A DESIGN DRIVEN PROCESS FOR A COLLABORATIVE AND PLAYFUL LEARNING EXPERIMENT IN THE MIDDLE SCHOOL
Introduction

Lamp&d is an experimental teaching project, fruit of collaboration between a group of teachers from a middle school and researchers from the Politecnico di Milano's Department of Design.

The underlying goal of the activity conceived and presented was to introduce a brief experience of the process of designing a simple artefact (a table lamp), experimenting with a peer learning approach through group work with teachers and external ‘technicians’ in a succession of design stages culminating in the production of a prototype using digital fabrication technologies.
The specific objectives of the activity presented were

01
To understand
the principles of design: general definition, fields of action, processes and methods (from the Milanese designer Bruno Munari to ‘design thinking’)

02
To stimulate
powers of observation of innovation phenomena in the man-made world

03
To cultivate
the ability to reflect on the relationship between artefacts’ form, use and function, through examples and applications in the field of lighting equipment design
The specific objectives of the activity presented were:

04. To develop the creative dimension: to understand a design problem, organise ideas, propose solutions, test them out and verify them.

05. To cultivate co-working skills, both with peers in groups of students and with the project leaders and the ability to analyse and represent components of objects through preliminary representations and models.

06. To give form to design ideas, test them empirically and prototype them.
Methodology

The project refers to the 2012 National Guidelines under Italian Ministerial Decree no. 254 of 16/11/2012, particularly where these set out the ‘citizenship’ and ‘lifelong learning’ competences (recommendation of the European Parliament and of the Council of December 2006) and Italian law 107/15 (Good School). This is the primary backdrop against which the presented programme develops.
The Transformative Learning Technologies Lab at Stanford University launched the FabLab@School project some time ago, confirming the potential inherent in these environments and processes: “It’s a place for invention, creation, discovery and sharing, a space of inquiry where everyone learns and knowledge gets integrated into personal interests and daily life. It permits the acknowledgement and embracing of different learning styles and epistemologies, engendering a convivial environment in which students can concretize their ideas and projects with intense personal engagement.”
Results

The Lamp&d activity was presented to a class two of the middle school in question and led by a group of researchers from the Politecnico di Milano’s Department of Design, in concert and collaboration with the school's maths, science and technology teachers. The class involved in the project consisted of 23 male and female students, divided into five mixed-sex work groups. The project was implemented over a period of approximately two months.
Phases

The work was divided into several stages, each of which adopted a different methodological approach and tools appropriate to specific purposes. All the phases were subject to detailed analysis, revision and documentation, through supporting texts and photographs on the web platform managed jointly by the class, with each group producing reports, texts and images in a shared and collective blog.
Introduction to design and presentation of the process

Venue: traditional teaching classroom.

Objectives: to understand the principles of design: general definition, fields of action, processes and methods (from the Milanese designer Bruno Munari to ‘design thinking’); to stimulate powers of observation of innovation phenomena in the man-made world; to cultivate the ability to reflect on the relationship between artefacts’ form, use and function, through examples and applications in the field of lighting equipment design;

Tools and methods: a face-to-face lesson was held with visual aids for introduction to design principles such as practices and codification of the discipline, with specific focus on design for innovation strategies, the lighting design tradition in Italian design history, and the frontiers of new fabrication and prototyping technologies. The overall process was also illustrated, with explanation of the objectives to be achieved and the work phases involved.
Conception and ideation phase based on briefs provided by the project leaders

**Venue:** technology lab.

**Objectives:** to develop the creative dimension; to understand a design problem and the constraints to consider, organise ideas and propose solutions; to cultivate co-working skills, both with peers in groups of students and with the project leaders.

**Tools and methods:** the students were subdivided into five groups of 4/5 students and given a design brief setting out the field of investigation and action, including a series of constraints imposed by the leaders and other ‘free’ constraints. Through a playful approach, each group was allocated the essential ingredients to begin working, in pre-packaged ‘mystery boxes’ based on sets of ‘cards’ intended to stimulate, trigger and guide their creative thinking. These included certain constraints to contend with, such as the formal typology to adopt (repetition of horizontal elements, repetition of vertical, radial or parallel elements, luminous enclosure or assembly of free elements) and the material to use during the prototyping phase (wood or plexiglass). These constraints were assigned through random extraction of cards by the students, an action that also introduced a dimension of play, unpredictability and surprise into the process. Other design constraints were offered to the students as a range of possibilities that they could deliberately choose, from different systems for joining the parts (interlocking, glue or tie-wraps) and, above all, different design ‘contexts’.

Consistently with the narrative approach described above, the groups were asked to choose a book, film or song and to identify its key words and images, from which to draw a specific design ‘theme’.
Venue: technology lab.

Objectives: to develop the creative dimension: to organise ideas and propose solutions, test them out and verify them; to cultivate co-working skills, both with peers in groups of students and with the project leaders; to develop powers of analysis and representation of objects’ components, using preliminary representations and models.

Tools and methods: the work groups were asked to further investigate and perfect the ideas developed in the form of sketches and images, through construction of preliminary models using simple materials (cardboards). During the initial phase of a project, the formal objective is not clear from the start but, rather, is formed during the process itself: sketches, models and comments not only generate representations that describe the final product with varying levels of precision but are, themselves, research and design tools. Working immediately with ‘volumetric’ forms enabled the students to instantly get to grips with elements such as the object’s size and physical, three-dimensional ‘presence’, its perception and interaction with the user, its function, and the type of lighting experience produced, and to ask themselves questions about the assembly and construction system in a self-learning process involving hypotheses and immediate testing.

Initial modelling phase using simple materials (paper and cardboard)
Finalisation and graphic rendering of the design

**Venue:** technology lab and assignments at home

**Objectives:** to develop the ability to represent objects’ components through technical drawings; to give form to and communicate design ideas.

**Tools and methods:** having defined the design through a preliminary model, the next phase concerned detailed representation through technical drawing. Each group produced a list of their design’s components with two-dimensional scale drawings of each element. The drawings were produced by hand by the students and converted into digital drawings by the project leaders. This step, which was essential to production of the laser-cut prototype, required further definition of the details of some components (radii of curvature appropriate to the technology, line thicknesses, etc.). The process was explained to the students although they did not actively participate in it. In order to use the available effectively, it was decided to work with them mainly on the creative phases rather than the engineering ones.
Prototyping by laser cutting

**Venue:** Polifactory (the Politecnico di Milano’s FabLab)

**Objectives:** to give form to design ideas, test them empirically and prototype them; to become familiar and experiment with digital fabrication technologies; to experience a FabLab environment.

**Tools and methods:** the students were taken inside Polifactory, the Politecnico di Milano's FabLab. During the visit, the laboratory managers showed them the spaces and available technologies and explained the function of and, naturally, the philosophy behind a FabLab in an academic setting. The fundamental principles of prototyping by 3D printing, laser cutting and Arduino programming were illustrated through several sample products created and explained by students of the Politecnico. The children then watched the production of the lamps designed by them.
Component assembly phase

Venue: technology lab.

Objectives: to give form to design ideas, test them empirically and prototype them through assembly of components; to celebrate the completion of a process and acknowledge the results achieved by the community of designers.

Tools and methods: using tools appropriate to the planned assembly method (glue, tie-wraps, etc.), the lamps were assembled by each group and appropriately fitted with lighting fixtures (led bulb and socket). On completion of the work, the lit lamps were exhibited and demonstrated to the class’ other teachers in a celebratory atmosphere of satisfaction in the results achieved.
Conclusions

Based on the national guidelines indicating the competence development goals, and on the ministerial circular letter of 10/11/2005 which interprets “competences as units of knowledge and know-how from the perspective of social and interpersonal skills”, the activity presented constituted a highly real-world task, consolidating the competences acquired at middle school.
Results Obtained

Area A – introduction and comprehension: “I’m starting to understand what we’re talking about”

This area relates to comprehension of the principles of design and digital prototyping and gaining an overview of the project. Even if not yet able to envisage its outcomes, the students consider the presented activity and imagine possible paths it could take.

Area B – conception: “How can I interpret the problem and find a solution?”

This area relates to creativity, comprehension of a design problem, organisation of the constraints, proposition of ideas and solutions, accessing powers of abstraction, conceptualisation, imagination and modelling.

Area C – collaboration: “I need to discuss my ideas and exchange them with those of others in order to identify the best one”

This area relates to the skills of collaborative working, listening, comparison and negotiation with peers, in groups of students, and with the project leaders.

Area D – creation: “I can produce a result”

This area relates to developing the skills of analysis and representation of devised solutions through preliminary representations and drawings, empirical testing, experimentation leading to a tangible result, contending with manufacturing technologies, and comprehension of operating principles.
Wrap-Up

This paper focuses on an on-field-research experience carried out in a seventh-grade class in Milan by a team of teachers from different educational level: it was a fruitful collaboration between two educational institutions, the middle school and the university, that hardly find opportunities for dialogue. Moreover, it turned out to be a valuable experience in terms of approach to design by younger students, application of innovative teaching processes and methods, experimentation of production technologies specific to the “industry 4.0” paradigm, use of co-design practices.

The "Lamp&d" project, in fact, led to the prototyping of a table-lamp through: a brief co-built by the university researchers and the middle-school teachers; a collaborative and problem-based learning that actively involved all the actors of the process; an experiential and playful methodology to develop a design thinking, based on “playing cards” able to stimulate and guide students’ creativity; a design-oriented learning driven by a trial and error process; a first approach to digital fabrication technologies which led to a physical prototyping realized thanks to the collaboration with the FabLab of the partner university.


5 www.reggiochildren.it/activities/atelier


17 R. Roy and J. Warren, “Card-based Tools For Creative and Systematic Design”, in Proceedings of
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