initial teacher training doesn't encompass learning while doing, nor does a school which favours a lecture-style approach to teaching.

For that, we need spaces where everyone can learn while doing, creating and inventing together. We need environments where students can work hands-on to get first-hand experiences as they take advantage of an unbeatable group-working opportunity.

Laboratories facilitate real-world projects and an exploration of the connections between subject areas.

They are also environments where it is possible to play different roles and create interesting synergies through interacting, cooperating and collaborating. They are exceptional spaces for developing inter/intrapersonal competencies and a range of others.

LABORATORIES: WHY AND WHAT FOR?

Laboratory-style education enables us to bring what we've learned to reality, to try it out and play with it, because it invites us to test out the theory. **Errors are no longer a barrier, a one-way street or a stigma, but a driving force for learning.**

The laboratory is a more humane learning space where the barriers between 'the people who know' and 'the people who learn' are dissolved.

The full complexity of the changing reality that we live in cannot be reflected in textbooks. We cannot lock knowledge away in drawers – knowledge isn't something sealed but something which is created, altered and shared. The laboratory is an excellent environment for experimentation, enabling us to develop projects creatively as a fundamental stage of the cognition process, knowing that many projects will still be in the pipeline.

Schools have fewer and fewer spaces for creation and implementing learning. As a result, students feel a strong disconnect between what they learn and the reality outside of the school. This gap between theory and practice and a lack of truly significant experiences in school work dampens students' motivation and quashes their desire to learn.

Schools also lack spaces where learners can feel truly free. Laboratories – provided they are run properly – are spaces of personal and collective freedom.

School spaces aren't designed to enable us to move around freely and organise ourselves, but are set up to divide, manage and control. Classrooms are closed and entrances and exits are controlled. We're monitored and obliged to monitor during leisure and rest time.

Laboratories offer quite the opposite: the students themselves and even the school community can take responsibility for their needs and learning experiences.

In this sense, the laboratory is an important resource for building an inclusive and egalitarian school, because students on the 'periphery' can be integrated.

It can also be a wonderful tool for strengthening links in the school community and creating opportunities and synergies so that teachers, parents, relatives and students can learn together.

What for?

A prominent part of our reflection from the outset has been the idea that we need spaces for learning and creation that **change our relationship with knowledge**, combining it with experience, bringing theory to practice and applying what has been learned in the real world.

The laboratory is an ideal space for developing creativity. Open activities will enable students to open up and enrich their learning process. The laboratory is a flexible space for testing and experimenting that facilitates learning from mistakes. It opens up routes for learning and working as equals.

It's a well-known fact that he who doesn't want to learn doesn't learn. Laboratories are a powerful tool for creating significant learning experiences and thus sparking students' motivation, something which is often snuffed out by an education approach based on information transference or content far-removed from their interests.

Laboratories would also fulfil one of the most-forgotten aspects of the curriculum, particularly in secondary education: enabling students to acquire the ability to learn while doing and to learn to do it together.

Laboratories also serve relational, social and political purposes in addition to those linked with learning processes.

Thinking in laboratory mode (or experimental mode) makes us lower our demands and become more tolerant to other people's ideas, more open to collaborating and making mistakes, and more able and willing to learn.

LABORATORIES: WHY AND WHAT FOR?

Laboratories are powerful tools for bringing group and individual ideas to life, in both formal education and informal settings. The greatest challenge in setting up a creation space is making the community involved understand that their ideas can be developed in a laboratory, and that it's possible to move from consumption to creation.

We live in an increasingly consumerist society, and this makes it hard for people to fully appreciate the motivations for setting up a laboratory. A consumerist society isn't based on creativity, hence creative spaces don't make much sense. Why create something we can purchase?

To overcome this challenge, we could take a more 'political' viewpoint by connecting the laboratory's goals with the needs of the community using it, and setting out a specific sphere of action, such as ecology, sustainability or energy poverty, for example.

WHAT DO WE WANT TO ACHIEVE WITH LABORATORIES IN EDUCATION?

One prominent conclusion of the group reflection process was the need to offer educational alternatives that place people in positions and projects which enable them to participate as agents.

The education laboratory has traditionally been associated with science, but we don't want to imitate nor seem like scientists when we're learning. Rather, we want to develop each person's capacity for asking questions, researching these questions and trying to find answers through experience (in this case in the laboratory), whether they achieve satisfactory results or not.

We should bear in mind (and make others do the same) that the laboratory is the context within which **'to achieve satisfactory results or not'**. It's about the process more than the products and results that come out of it.

The laboratory is a development environment for learning things which are directly linked to the project being worked on, but it's also a place for learning from dynamics and through management, cooperation, organisation and sharing knowledge.

WHAT'S THE METHODOLOGY?

The most common methodology used in laboratories is ***Project-Based Learning***, though there are many alternatives and nuances that can help us explore the epistemological, cognitive, emotional and political richness that an experimental environment provides.

In fact, **any methodology that makes the learner aware of and responsible for their learning process is a possible alternative. This cross-cutting approach is just as applicable to science and digital manufacturing laboratories as it is to libraries, theatres, art studios and creation spaces in general.**

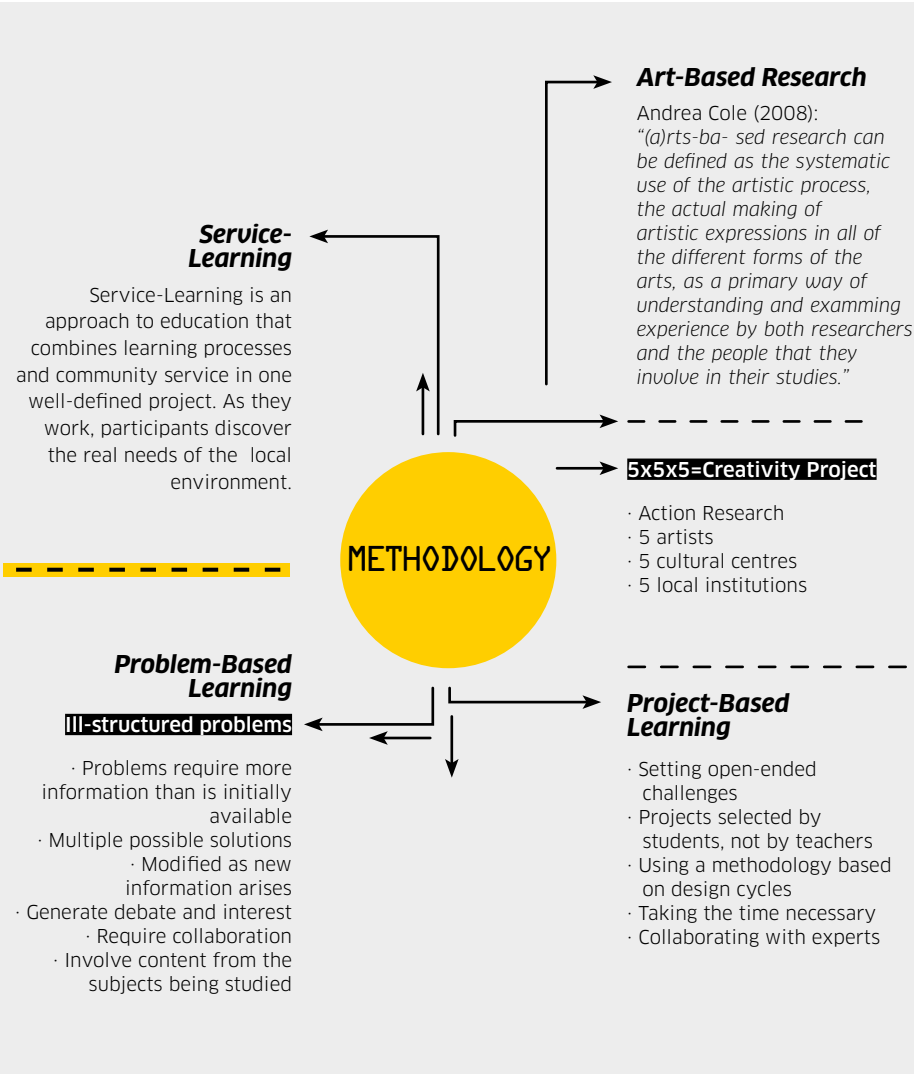
Project-Based Learning is one of the most compatible methodologies with the laboratory approach, but we should highlight some of the reasons why laboratories are inspiring spaces.

Open-ended challenges are always more effective, and projects should be chosen by the students themselves or at least designed based on their interests. Work should be organised in prototype cycles so that there is time and space for reflection and learning from mistakes.

Time is an important facet of learning processes based on interest and experimentation. As Papert said, we must take the time necessary for the work we wish to do. This is a sensitive issue in such a confined context (in terms of time and space) as a school.

In addition to *Project-Based Learning* we have *Problem-Based Learning*, *Service-Learning* and *Art-Based Research*.

Problem-Based Learning has some common threads with *Project-Based Learning*, but is closer to the educational applications of the scientific method. It is based on setting problems related to the subjects being studied. These problems have very little structure.


Art-Based Research
Andrea Cole (2008):
"(a)rts-ba- sed research can be defined as the systematic use of the artistic process, the actual making of artistic expressions in all of the different forms of the arts, as a primary way of understanding and examming experience by both researchers and the people that they involve in their studies."
Service-Learning
Service-Learning is an approach to education that combines learning processes and community service in one well-defined project. As they work, participants discover the real needs of the local environment.
5x5x5=Creativity Project
· Action Research
· 5 artists
· 5 cultural centres
· 5 local institutions
METHODOLOGY
Problem-Based Learning
Ill-structured problems
· Problems require more information than is initially available
· Multiple possible solutions
· Modified as new information arises
· Generate debate and interest
· Require collaboration
· Involve content from the subjects being studied
Project-Based Learning
· Setting open-ended challenges
· Projects selected by students, not by teachers
· Using a methodology based on design cycles
· Taking the time necessary
· Collaborating with experts

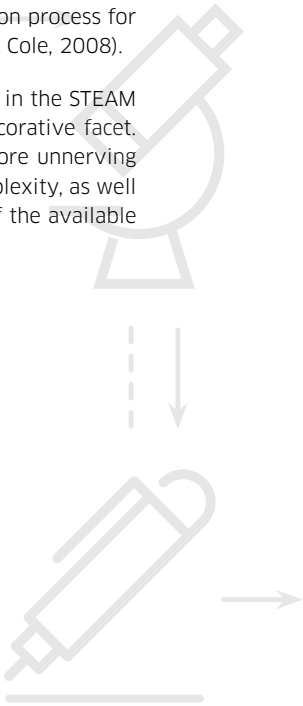
WHAT'S THE METHODOLOGY?

Solving these problems requires more information than is initially available. They have multiple solutions and are modified when new information arises. The problems generate debate and interest and require collaboration to solve them.

Service-Learning is an education approach that combines learning processes and community service in one well-defined project. Participants learn to work on real needs arising from their community and to improve their local environment.

Any query-based approach usually functions well in laboratory mode, such as ***Art-Based Research***. That is, the systematic use of an artistic creation process for understanding and learning about the reality around us (Knowles & Cole, 2008).

Embracing this type of approach also enables us to work on the A in the STEAM acronym, which regrettably is sometimes considered a merely decorative facet. Strengthening artistic practice in STEAM education facilitates a more unnerving process and various layers of technological and interpretative complexity, as well as a multi/interdisciplinary process and critical and creative use of the available technology.



WHAT'S THE LEARNING OBJECTIVE?

Students' learning in experimental and creative environments exceeds the limits of the subjects being studied and goes beyond the curriculum.

We're talking about values, an active attitude, self-confidence, a critical spirit towards ourselves and others, ethics, the ability to work alone and in a group, and the habit of working (and motivation to do so). Young people can and need to learn these things and can experience them in creative environments.

It's about a learning process where the students are active and interested, and the teachers are supportive and capable of broadening the subject to meet students' needs.

It's about developing multidisciplinary learning and knowledge and going beyond specific subject knowledge to work on social skills, autonomy, creativity, knowing how to accept criticism, etc.

They say that schools should prepare a person for real life. In that sense, there would be no reason to separate the learning acquired in creation spaces from that acquired in other school departments. Otherwise, laboratories would become *ghettos* within the school.

Framework

In a laboratory setting, students can acquire knowledge across a range of areas. They can learn curriculum content, procedures, how to use tools, systems and devices, and can practice being and cooperating with others.

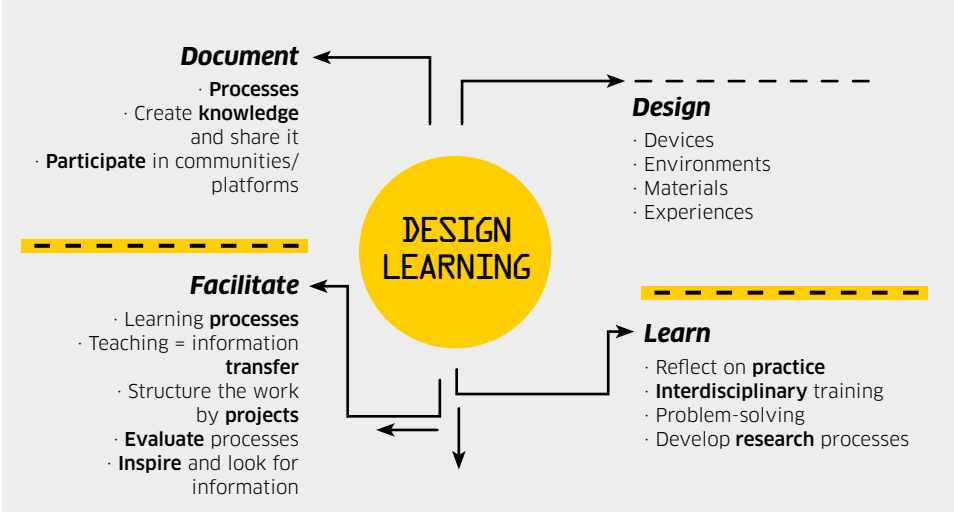
The recommended approaches arise from a construction-based vision of learning. That is, the idea that learning results from building knowledge structures through the gradual internalisation of actions (Jonassen, 1994). Added to this is that learning is more successful when the person is involved in actively constructing devices that can be taught and shared (Papert & Harel, 1991).

WHAT'S THE LEARNING OBJECTIVE?

The construction-based approach puts the focus on the person's learning process and on their interest in learning and building devices and systems. The teacher figure in this set-up is a facilitator who supports the student's learning, without establishing guidelines, and limiting their instructions.

In this aspect of our reflection we have come across different standpoints on balancing learner freedom with a framework that guides without limiting, and which favours initiative and interest on one hand with trying to mediate content and abilities from the curriculum through the teaching activities designed for that purpose on the other. In some examples, those involved believed in complete liberty to experiment, and in others, the teacher figure was seen as having to structure the activity at different levels. Their standpoint, as always, depends on the context and the teacher's style.

A teaching style based on *design learning* may prove useful. It is widely adopted in *maker-centred* and *design-centred education*, as illustrated in the following table.

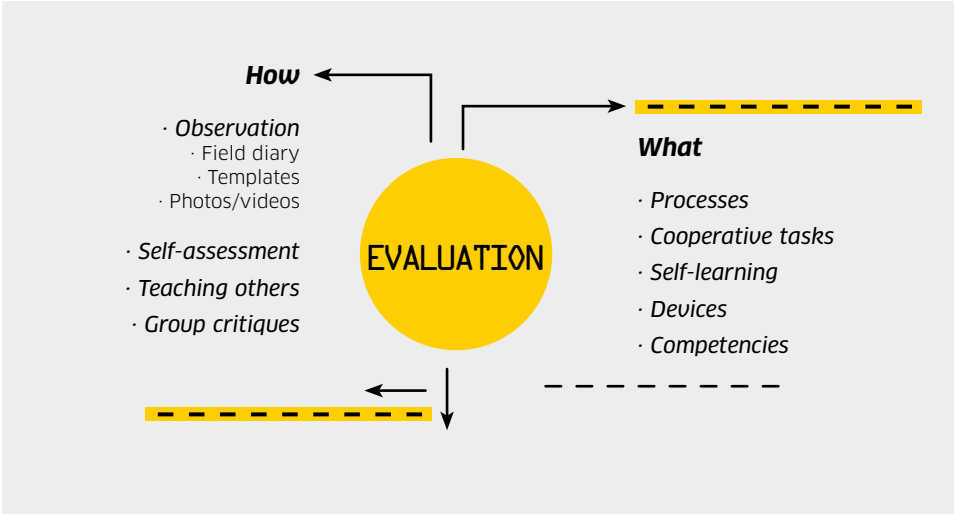


Evaluation

Evaluation is another crucial aspect when considering experiential learning and creation spaces. What is evaluated in a laboratory, and how?

The educational nature of laboratory activities is usually assessed as the work progresses. Various methods of documentation are used: field journals, reports, discussion groups, conversations, interviews, observations, images/videos, devices, rubrics, etc.

The goal of evaluation is to alter the initial design of the environment throughout its use to adapt to the responses of the people using it. Processes (rather than results) are evaluated, based on practical observation and analysis of behaviours, creations and interpersonal and cooperative dynamics. The overall aim is to improve how education is delivered, rather than students' marks.



WHAT ORGANISATIONAL CHANGES ARE WE LOOKING FOR?

When it comes to introducing new spaces and, above all, new approaches in traditionally rigid settings such as schools, activating a change process within the existing organisational framework can be a problem.

Some say that introducing a laboratory requires huge organisational changes in the school in terms of time and space. According to others, changing the entire school dynamic based on laboratory initiatives would be impossible. Under this perspective, the change would have to happen the other way round. That is, a laboratory can be an important part of a transformation process which is driven by a committed leadership.

Our reflection also revealed that the first stage of change doesn't have to be so intrusive. It could be like a small virus which spreads dynamics and ways of doing things. The concept of *experimental, dynamic and open* working would be introduced in an existing cross-cutting space within the school, such as the library or art and technology areas. This interdisciplinary space would accommodate projects from different subject areas and informal learning.

In any case, these 'organisational' changes must be determined by the school based on the design of the initiative and the needs detected, so that the transformation is supported by the leadership and the entire school community and thus integrated into the school curriculum.

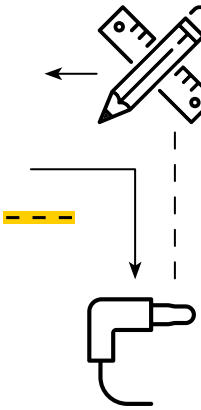
#3

WAYS OF DOING AND WORKING

How can we involve the school community?

What type of space?

What tools?



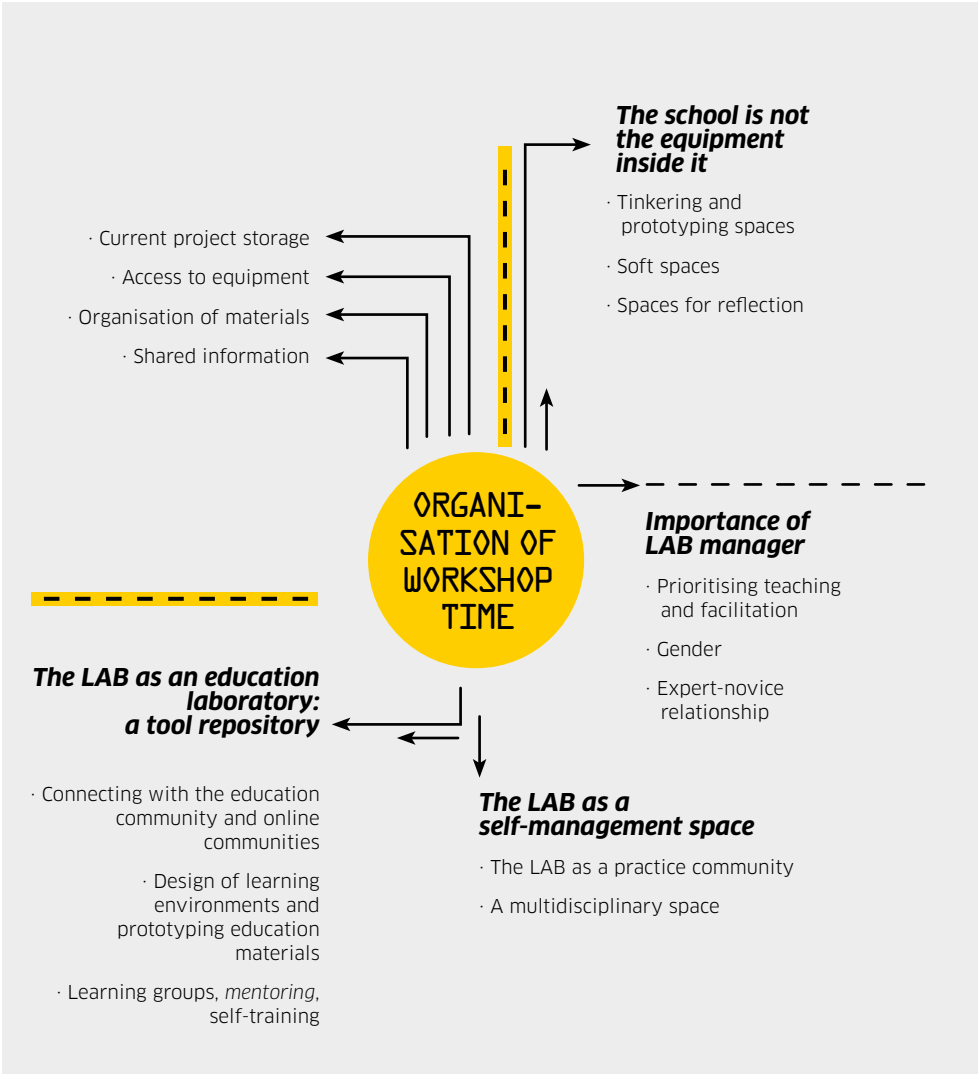
HOW CAN WE INVOLVE THE SCHOOL COMMUNITY?

The school community is a complex network of various actors following different curricula and with different roles. This model of layered action on constituent parts is a shared strategy.

It has to involve both teachers and school leaders, and must focus on the most pedagogical aspects of the project. As suggested already, the laboratory or creation space should ideally be integrated into the school curriculum, positioning it as a lever for activating and planning pedagogical change.

A complementary strategy could be to involve the parents' association, and orientation and/or teaching innovation centres. The process could also draw on the relationship between the school's leadership teams or teachers groups interested in creating other education spaces and models, **and current or former students could be involved too.** Putting out a call for proposals would seem the most sensible path in this regard.

WHAT TYPE OF SPACE?



It's hard to provide a general response to this question. As often happens in schools, the idea comes first followed by the resources later. It is up to each school to decide where to begin and in what direction and to work towards meeting goals, based on their resources and curriculum.

There is agreement within the reflection group that the laboratory has to be an open environment with various spaces for reflection, brainstorming, manufacturing, tinkering, prototyping, discussion and documentation.

It's a place for experiencing the 'hard' and 'soft'[3] aspects of technology and for playing with the different types of laboratory, such as the chemistry lab, art studio, carpentry workshop, tailoring and textiles lab, print shop, kitchen, makerspace, farm, multimedia lab, library, etc.

The design of the space is gender-neutral and aesthetically pleasing to all. It doesn't just evoke traditionally masculine, technology-based knowledge creation spaces, but expands on the idea of technology and integrates it with traditional craftsmanship, culturally relevant elements and art and science.

Some would say that the laboratory has to be a kind of redesigned and kitted-out classroom space which challenges the school's work dynamics, breaks up the linear curriculum and facilitates more hybrid encounters. They see it as a classroom transformed into a work laboratory used by all students.

For others, a space that breaks from current systemic practices throughout the school is seen as ostracism of the space, its manager and the work carried out within it.

They worry about the impact that a space with the potential to transform teaching practices could have on teachers who aren't directly involved. They believe that the project is doomed to failure if the space/manager/methodology is perceived as a threat by the rest of staff.

[3] Soft technologies are those which specifically try to question and improve social relationships and how the systems we organise ourselves around operate. Eg. Those related to knowledge generation, talent management or learning development.

WHAT TOOLS?

When it comes to tools, there is no magic formula nor pre-defined shopping list. They must be chosen to strike a balance between the goals for the space, available resources and the context of each school. The laboratory doesn't have to be located within the school grounds. Resources from the wider area can be used and existing spaces redefined.

We don't need much material to start experimenting.

A variety of equipment and tools can be chosen and will be depend on the shared interests and goals of those involved, and on the resources available.

There's a place for digital equipment and equipment for design, research, rapid prototyping, programming and digital manufacturing.

There are spaces for reflection and discussion that facilitate comfortable group work and which have tools and resources for expressing ideas, documenting them and exploring them.

There are building spaces with tools for manufacturing, tinkering, painting, sculpting, silk-screen printing, moulding, experimenting with different materials, reuse and recycling, sewing etc.

The space should be flexible and adaptable to different needs and ways of working so that each group and project can be configured in different ways, and each student can influence and define how the space is organised.

One of the goals when considering an open space is that people experience it as their own. To achieve this, the organisation of the space must consider the following:

· The school is **not** the equipment it houses, but its people and knowledge.

· **Access to tools** should be a priority. Information and training should be focused on independent use of resources.

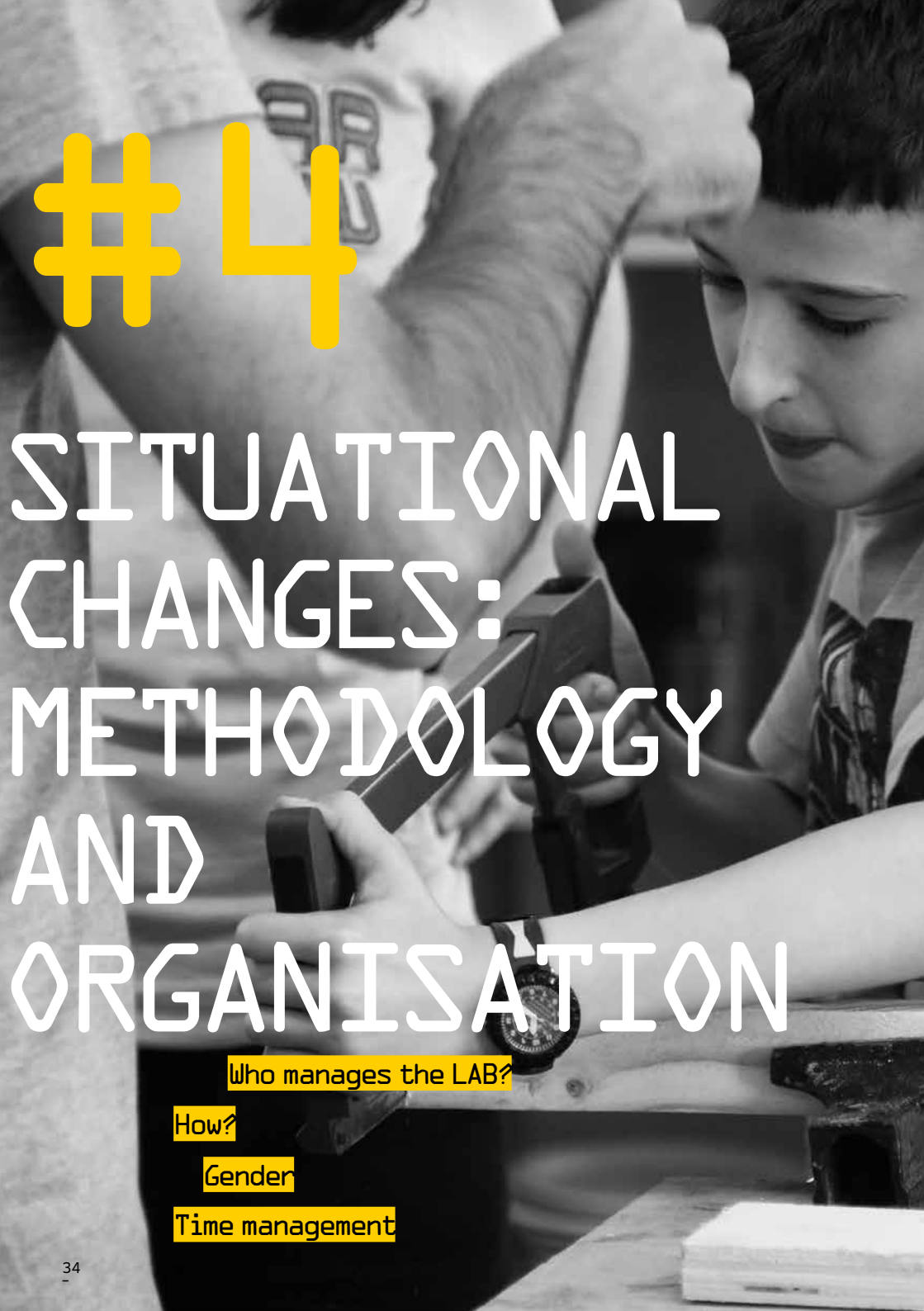
· **Materials should be organised** to encourage accessibility, experimentation, remixing and sustainability.

· Each project needs **storage spaces** throughout the process. Something that fulfils a practical space-management function as well as a more pedagogical role of promoting a sense of belonging and of having a place within the collective group space.

· The **information** about how the tools and space function has to be **shared**, as does the resulting project documentation.

· **Encouraging** respect for other people's work.

· **Cultivating** a love of learning, not of competing.



#4

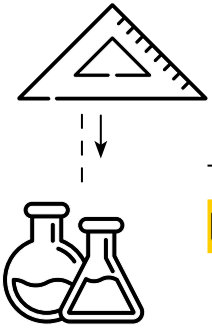
SITUATIONAL CHANGES: METHODOLOGY AND ORGANISATION

Who manages the LAB?

How?

Gender

Time management



WHO MANAGES THE LAB?

An important aspect of implementing a creation space is the desired profile of the people who will coordinate and run activities within it.

The LAB manager figure doesn't exist yet, and the functions and tasks of this role are yet to be fully established. Moreover, the LAB manager role should be taken on by someone from the school's teaching staff.

We've discussed what profile, attitude and characteristics the LAB manager should have, and there's a level of agreement around attitudes, tasks and knowledge.

We don't want to set strict, limiting and excluding requirements but rather to inspire those people who are interested when it comes to seeking resources to expand teaching. The fundamental element (more than prior training and technical knowledge) is their attitude towards learning, and the desire to experience new methods, tasks and tools in order to integrate them into teaching or socio-educational and cultural interventions.

Our vision has a place for someone approachable and attentive, an enabler geared towards problem solving. They don't have to be the one who provides the solutions, but who facilitates the means and the context for others to find them. They'll be more of a manager than a doer. This is a difficult balance for people who like to have their own projects.

WHO MANAGES THE LAB?

In terms of desirable knowledge and abilities, we envisage **someone**:

· **Trained in teaching** and with previous experience in active methodologies where possible.

· Experienced in cooperative **work dynamics** and creative techniques etc.

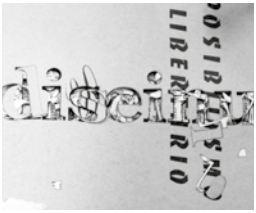
· **Who is an expert technology user** (hard and soft), and who may have knowledge of digital design, electronics and equipment maintenance.

· **Capable of managing web content effectively** to stay on top of what's happening in the *maker* community, a world which is changing at an incredible pace.

· With an **artisan spirit** and artistic curiosity, and who likes *doing*: good with their hands, enthusiastic and considerate of others etc.

· **Who can make decisions**, use their initiative and show resilience.

· With a natural interest in **experimenting**.



HOW?

We believe that a laboratory management philosophy based on self-management or shared management facilitates the best use of the space.

Taking decisions collectively, encouraging assembly-based management and taking charge of managing the space all lead to a more respectful attitude towards our surroundings.

The people who use the laboratory – students, teachers or the wider school community – need to experience the space as though it were their own. They should have access to material resources and information and decide collectively about how the space is organised and used. This requires sharing our responsibilities, and a sense of responsibility over the management of the space.

This philosophy has already been applied in some contexts. For example, Jokin Lacalle says he had this aspect in mind when he launched the Koolaborategia in Jakintza Ikastola (Donostia / San Sebastian). He put students in charge of managing the Koolaborategia during class time, and got parents and teachers involved outside of teaching hours.

It's a powerful dynamic, and a project which isn't viable without support from the school management. The road towards autonomous management is long and requires managerial involvement in the beginning.

GENDER

Creation of/with technology and science and technology research remain male-dominated fields characterised by a lack of policies addressing equality and the inclusion of traditionally marginal subjects for creating technological knowledge.

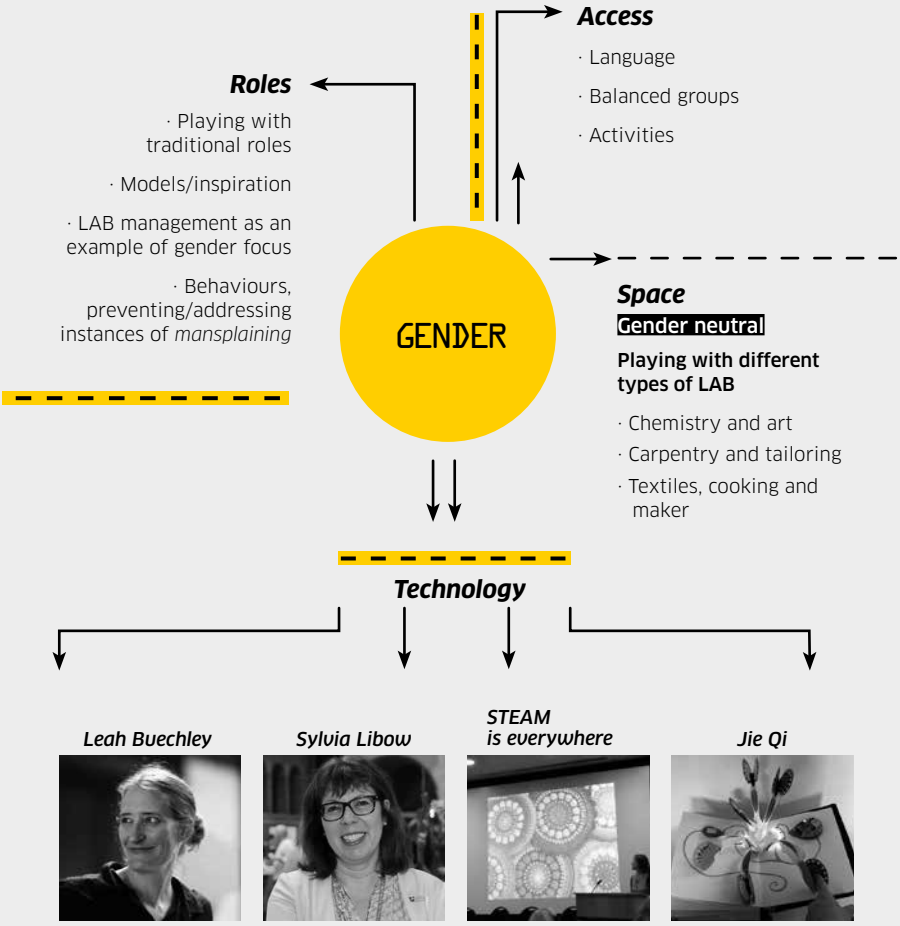
Technology education, STEAM and the world of making and DIY are not exempt from such dynamics and, contrary to what we might think, actually encourage them. They uncritically incorporate models, examples and practices which stem directly from the more traditional and exclusionary world of technology production.

Several researchers looking at education dynamics within technology democratisation movements, such as Buechley, Libow and Rosenfeld, warn that there remains much critiquing, reflection and awareness-raising to be done before current learning environments based on the creative use of technology are truly inclusive and nourished by the complexity of difference.

Strategies to facilitate gender inclusion in the LAB can address different aspects of creative practice. For example, they identify key spheres of action such as **access** and participation, **space design**, definition of **roles** and the selection of a specific **technology vision**.

In terms of LAB access, aside from structuring groups in a balanced manner it's important to consider how language is used to define, name and describe what goes on in the laboratory. Some activities are traditionally considered 'masculine', like robotics. Others are associated with more 'feminine' knowledge, such as sewing or smart textiles. It will be hard to incorporate diverse subjects into activities in the laboratory if we limit ourselves to these concepts. We have to use more general names and pay more attention to the image being communicated.

Hybrid art and science activities, and using diverse techniques and know-how to present information, may be an effective route towards dismantling the masculine/feminine divisions that limit our knowledge and technological development.


Access
· Language
· Balanced groups
· Activities
Roles
· Playing with traditional roles
· Models/inspiration
· LAB management as an example of gender focus
· Behaviours, preventing/addressing instances of *mansplaining*
GENDER
Space
Gender neutral
Playing with different types of LAB
· Chemistry and art
· Carpentry and tailoring
· Textiles, cooking and maker
Technology
Leah Buechley
Sylvia Libow
STEAM is everywhere
Jie Qi

GENDER

Other vital aspects of looking after these dynamics are the constant review and improvement of the process, supervising participation and researching the process, and seeking positive or negative changes to incentivise or eliminate certain elements and thus improve the process.

As we discussed already, **space design** must be gender neutral and fed by different types of laboratories, workshops and creation spaces.

The **roles** people play in managing the use of the laboratory and setting examples to students are also relevant. We must be careful not to focus education on competition and outperforming others.

Inclusion and diversity must be the fundamental ingredients when creating groups. That, and highlighting each person's qualities and working collaboratively.

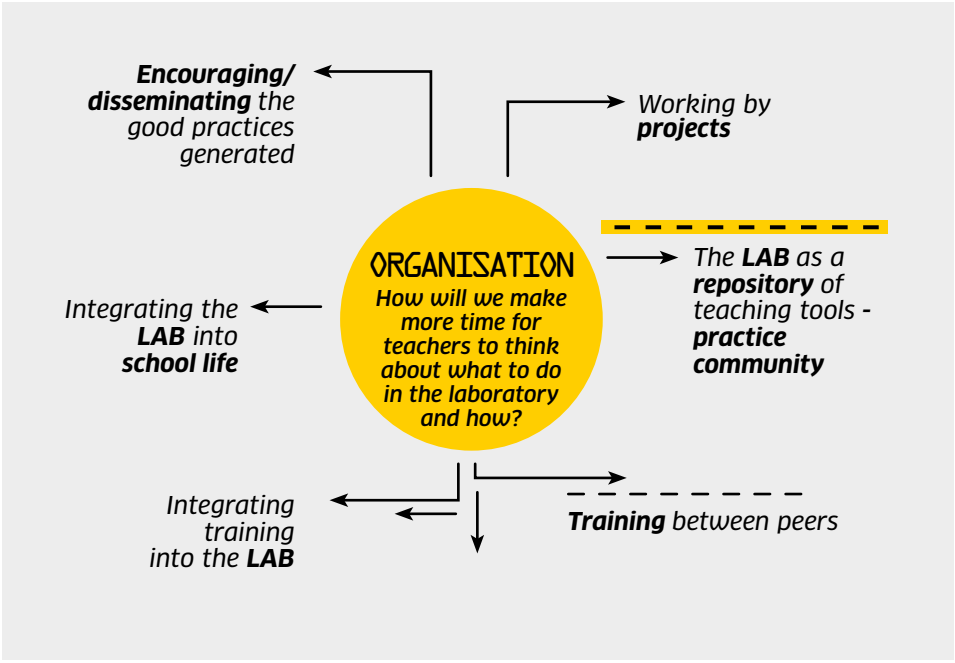
We must seek examples, cultivate spontaneity and try to find collaborators and projects that provide a more inclusive and less mainstream vision.

In terms of the **technology** that we should work on/build/design/learn about, once again there are no magic formulae. Our reflection suggests that any form of technological knowledge (in the broadest sense) can be a creative stimulus, including that linked to the social technology which affects how we organise and relate to ourselves. The choice will depend on the LAB context.

TIME MANAGEMENT

Time management is one of the most common problems or obstacles when running a laboratory in a school, in terms of organising students and activities and availability of teacher time.

We haven't considered how to create more time for teachers to think about what to do in the laboratory and how. While some viable strategies exist, we still don't appreciate that this is probably the most complex aspect within the network of actions necessary for creating and implementing creative spaces and methodologies in school settings.



TIME MANAGEMENT

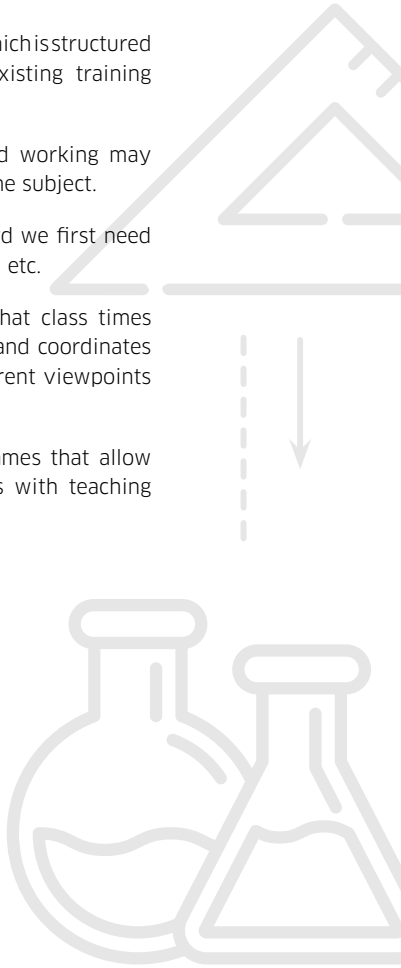
As the table shows, the strategies support **interdisciplinary** design which is structured by projects. The strategies also support the **integration** of existing training **activities** and production of materials **into the laboratory**.

Encouraging an interdisciplinary environment and project-based working may mean that in one classroom there are teachers from more than one subject.

For example, before certain science projects can be taken forward we first need devices for taking measurements, guaranteeing reliability of data, etc.

Another possible route might be to join subjects together so that class times are more continuous, as well as having someone who manages and coordinates different teachers and who can see the same content from different viewpoints and propose common projects.

Another option would be to take advantage of release programmes that allow teachers to train and to design curricular material, as happens with teaching Basque language (IRALE[4]).



[4] IRALE is a programme by the Department of Education of the Basque Government. Its objective is to increase the number of Basque speakers and the level of Basque literacy among non-university teachers and special education teachers.

The issue of training for teachers is more complex, as suggested by this statement by Jokin Lacalle:

> *I started providing technology training to teachers 18 years ago. It's a really complex issue. I gave workshops on PowerPoint, RSS and blogs, and even robotics. Motivation and willingness to implement what's been learned are always crucial factors. I've never seen teachers so terrified about the future as those I see now. Whenever I've tried to teach robotics, 2D and 3D design, laser cutting or similar things in Jakintza, I've encountered a fear that I hadn't seen before. In some respects I suppose it's normal: a significant proportion of teachers have yet to accept the previous technology revolutions, so it's no wonder these things scare them.*
>
> *I see a huge problem in teaching: the digital divide. And this is now. What'll happen in five years time?*
>
> *Jokin Lacalle*

#5

CONCLUSIONS

The *open laboratories* group was launched in Hirikilabs — a technology and digital culture lab open to anyone — with a clear educational purpose: to give a voice to people who use active practices to transform education.

There are many different ways of looking at a laboratory, but most agree that they are spaces and methods for experimentation, where the focus is on people, where reality is the context, and where people work together.

Such variety in how we define the laboratory means it cannot be packaged as a unique and replicable element. It's the concepts and values around the laboratory which are replicable. Technology is a tool that can facilitate different ways of working, interacting and expressing. Technology will continue to change, but if a laboratory is clear about its *whys*, *what fors* and *hows*, change shouldn't be a problem.

This document tries to lay the questions and anxieties on the table which are expressed by teaching professionals in their work. It also aims to open and spread debate about the education model and ways of working, and to open a channel for dialogue between teachers and institutions.

Various collaborators from the world of education have brought their experience to the process of putting this document together. We'd like to acknowledge them here.

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#6

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