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THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

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IJPBL is Published in Open Access Format through the Generous Support of the School of Education at Indiana University, the Jeannine Rainbolt College of Education at the University of Oklahoma, and the Center for Research on Learning and Technology at Indiana University.

The Interdisciplinary Journal of Problem-based Learning

2021 SUMMER ISSUE

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ABSTRACT

Innovation in architecture education is increasingly oriented towards the analysis of real problems considered in their complexity and multi-dimensionality and the active involvement of the stakeholders. The aim of this paper is to highlight how the active role of stakeholders can improve the economic and cultural value of enhancement projects developed in architecture and planning schools, focusing on the potentialities of the problem-based learning (PBL) approach. A three-step educational procedure based on the PBL approach, applied at the atelier "Heritage Preservation and Enhancement" of the Politecnico di Torino, is presented. The results showed how a continuous interaction and dialogue with teachers and stakeholders can effectively support students in addressing real problems and in developing sustainable and feasible enhancement projects able to integrate heritage preservation and economic-financial issues.

Keywords: Problem Based Learning, architecture education, sustainable cities, cultural heritage, economic evaluation, stakeholders

Introduction

One of the challenges of architecture education is to develop sustainable enhancement projects, strictly linked to the real territorial and socioeconomic contexts and to the stakeholders' points of view. Hence architecture and planning schools have the challenge of integrating different disciplines such as economic evaluation, preservation, restoration, and reuse of existing heritage, and advanced technologies for energy retrofit interventions.

Currently, innovation in education has new and far-reaching goals: it is increasingly oriented towards the analysis of real problems considered in their multi-dimensionality and complexity, and for this reason it affects all disciplines. Students are called to acquire the ability to deepen different aspects of the same real problem, to successfully collaborate with experts and external actors, and to develop key competencies, including problem-solving skills, that are required for professional work.

In architecture and planning schools in Italy, even if case-based or project-based approaches and collaborative learning are widespread and often adopted, specific educational procedures based on a continuous interaction between students, teachers, and stakeholders are not often applied nor properly planned at the beginning of courses.

The aim of this paper is to highlight how the active involvement of stakeholders can improve and better structure the learning process and increase the economic and cultural value of enhancement projects developed in architecture and planning schools by presenting an education procedure based on the PBL approach. It focuses on the specific aspect of the relationships between teachers, students, and stakeholders in the innovative development pathways for the sustainable cities' framework, with particular reference to the integration between economic evaluation tools and heritage preservation perspectives.

The proposed educational procedure was applied during the atelier "Heritage Preservation and Enhancement" of the master's degree course in Architecture for Heritage Preservation and Enhancement at the Politecnico di Torino, implemented as a module within the Erasmus + EU project "CityLab. Engaging students with sustainable cities in Latin-America," co-funded by the European Commission[1]. The main learning goal of the atelier was to face the real problem of improving the economic and cultural value of the urban and architectural heritage located at the 54th UNESCO site by integrating two different disciplines, heritage preservation and economic evaluation. Obviously, the integration of these two disciplines implied the goal of considering, simultaneously, different scientific research areas' viewpoints that are sometimes even conflictual.

This experience was aimed to enhance the learner's role in defining problems and different kinds of solutions, focusing not only on the expected learning outcomes, but also on the path to reach possible sustainable scenarios related to the considered problems.

The results carried out by applying the educational procedure illustrated in this paper showed some potentialities of the problem-based learning (PBL) approach in architecture and planning schools. Particular attention is paid to the effective support that a continuous interaction between students, teachers, and stakeholders can give in addressing real problems, in developing sustainable and feasible enhancement projects, and in developing different skills to analyze also non-technical aspects of problems. Moreover, results confirm that economic, energy-environmental sustainability, and circular economy concepts have to be linked to heritage preservation, thus sharing the aim to hand down heritage for future generations, while considering the deriving criticalities.

This paper is structured as follows. In section 2 the literature background and the scientific framework are presented. Section 3 illustrates the three-step educational procedure. Section 4 presents the case study, and section 5 discusses the results. Section 6 presents the conclusions.

Background

Literature background and the scientific framework

A wide literature deals with the field of architecture education for sustainable cities and analyzes aspects of innovative learning (De Graff & Cowdroy, 1997). Among others in this research we focus on the PBL approach as defined by Savery (2006), which was studied for the first time at McMaster University in Canada in 1969 and subsequently developed and modified in other forms and structures (De Graff & Kolmos, 2003).

Since the change to a full problem-based learning approach is time-consuming for universities to commit to, there are several closely related learner-centered instructional strategies, such as project-based, case-based, and inquiry-based learnings. These are used in a variety of content domains that can start to move students along the path to becoming more self-directed in their learning (Savery, 2006). Currently, the architecture learning in some courses at the Politecnico di Torino is already carried out by applying a case-based or project-based approach with some elements of problem-based learning. Project-based learning is similar to problem-based learning in the organization of learning activities around achieving a shared goal (project); teachers in both approaches are more likely to be instructors and tutors who provide expert guidance, feedback, and suggestions for "better" ways to achieve the final product. Moreover, in project-based learning, the teaching process (modelling, scaffolding, questioning, etc.) is provided according to learner needs and within the context of the project, and similarly to case-based instruction, learners are able to add an experience to their memory that will serve them in future work situations (Savery, 2006).

While cases and projects are excellent learner-centered instructional strategies, they tend to diminish the learner's role in setting the goals and outcomes for each urban and architectural "problem." When the expected outcomes are clearly previously defined (project requirements), then there is less need or incentive for the learner to set his/her own parameters. In the real world it is recognized that the ability to both define the problem and develop a solution (or a range of possible solutions) is important (Savery, 2006).

Brundiers, Wiek, and Redman (2010) highlight the relationship between students and stakeholders involved in the project process. In learning processes, it is useful to face real case studies so that students acquire disciplinary tools and technical knowledge for the definition of sustainable projects, closely linked to the territorial reality, the socioeconomic context, and the needs expressed by the different stakeholders involved (Coscia, Fregonara, & Rolando, 2015; De Filippi, Coscia, & Cocina, 2017). With a student-inclusive approach in the process of knowledge and definition of the problem under study, learners are responsible for their project, collaborate with each other and with external stakeholders, and become active in the reference community. For the students, this includes gaining competencies in engaging with stakeholders by establishing consistent vocabularies and technical glossaries and facilitating participatory research and decision-making in collaboration with experts from academia,

1 The experience results were presented to the academic conference "PBL for Sustainable Cities" held in Bogotà, Colombia, 19-20-21 September 2018.

industry, government, and civil society (Haan, 2006). These criteria are compatible with the so-called trans-academic (e.g., transdisciplinary, participatory, and community-based) research and educational approaches. A common feature of these approaches is that scholars (intended both as students and professors) collaborate with non-academic experts (here intended as community partners, public and private subjects, profit and non-profit associations, and other stakeholders) in all the phases of a research project. They are engaged as different but equal partners (different regarding expertise and experiences; equal regarding rights and obligations), producing outcomes that are scientifically sound and applicable, and that respond to the needs and rewards structures of all parties (Scholz, Lang, Wiek, Walter, & Stauffacher, 2006; Hirsch Hardon, Bradley, Pohl, Rist, & Wiesmann, 2006; Van Kerkhoff & Lebel, 2006; Wiek, 2007).

The PBL approach is suitable for developing the main aspects of educational innovation aimed at sustainable development (Lehmann et al., 2008). Sustainable development (SD) may be read as a continuous process that requires a balance between the emergence of problems and the capabilities to solve these problems. Thus, sustainability "refer(s) to a process and a standard—and not to an end-state—each generation must take up the challenge anew, determining in what directions their development objectives lie, what constitutes the boundaries of the environmentally possible and the environmentally desirable, and what is their understanding of the requirements of social justice" (Meadowcroft, 1997). In fact, as Lehmann et al. (2008) explain, sustainable development directly linked to the design of sustainable cities is based on the continuous increase of the various "capitals" or "potentials" that feed it: human and intellectual, productive and social capital.

By collaborating with experts and stakeholders who have different understandings of the problem and visions of its possible solution, students begin to be part of their professional and civic environment and become familiar with different (sometimes conflicting) perceptions and values, and different (sometimes conflicting) processes of reasoning and decision-making (Norese, Rolando, & Fregonara, 2015). Moreover, students begin to understand the different institutional contexts within which a sustainability problem may exist and to what extent the context influences which strategies are proposed and pursued by experts or stakeholders (Brundiers et al., 2010). Thus, it becomes evident that students in architecture schools, like future professionals, must become more and more capable to solve problems and to understand how these can be influenced by the different capitals and connections that exist between them.

Educational set-up at Politecnico

The educational procedure proposed in this paper was applied during the atelier "Heritage Preservation and Enhancement," carried out during the first semester of the second (and last) year of the master's degree course in Architecture for Heritage Preservation and Enhancement of the Politecnico di Torino (Curto et al., 2018).[2]

The atelier "Heritage Preservation and Enhancement" correlates, in an interactive and synchronic dialogue, the disciplines of urban restoration and economic enhancement, providing the students with interdisciplinary in-depth analysis themes that reinforce and develop the knowledge gained during the first three years of the bachelor's degree.

The bachelor's degree in Architecture at Politecnico di Torino focuses on the practice of architectural design in its various aspects and at different scales, incorporating both humanistic and technical disciplinary contributions. The courses are structured as theoretical lectures and mono/multidisciplinary ateliers (studios). In the first year, students take courses in mathematics, history, technology, representation, and English. In the second year and third year students take courses in building physics, structures, history, urban planning, restoration, and appraisal, along with monodisciplinary workshops and multidisciplinary ateliers that address the design problem at different scales, with in-depth exploration of themes ranging from building in already-built areas to realization of new projects, and development of the concept of architectural and urban sustainability (Lo Verso et al., 2014; Coscia & De Filippi, 2020). There are also elective courses which enable students to address different design and conceptual aspects, including design of detail, interior architecture, sound design, lighting and energy techniques, materials science, landscape, and social, geographical, and economic problems of urban and territorial transformation. Students address specific design questions or further disciplinary exploration in the final exam that concludes the three-year program (https://didattica.polito.it/ offerta).

2 The atelier "Heritage Preservation and Enhancement" was implemented as part of the "CityLab. Engaging students with sustainable cities in Latin-America" Erasmus+ project co-funded by the European Union. The project was designed and implemented by Prof. Rocco Curto and the teaching assistants: arch. Diana Rolando, arch. Alice Barreca (Economic enhancement, AYs 2016/2017, 2017/2018, and 2018/2019); with support from: arch. Lisa Accurti (Restoration, AY 2016/2017), arch. Francesco Novelli (Restoration, AY 2017/2018), arch. Cristina Natoli (Restoration, AY 2018/2019), and arch. Diego Ferrando (Economic enhancement, AYs 2016/2017, 2017/2018 and 2018/2019). Students were also supported by arch. Cristina Azzolino and arch. Rossella Taraglio, staff of the Laboratory of Analysis and Modelling of Environmental Systems (LAMSA) of the Politecnico of Turin, for the evaluation of alternative interventions of energy redevelopment of buildings, through the application of the Termolog software.

The master's degree course in Architecture for Heritage Preservation and Enhancement of the Politecnico di Torino aims to train architects who will mature skills for the understanding, conservation, enhancement, management, and promotion of heritage. Such an objective is achieved through a well-structured and complex design path that evolves over the two-year period: it aims to combine the unique value of the cultural assets with the up-to-date economic and social mechanisms of their environment. During the first year students attend the following modules: Atelier "Renovation of the Consolidated City," "History of Architecture and Cities," "Existing Structures: Analysis and Testing," Atelier "Architectural Restauration Project," Atelier "Urban Design," and "Urban Sociology and Cultural Heritage Legislation." Subsequently, during the second year students attend the following modules: Atelier "Heritage Preservation and Enhancement," "Digital Urban History," "GIS and 3D for Cultural Heritage," and "Professional Training" (https://didattica.polito.it/2018).

In particular, during the second year, students must acquire skills finalized to manage instruments for their future professional work and to face problems that really occur in professional practice. Furthermore, they must demonstrate autonomy in structuring their research work and the related knowledge background, as well as in applying different tools (such as software and analytical methods) and in understanding and updating the normative framework. The atelier "Heritage Preservation and Enhancement," developed during the second and last year, is a module that lasts 14 weeks (42+42 hours of classes, 18+18 hours of class exercises, 35+35 hours of tutoring) for a total 12 CFU (national university credit formation units).

Educational procedure based on PBL pedagogical approach

Pedagogical approaches

Well-established and widely used pedagogical approaches in architectural education include problem-based learning (PBL), project-based learning, case-based learning, and inquiry-based learning. All of these pedagogies certainly emphasize skill-based learning outcomes and mindset-based learning outcomes. These learning methods have proven to be more effective than the traditional "chalk-and-talk" passive lecture methods and include a multitude of active/collaborative techniques (e.g., think-pair-share, quick think, jigsaw, and gallery walk) (Gerhart & Melton, 2017).

In each of these methods students are at the center of the learning process and excel in learning content as well as in applying a variety of process skills such as critical thinking, higher-level reasoning, differentiating views of others, and teamwork.

Problem-based learning (PBL) shifts the traditional teaching paradigms: it is student-centered, presents the problem first instead of content, and encourages students to face ill-structured problems with no clear solution. The present research evidence, although still limited, confirms that PBL is more effective than the traditional teaching paradigm. The PBL approach is one of the more commonly used techniques in architecture learning and follows some basic principles such as (Krajcik & Blumenfeld, 2005):

- Intellectual challenge and accomplishment: Students think critically, learn deeply, and strive for excellence;
- Authenticity: Students work on projects that are meaningful and relevant to their culture, their context, and their future;
- Public product: Students' work is publicly displayed, discussed, and critiqued;
- Collaboration: Students collaborate with other students in person or online and/or with adult mentors and experts;
- Project management: To proceed effectively from project initiation to completion students use project management processes;
- Reflection: Students reflect on their work and, on the basis of the external suggestion and direction, often go outside their "comfort zone."

These principles were transformed into teaching elements or operations that form the operative cycle of the learning process around common learning goals (Figure 1).

Figure 1: The principal teaching elements in a project based learning process (Source: Elaboration of the Authors)

All the above-mentioned principles are classically related to participatory modelling (PM) and collaborative learning (CL), which from their origins in the 1960s, promoted learners working in groups on the idea that learning is a naturally social act in which the participants communicate, and through this communication, learning occurs. Collaborative learning is efficiently used to work together on problems, complete a task, or create a product/project (Voinov & Bousquet, 2010).

Finally, problem-based and project-based learning require both students and teachers to clarify their roles at the beginning of the course during the various phases of its implementation.

The students' role is twofold: firstly, they may use the theoretical framework of the previous years to autonomously carry on knowledge acquisition and to decide which problem they want to deal with. Secondly, they may use all their capabilities to work in groups, carry on the brainstorming, contact external experts to have an in-depth view of the chosen task, and ask for a revision by the teachers to update the work.

The teachers' role is likewise twofold: they need to define hard and soft scaffolds (Ertmer & Simons, 2006), and they also have a role to play as an intermediary among students and stakeholders. The hard scaffolds could be defined as support moments/instruments or some necessary preliminary collective discussions, planned in advance, based on typical/known student difficulties with a task. The soft ones are developed in line with students' problems. Within problem-based learning, teachers can use scaffolds to accomplish four important goals: initiating students' inquiries; maintaining students' engagement; aiding learners with concept integration and addressing misconceptions; and promoting reflective thinking (Ertmer & Simons, 2006). The teachers' role is also to apply new types of classroom management strategies to facilitate students' inquiry and to provide constructive feedback. Students have to be supported during the learning

process to develop their own strategies to address complex problems and to negotiate design solutions in a collaborative manner (Hannafin, Hill, & Land, 1997).

Moreover, the stakeholders' role is to understand the needs of the students, mainly related to the lack of data and lack of information on regulations and procedures. On the other side, their role is to explain their point of view, needs, and expectations to the students.

The experts' role is above all an additional tutorship for students, to meet with them and to work with them to implement some parts of the work. The experts involved come from the University, as part of the academic board (professors of other disciplines or technicians), and from other bodies such as the Municipality, the Superintendence, and some private enterprises.

The learning experience process

A multiple-step educational procedure based on the PBL approach is here proposed in order to facilitate the active involvement of stakeholders and to guide the development of sustainable and feasible projects able to improve the economic and cultural value of complex building heritage at the architectural and urban scale. Starting from the identification and definition of a real main problem, the proposed educational procedure consists of three phases and a series of steps, each with a specific timing and objective, achievable by means of evaluation tools and through the interaction among stakeholders, teachers, and students (grouped in 2-3 people teams). It is worth mentioning that the presence of the stakeholders is considered essential during the whole

Phase/ Step		Objective	Scale	People involved	Tools and methods	Timing
1a (milestone)	Preliminary context analysis and main problem definition (case study)	Analysis of the context, stakeholders, and possible impacts in relation to the main problem to be faced	Territorial/ urban	Stakeholders Teachers	CIA	May-September
1b (milestone)	Start of the course and main problem presentation	Multidisciplinary description of the case study and the main problem to the students.	Territorial / urban/ building	Stakeholders Teachers Student teams	Curricula Conference	October (week 1)
1c	Secondary problems definition	Identification of secondary problems to be faced and their interrelation with the main problem, in relation to the module's learning goals and the scheduled evaluation steps	Urban/ building	Stakeholders Experts Teachers Student teams	Problem Tree Analysis	October (weeks 1-2)
1d (milestone)	Choice of issues	Focus on secondary problems, buildings/sites selection	-	Teachers Student teams	Brainstorming	October (week 2)
2a	Knowledge inventory and management	Data collection, socio-economic/territorial analysis, building metric surveys, historical research and state of the art, actors interviews	Territorial/ urban/ building	Stakeholders Experts Teachers Student teams	Field Research SWOT GIS	October (weeks 3-4) November (weeks 1-2)

Table 1: Phases and steps of the proposed educational procedure (Source: Elaboration of the Authors)

Phase/ Step		Objective	Scale	People involved	Tools and methods	Timing
2b (milestone)	Mid-term collegial review	Collegial presentation on socio-economic/territorial analysis, building history and state of the art	-	Stakeholders Experts Teachers Student teams	Flipped Classroom Peer-To-Peer Review	November (week 2)
3a	Development of feasible and sustainable projects	Enhancement projects development, economic-financial evaluation	Building	Stakeholders Experts Teachers Student teams	DCF BEP	November (weeks 3-4) December (weeks 1-2) Holydays interruption January (weeks 2-3)
3b (milestone)	Final review	Collegial presentation of the developed enhancement projects and the economic-financial evaluation results	-	Teachers Student teams	Flipped Classroom Peer-To-Peer Review	January (week 3)
3c (milestone)	Exam	Final evaluation based on the results achieved by each student team	-	Stakeholders Experts Teachers Student teams	Presentation Discussion	February
3d (milestone)	Final Event	Public presentation of the results achieved during the whole course and by each student team	-		Presentation Discussion	May/June

Table 1 (continued): Phases and steps of the proposed educational procedure (Source: Elaboration of the Authors)

process of the teaching experience, from the early stages of the main problem definition up to the final presentation by the student teams and evaluation phases by teachers and stakeholders (Table 1).

During each phase of this educational procedure teachers operate on several fronts: they plan and organize interactive activities finalized both to explain the theoretical foundations and to put the students at the center of the learning process; they are available for meetings and debates with the student teams, in order to help and support them in the most tricky analysis; they support the coordination among different student teams by suggesting collaborations and stakeholders to involve; they set a series of deadlines in order to guide students to achieve the learning goals by the end of the module.

In parallel, students follow the phases and steps of this educational procedure by participating in the proposed innovative didactic activities (such as peer-to-peer revisions, collegial revisions, flipped classrooms) and by autonomously organizing their work within their own team. Furthermore, student teams are also asked to autonomously contact and meet stakeholders and different actors in different moments of the learning process.

Phase 1: Preliminary context analysis, main and secondary problems definition

The first phase of the educational procedure is structured in three steps: the preliminary context analysis and main problem definition (1a), the first interaction with the student teams at the beginning of the course (1b), and the secondary problems definition (1c).

The first step, which is developed before the beginning of the course, is aimed at selecting the case study, a real complex problem, analyzing the territorial/urban context, and activating a first interaction between teachers and the principal stakeholders. Therefore, this step is finalized to identify, select, and map the group of stakeholders according to their representativeness and according to the possible impacts that projects can generate. In fact, the context definition and stakeholders' selection are strictly correlated to the problem/s identification, based on the analysis of impacts/effects (positive or negative) that potentially emerge from the project and that can directly/indirectly interest the subjects.

Moreover, it is considered essential to involve as many possible different subjects representative of the public sector (public administrations, for example, Municipalities), of the private subjects (for example property owners, developers, investors), and of the citizens involved in the project/plan/actions, directly or indirectly interested (or potentially interested) in the selected case study.

Methodologically, a support to this first preliminary step may be offered by tools useful to identify and map all possible stakeholders, to analyze the context, and to facilitate the statement of different scenarios.

Among these it is worth mentioning the Community Impact Analysis (CIA) developed by N. Lichfield (Lichfield, 1994; Lichfield 1996; Norese, Rolando, & Fregonara, 2015; Coscia & De Filippi, 2016). The aim of this approach is to preliminarily identify all the impacts/effects of the project on different subjects involved. The CIA represents the foundation for the following evaluation phase, known as Community Impact Evaluation (CIE), that consists in sectorial balances, founded on the preliminary identification of the potential positive/negative impacts and effects generated by the project on the various subjects (social groups, operators, administrators, citizens, etc.).

A distinction is made between subjects directly or indirectly involved in the project ("active" and "passive" subjects), considering also their public or private role. The CIA approach supports these activities by introducing some criteria for differentiating two territorial levels: the "off-site" (represented by the most peripheral boundaries of the project, in other words the largest territorial level interested by the project impacts/effects) and the "site" (represented by the district/micro neighborhood territorial level or the site strictly and directly affected by the intervention).

In the background, the general territory and the economic context in which the subjects operate are considered; in fact through the CIA it is possible to georeference stakeholders, impacts, and effects, providing a foundation for the application of specific evaluation tools.

Furthermore, the CIA provides a preliminary analytical framework of the conditions of the case study and its context (both territorial and socio-political), explaining the decision-making problems and the factors capable of conditioning and compromising the sustainability of the project. Moreover, the project is analyzed by breaking it down into different time phases. It is worth specifying that the "main problem" or "general problem" can be considered as a starting point for the student teams' activity, thus identifying the "secondary problems" to be faced during the module's implementation.

Therefore, the results of step 1a are presented to the student teams at the beginning of the course during a curricula conference. This second step (1b) represents an important moment, when the first interaction with student teams is activated in order to illustrate the selected main problem (case study), to investigate the students' level of knowledge on different methodologies and tools, and to schedule some activities during the course.

After that, student teams, stakeholders, and teachers are asked to interact and identify secondary problems interrelated with the main problem, considering both the module's learning goals and the scheduled evaluation steps (1c).

During this step the Problem Tree Analysis (EC, 2004) can support the dialogue between experts, stakeholders, student teams, and teachers about the real criticisms and potentials related to each identified secondary problem. Subsequently, a brainstorming activity between teachers and students is oriented to guide each student team in choosing an issue focused on a secondary problem to be developed and solved during the course (1d). During this step, teachers often act as mediators between student teams, taking into account students' specific requirements/preferences and trying to assign all the previously identified issues. Furthermore, for each student team the expected outcomes are initially defined and shared, taking into account that they can be modified during the module's implementation period.

The outputs from all the meetings and interactions between student teams, teachers, experts, and stakeholders are registered in a "teachers' logbook" to let teachers remember the whole learning progress of each student team.

Phase 2: Knowledge inventory and management

The second phase of the proposed educational procedure is developed in the first part of the semester and is aimed to define the knowledge inventory (2a) and to collegially present the progress on the first analyses at the urban and building scale (2b).

During the knowledge inventory activities student teams start to analyze the chosen issue by collecting data and setting up socio-economic/territorial analyses at the territorial and urban level. Moreover, they collect data and materials at the building level (building metric surveys, historic research, and state of the art) by doing field research. In this step the interaction with teachers, experts, and stakeholders is fundamental in order to study the real context, lay the foundations of the knowledge base, and organize the first actors' interviews (Figure 2).

In this step the student teams independently organize investigations in private archives, contacting owners and managers, choosing which kind of information is needed in order to collect useful data. The data collection is guided by teachers who provide the structure of a unique information system (GIS) about socio-economic and territorial context that collects different kinds of data: data about the population, the state of the art of the tourist facilities, and the presence of services, metrics, and surveys of building degradation. Furthermore, the different needs of the population, of the owners, and of the investors are collected, also with the use of interviews. The GIS is completed with all the collected data, allowing student teams and teachers to analyze socio-economic data geographically. By means of the creation of thematic maps and a historic period sequence, it is possible to better understand the dynamics that influence/drive a

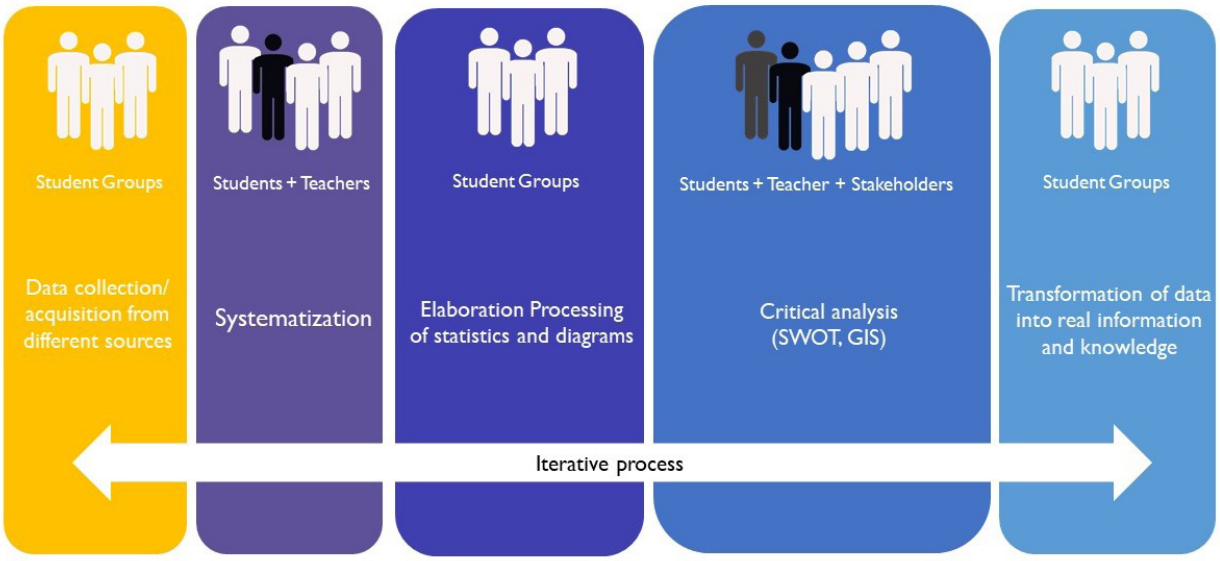


Figure 2: Process scheme of the first stage of data collection, analysis, and definition of information contribution (Source: Elaboration of the Authors)

territorial area, supporting the proposal for some change and enhancement and facilitating the coordinated choice of project use destinations (Curto, Barreca, & Rolando, 2018).

The SWOT analysis (Armstrong, 1982; Hill & Westbrook, 1997; Coscia & Curto, 2017), used simultaneously with the GIS, allows student teams to understand which opportunities they could focus on and to develop their project based on the weaknesses and threats that they identify. This tool allows the student teams to think about concrete solutions, directly linked to the territory, thus avoiding proposing decontextualized solutions.

The main results achieved with the knowledge inventory are presented by student teams to teachers, stakeholders, and experts during the mid-term collegial review (2b). This step represents an important moment to share the progress on the development of some possible solutions to the main and the secondary problems and the collection of first-stage proposals for the development of feasible and sustainable projects. Drawing up all the information included in the GIS, different proposals can be rationalized in different ways. A shared master plan is collectively discussed, and each new function is firstly shared and then approved, and in the meantime the typologies of new functions can be changed or deleted, linked visit paths are defined, and finally it is possible to analyze an early-stage priority schedule program of intervention. Each new function solution, energy retrofit intervention, and enhancement project is developed at the building scale in the final step.

Phase 3: Development of feasible and sustainable projects and final evaluation process

The third phase of the proposed educational procedure is based on the interaction among stakeholders, experts, teachers, and student teams with the aim of developing feasible and sustainable enhancement projects at the building scale and improving the economic value of the selected case studies through the identification of new functions and the evaluation of the economic-financial feasibility (3a). This phase is carried out in the last part of the atelier and concludes the course with three final steps: the final review (3b), the exam (3c), and a possible final event (3d).

Step 3a is the most crucial step since teachers, stakeholders, and experts from different scientific domains build up with student teams all the necessary information, tools, and data for them to develop their projects. The stakeholders' and experts' role is indeed to collaborate on the projects' development by providing or validating all the necessary data to choose the best alternative functions—compatible with the existing buildings and with the territorial and socio-economic contexts—and to strategically evaluate the general framework of the private and public interests related to the projects.

In particular, student teams interact with the stakeholders identified during the first phase of the proposed educational procedure in order to identify strategies and technical solutions that have to be not only feasible according to the restoration project's requirements, but also able to guarantee energy efficiency and economic-financial profitability. Therefore, the main results of this step are the enhancement projects, which have to be feasible and sustainable by integrating the following four disciplines: restoration, economic enhancement, design, and technologies for energy retrofitting.

The economic evaluation plays a central role during the projects' development in considering and comparing different alternative scenarios. It can be supported by several tools, such as the Discounted Cash Flow analysis (DCF), which is fundamental to quantify costs (restoration, construction, energy retrofit, and management costs) and to evaluate the project's feasibility by means of a series of profitability indicators (Net Present Value, Internal Rate of Return, Pay Back Period). This tool allows the analysis of the financial incomes in comparison to the capital invested for both the redevelopment and the management phases, and to assess the asset's residual value at the end of the project's estimated duration. The analyses are aimed not only at verifying the investments' profitability, but also at identifying the necessary economic and social conditions to guarantee the enhancement of the assets in the long term. In particular, when cultural and social public services and activities are considered, the Break Even Point analysis (BEP) is fundamental, since it allows the calculation—on the basis of the management costs and the prices of the tickets—the necessary number of visitors to guarantee the balance between costs and financial incomes. Nowadays, the relation between sustainability—environmental, economic, energy—and interventions on the existing buildings heritage plays a central role in the scientific debate, as the recent international literature demonstrates (Fregonara, Moretti, & Naretto, 2018). Focus is centered on modalities that are able to respect the targets fixed by the laws and all the conservation principles defined by the international regulatory framework on sustainability in relation to the built heritage. A first difficulty depends on the fact that, in many cases, the built heritage is characterized by low energy-environmental quality but also by potentialities for improving performances through energy retrofitting interventions. The latter are complex, expensive, and generally less effective in comparison with reconstruction strategies. Furthermore, the complexity seems even higher when shifting from the building scale to the urban/territorial scale and when, as in the case of the experience presented in this paper, sustainability is developed on both scales.

Finally, after having developed their enhancement projects and evaluated the economic-financial feasibility, the student teams collegially present and share their findings and solutions with teachers during the final review (3b).

The final review before the exam is a technical review during which teachers verify the correspondence of the work done by the student teams with the atelier's learning goals. During these presentations, peer-to-peer discussion is encouraged to simulate possible final questioning, prepare possible answers, and receive comments/feedbacks and suggestions.

The subsequent evaluation step is the final exam (3c), during which student teams have to demonstrate that they have reached the common learning goals and present their final projects. The collegial presentations on the developed enhancement projects and the economic-financial evaluation results can also be supported by an exposition of posters realized by student teams to briefly and graphically disseminate their results. Stakeholders, external and internal experts, and the teacher discuss with each group their project, trying to simulate a real-world project validation. The evaluation criteria take into account the student teams' ability to integrate the acquired knowledge and to develop feasible and sustainable projects from the economic-financial and heritage preservation points of view. Furthermore, each student should demonstrate their ability to illustrate various processes by using scientific-technical language, explaining their design choices in relationship to theoretical references and critiques, and applying both the restoration and

valuation principles and methods. The evaluation should also consider the level of the students' learning, their ability to apply the acquired knowledge and discussion (current and past), and the interdisciplinary problems and the restitution of proposals. The theories of control capabilities, methodologies and tools used, and the skills to effectively communicate, exhibit, and study issues addressed are also to be evaluated. The rating is unique and individual, consisting of the average result of the evaluation of individual teaching modules and individual contributions to the design documents, analyses, and reports.

After the final exam, a public event (3d) can be organized in order to present the results achieved during the course and by each student team to a wider public, including both the previously involved stakeholders and others interested in a broader context.

Monitoring the learning experience process

The abovementioned phases and steps of the proposed educational procedure (Table 1) constitute a useful guideline to plan the process of the learning experience. It's worth mentioning that, assuming the proposed educational procedure, the same module can be differently implemented in different academic years due to a series of reasons: the students and the related ideas and proposals are different, such as the stakeholders and the external experts to be involved, and also the socio-economic context that is continuously changing.

Therefore, the learning process changes and leads to different results. In order to implement the educational procedure, it is important to set up a detailed timetable where specific activities and events are filled in from the beginning until the end of the module. On the basis of this document, teachers should constantly collect and register data in order to monitor the most important factors occurring during the module and evaluate the achievement of the expected results at the end of it.

For example, this structured timetable can be fundamental for registering all the meetings between teachers, student teams, and stakeholders and for specifying the place of the meeting, the topics and the problems discussed, and the people involved and their roles.

The educational procedure applied to the atelier "Heritage Preservation and Enhancement"

During AYs 2016/2017, 2017/2018, and 2018/2019, the main problem to be tackled during the atelier was the enhancement of the urban and architectural heritage of the UNESCO site "Ivrea, industrial city of the 20th century," included in the UNESCO's World Heritage List from 1st July 2018 (https://whc.unesco.org/en/list/1538). The site is a complex urban system that constitutes an outstanding and universally valuable example of the industrial history of the 20th century. It consists of more than 100 buildings commissioned by Adriano Olivetti and conceived to be perfectly integrated with the elements of the infrastructure system and green spaces. This heritage, consisting of residential buildings, industrial buildings, offices, and other buildings designed for different kind of services, represents different expressions of the Italian Modern Movement heritage. The buildings are valuable examples of brutalist and organic architecture, designed between 1934 and 1988 by famous architects such as L. Figini and G. Pollini, I. Gardella, E. Vittoria, R. Gabetti and A. Isola, I. Cappai and P. Mainardis, and E. Sgrelli.

During AYs 2016/2017 and 2017/2018 the students of the atelier analyzed this site when it was still a candidate to be included in the UNESCO's WHL, while during the AY 2018/2019 the problem to enhance the site became a real and actual challenge for the Municipality of Ivrea.

Each student team analyzed not only the UNESCO site, called the "Core Zone," but also a broader territorial and socio-economic context of the "Canavese" area, which includes more than 130 municipalities located in proximity to the city of Ivrea. The distinction between these two territorial levels supported also the stakeholders mapping and the secondary problem definition.

After the preliminary context analysis and main problem definition, student teams, stakeholders, and teachers identified the following secondary problems to be faced during the implementation of the module:

Urban level:

- The UNESCO site is not easily recognizable both by citizens and visitors;
- The value of the Modern heritage is scarcely recognized both by citizens and visitors;
- The existing Open-Air Museum of Modern Architecture (MAAM) is old and not adequately developed and promoted (http://www.maam.ivrea.it);
- Infrastructure and green systems are hardly used both by citizens and visitors since they are scarcely equipped and have a low state of maintenance (almost total lack of bicycles routes);
- Services for the older population are insufficient.

Building level:

- Some buildings are in a bad state of conservation, so they require restoration;
- The most part of the buildings is unused, underused, or occupied for not very compatible functions, so it is necessary to find new uses;
- All buildings have a high level of energy inefficiency;
- The buildings belong to several private subjects, with different development strategies and profitability goals;
- The buildings' value is currently rather low due to the decreasing trend of the Ivrea real estate market and the weak interest from external investors.

Each student team chose an issue focused on a secondary problem to be developed and solved during the course.

In AY 2016/2017, 37 students were grouped into 16 teams, in AY 2017/2018, 28 students were grouped into 11 teams, while in AY 2018/2019, 33 students were grouped into 11 teams (Table 2).

The final step of the knowledge acquisition was addressed to define an initial shared master plan for the enhancement of the urban area. A Geographical Information System (GIS) project, "Ivrea, an industrial city of the 20th century," structured by the teachers, was filled in and modified by the student teams in several separate meetings. Sharing data and ideas enabled student teams to have a common goal and to share challenges in order to work simultaneously on different scales (architectural and urban). The GIS was structured to

	Students	Teams (2-3 people)	Restoration and enhancement projects	Urban areas	Buildings
AYs 2016/2017, 2017/2018, 2018/2019	98	38	43	16	54

Table 2: Number of students, teams and related projects developed during Ateliers of AYs 2016/2017, 2017/2018 and 2018/2019 (Source: Elaboration of the Authors)

collect and analyze all the information concerning the built and not built elements of the UNESCO site (Barreca, Curto, & Rolando, 2017), 29 Areas (Municipality of Ivrea and Guelpa Foundation, 2014), 94 cadastral parcels, 116 buildings (74 main and 42 accessories), 29 elements of the infrastructural system and 32 elements of the system of the green, a building outside the area but of great documentary value (West Residential Unit), as well as information concerning the territorial, socio-economic, and cultural context.

The definition of the master plan, on the basis of the numerical cartography of the Municipality of Ivrea, was used by the student teams as support for decisions and the definition of sustainable and suitable uses during the mid-term collegial review (Figure 3).

On the basis of the shared master plan and assuming the strengths and the weaknesses of the management plan of the UNESCO site, developed by the Municipality of Ivrea (updated in 2017), the definitions of new functions were presented by student teams during the first mid-term collegial review (step 2b) by means of a "flipped classroom" where student teams presented and explained their initial projects to teachers, stakeholders, experts, and other students (Figure 4).

The development of feasible and sustainable enhancement projects was conducted in the second part of the atelier (step 3a). For each issue, at the building scale, a new functional mix was identified, and the economic-financial feasibility was evaluated. Projects needed to be compatible with the architectonic assets and the construction features, innovative and energy-efficient but also coherent with the buildings' identity and with their original functions.

Results and findings

The active involvement of the stakeholders improved the course activities, and the continuous interaction and dialogue with teachers and stakeholders supported the student teams in facing real problems and in developing enhancement projects in the sustainable cities' framework.

The relationships between teachers, student teams, and stakeholders supported different learning activities, with particular reference to important milestones (1b, 2b, 3c, 3d)

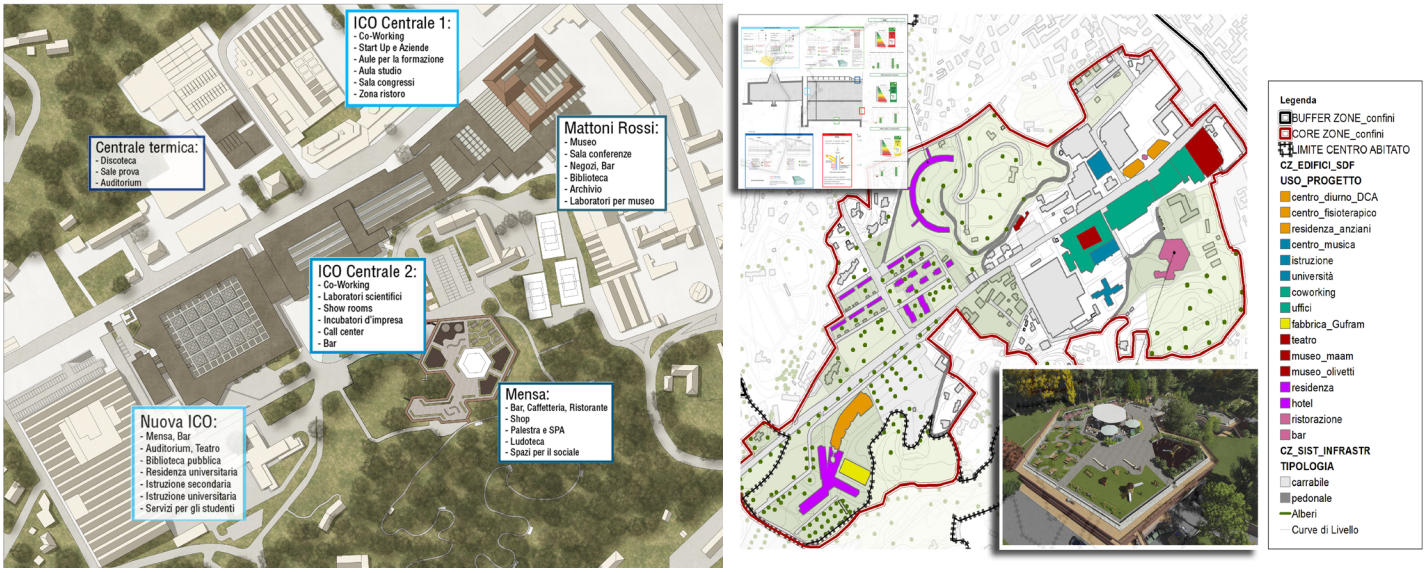


Figure 3: Master plan and GIS thematic map (Source: Elaboration of the Author on the poster of the students: Giulio Bianco, Matteo Arato, and Alberto Chialva, AY 2016-2017)

and other steps of the process: start of the course and main problem presentation (1a); secondary problems definition (1c); knowledge inventory and management (2a); development of feasible and sustainable projects (3a);

Results of the application of the proposed educational procedure underlined the potentialities of the problem-based learning (PBL) approach in: mapping and involving the stakeholders; fostering the interaction between teachers, student teams, and stakeholders; enhancing the learner's role in defining problems and different kinds of solutions; and addressing real problems in the professional work.

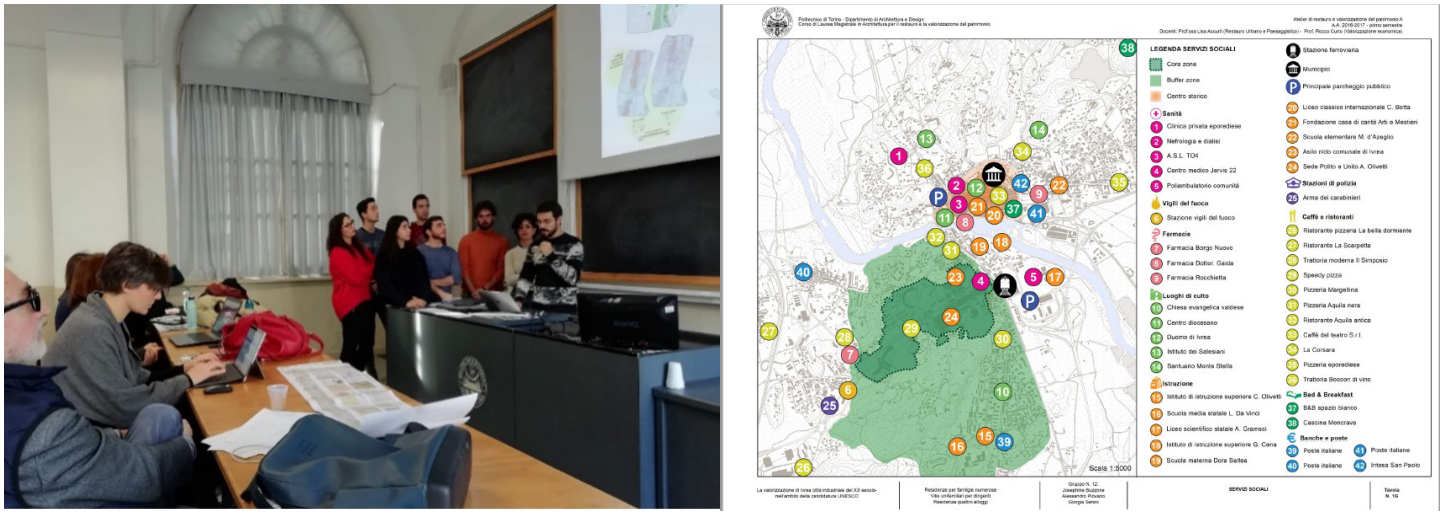


Figure 4: Context analysis of community services sited in the Core Zone, the city center, and the surroundings of the city of Ivrea (Source: Photo of the Authors Elaboration of the students Giorgia Senini, Josephine Buzzone, Alessandro Piovano, AY 2016-2017)

The stakeholders' mapping and involvement

The stakeholders directly or indirectly involved with the plan/project were initially identified and selected, differentiating between:

- stakeholders with a direct role in the problem analysis ("active" players, in our case, for example, promoters, who play a role in the executive phases during the project life cycle);
- stakeholders with an indirect role in the problem analysis ("passive" players, in our case, for example, the citizens, who are affected by the positive/negative impacts/effects of the project).

Teachers proceeded with the stakeholders' mapping (step 1a), with the support of a methodology and a set of criteria (http://ec.europa.eu/guidelines/ug_chap7_en.htm):

- identification of stakeholder categories relevant for or interested in the concerned territorial area(s);
- sorting stakeholder categories according to the level of interest in or influence on the concrete initiative that is to be consulted upon.

Potential stakeholders (community sectors) were distinguished as in the following example in Table 3.

The stakeholders' mapping was useful for teachers to fix the agenda and the meetings with student teams during the entire course. The difficulty in organizing the agendas of all the stakeholders and involved external actors was tackled before the beginning of the course, to ensure the presence of these subjects at least at milestone moments (1b, 2b, 3c, 3d).

The interaction between teachers, students, and stakeholders

When teachers met students at the beginning of the atelier (1b), they firstly drew up the "class contract," an agreement made between learners and teachers to follow certain rules and standards during the course. The class contract is useful to start a dialogue concerning how the class works and to encourage learner autonomy. In this occasion teachers introduced the general and strategic learning goals of the atelier, the necessary prerequisites, the expected learning outcomes, the basic principles of the PBL approach, some references, the final exam, and assessment criteria. Moreover, teachers explained other fundamental contents of the class contract, concerning the different levels of knowledge, abilities, skills, and tools that students were supposed to develop during the course. For example, teachers remarked that students have to gain the ability to develop pre-feasibility studies by strengthening different skills, such as a deep learning and an effective interaction with external experts (to choose the right variables to consider and consequently to collect useful data).

STAKEHOLDERS			
OWNERS/PRODUCERS/OPERATORS ***(ACTIVE ACTORS)***		**CONSUMERS** ***(PASSIVE ACTORS)***	
Lands and properties owners (companies/legal persons)	Municipality of Ivrea Olivetti Multiservice Spa IDeA Fimit Sgr Prelios Spa Savills Investment Management Sgr Spa University of Turin …	Cultural heritage consumers	Citizens of the municipality of Ivrea Citizens of the bordering municipalities Tourists and visitors …
Lands and properties owners (natural person)	Private owners	Lands and properties occupants	University of Turin Medical centre Nursery School Restaurant and Café Bank
Urban plan developers	Municipality of Ivrea – City's planning department		
	…		

Table 3: Stakeholders (community sectors) potentially directly or indirectly involved with the plan/project: a mapping example (Source: Elaboration of the Authors)

Infrastructures Government bodies	Working group for the UNESCO WHL Superintendence for Architectural and Landscape Heritage and the Piedmont Regional Directorate UNESCO Department of Ministry of Cultural Heritage and Activities and Tourism Metropolitan City of Turin Piedmont Region Chamber of commerce …	End-users of the new infrastructures, and services (redevelopment projects)	Tourists Workers MAAM visitors …
Companies sited in Ivrea (Core Zone)	Vodafone Spa Manutencoop Facility Management Spa L'Esagono Bar Copra Ristorazione Spa Comdata Spa Banca Fitness Club "La Direzione Del Benessere" …		
Associations and Foundations	Confindustria Canavese Association Spille d'Oro Association Guelpa Foundation Olivetti Archive Association Adriano Olivetti Foundation MAAM Museum (Open-air Museum of Modern Architecture of Ivrea) …		

Table 3 (continued): Stakeholders (community sectors) potentially directly or indirectly involved with the plan/project: a mapping example (Source: Elaboration of the Authors)

Among the standards and the rules explained, the dialogue and the active interaction with stakeholders and external actors was presented as a fundamental way to develop sustainable and feasible projects. Teachers and stakeholders illustrated the main problem to be faced during the course (case study): the project context was analyzed from different perspectives, and initial weaknesses and strengths were discussed with student teams. In particular, important stakeholders were the Coordinator of the Candidacy "Ivrea, industrial city of the 20th century" and the Mayor of Ivrea, who presented to students the case study and its complexity. They talked about the site, the process followed for the WHL UNESCO application, the problems faced and those still open, and the projects already implemented or to be implemented.

In this first meeting learners were not very active; even if they were attending their final year at university, they seemed not to be used to asking questions and expressing their ideas and considerations in public. This factor represented an initial difficulty: their reaction time to the new didactic approach (PBL) was slightly longer, and teachers had to stimulate dialogue and interaction several times. Nevertheless, during individual meetings and at the end of the atelier students recognized the potentialities of the interaction and discussion with experts; by absorbing and using suggestions from teachers, stakeholders, and other students, numerous student teams changed their initial point of view and some aspects of their projects.

One of the main results obtained from the interaction between teachers, student teams, and stakeholders during the first phases was the identification of secondary problems (step 1c) to be faced during the implementation of the module and their interrelations with the main problem. In this step the connection between urban problems and tools with theoretical assumptions was difficult. The main limitation was the difficulty for students to face such a complex case study, which seems even greater when shifting from the building level to the urban/territorial level. Moreover, student teams were not very used to sharing their work between groups, so the proposal of a unique shared master plan was a good trigger to start the discussion and foster the collaboration among student teams.

Subsequently, in the knowledge inventory and management step (2a,) the autonomous interaction of student teams with experts and stakeholders was very useful to the acquisition of new information and updated data, such as shape files, building metric surveys, and photos.

Some experts and stakeholders were very useful for all student teams' work, such as: the Technical Office of the Municipality of Ivrea, the Historical Archive Olivetti, and the Superintendence, Archaeology, Fine Arts and Landscape for the Metropolitan City of Turin. Representatives of these institutions, who attended the milestone meetings (1b, 2b, 3c, 3d), were contacted also by student teams for different reasons driven by their own projects. Thanks to their support, students were able to analyze the restraints using historical information.

Some student teams went beyond autonomously contacting other stakeholders and external experts. For example, student teams who had to address the energy retrofit of the residential buildings and public spaces enhancement contacted the private owners of the houses and the main private manager of the companies to understand the potential need of short-term residential rents. Those who faced the problem of services in the area contacted private companies and investment funds located in the area to know which future projects were planned to increase the attractiveness of the urban area. Finally, those who addressed the production theme contacted private companies and investment funds, not necessarily located in the area yet, to understand the key points to consider in choosing a new location for their headquarters.

Enhancement of the learner's role in defining problems and different kinds of solutions

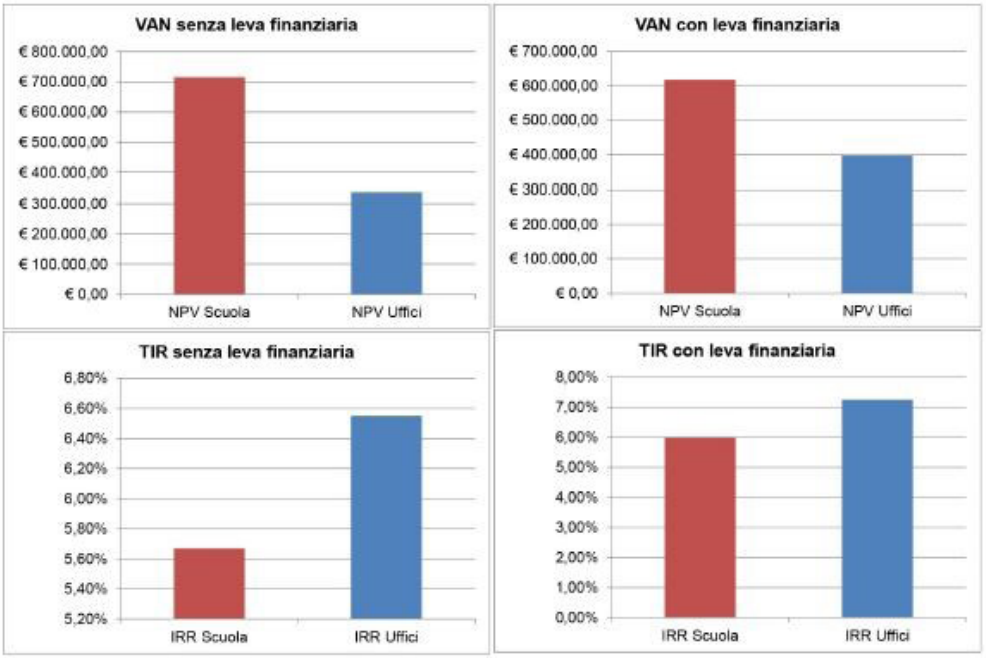
In the final phase of the learning process (3a), the student teams had to find concrete and feasible solutions to the previously identified problems by taking into account economic-financial, restoration, reuse, and energy retrofit issues. One of the objectives of the projects was to consider the assets as a unitary system integrated into the territory and maintain the general coherence at the master plan level. Furthermore, the student teams analyzed the convergence between public and private conveniences related to the buildings and, jointly, the economic and social opportunities at the urban level. The system of assets of the UNESCO site was considered as a cultural and economic hub able to foster urban regeneration processes and innovative enjoyment modalities for both the citizens of Ivrea and the different external user typologies. Therefore, also to this aim, the real interaction with the stakeholders was fundamental.

For example, a student team contacted some managers of the private company owner of the private asset "Study and Research Centre" in order to visit the indoor spaces of the building and to understand if the new function that they hypothesised was coherent with both the building's features and with the owners' future plans. When talking with investors/owners, the student teams' idea to transform the asset into an education center was completely questioned, even if the project was compatible from a restoration and architectonic point of view. Indeed, the owners illustrated to the student teams their need to have new offices and their intention

to use a great part of this building for this purpose. Therefore, the student team decided to develop two alternative projects (education center and offices building) and compared their respective economic-financial convenience in the long term (Figure 5).

In other cases, the external actors and experts specifically addressed the choice of design solutions by explaining to the student teams the required architectonic standards and gave important economic and financial references to guarantee an acceptable project's profitability. This is the case of the asset "New Olivetti Office Building," which the student team hypothesized to redevelop into a nursing home. Managers of a company specializing in managing this kind of activities met the student team and the teachers and shared their expertise by both suggesting the optimization and distribution of spaces to be designed and giving important input data for the DCF analysis (Figure 6).

In particular, they helped the student team to define the necessary construction and management costs, as well as to estimate possible incomes and the payback period by considering the minimum occupancy rate, the price levels (boarding costs), and the investment's risk. In the direct relationship with stakeholders the main problems and limitations encountered by students were the organization of the meetings with them: since each student team developed a specific project, different from others, the stakeholders and external experts involved had to multiply the number of meetings. Therefore, it was not always easy to find a date and time able to meet everyone's needs.



VAN senza leva finanziaria	
NPV Scuola	€ 714.813,42
NPV Uffici	€ 338.144,15

TIR senza leva finanziaria	
IRR Scuola	5,67%
IRR Uffici	6,55%

VAN con leva finanziaria	
NPV Scuola	€ 617.373,69
NPV Uffici	€ 396.744,97

TIR con leva finanziaria	
IRR Scuola	5,99%
IRR Uffici	7,25%

Figure 5: Results of the evaluation of the economic-financial convenience of two alternative projects: education center (in red) and offices building (in blue) (Source: Elaboration of the students Alessia Salato, Marianna Sanasi, Alex Ughetto, AY 2016-2017)

Addressing real problems in professional work

The PBL approach enables students and teachers to better connect all the issues related to professional work with all the theories and tools commonly learned during academic courses.

Assuming the abovementioned basic principles of the PBL approach (Figure 1), students were required not only to acquire knowledge and tools to formulate enhancement projects, but also to develop specific skills and abilities that they should keep as legacy for their future career development (Figure 7). For example, they gained the ability to critically analyze and read data from different sources and to find innovative and feasible solutions by linking different issues related to different disciplines. Moreover, they developed a series of soft skills, such as collaboration and mediation within their team, as well as task optimization and deadline scheduling (project management). A great skill the student teams acquired was also the flexibility to continuously

Figure 6: Meeting between a student team, teachers, tutors, and experts (a company specialized in managing nursing homes) for the case study of "New Olivetti Office Building" (Source: Photo of the Authors)

modify and improve their ideas and aspects of their projects by assuming positive and negative feedbacks from teachers, stakeholders, and other students.

At the beginning of the course, the heterogeneous levels of students' knowledge on methodologies and tools represented an initial limitation and problem that was solved by spending some extra time to recall theoretical frameworks of the previous years and to favor the specificity of knowledge coming from different disciplinary fields. Moreover, flipped classrooms with mixed student teams were scheduled so that students with a higher level of knowledge on a specific topic could teach the others. Furthermore, the interaction with external experts in different domains (restoration, economic enhancement, design, and technologies for energy retrofitting) went beyond the traditional tools and techniques of the design approach, guiding the student teams to face high complexity problems (at the urban level and to develop sustainable redevelopment projects that can be though as a "unitary cultural system"). Furthermore, at the end of the course, the active involvement of stakeholders and experts gave student teams the possibility to connect their work to the real world, by actively participating in a public event (3d). This final step constituted more than a good academic result. The Municipality of Ivrea and the Politecnico di Torino (Architecture and Design Department) organized the public event "Beyond Olivetti. Scenarios for the future of Ivrea. The heritage as urban regeneration and development chance," with the aim of presenting the site's master plan and all the restoration and enhancement projects developed by the student teams to citizens and institutions not directly involved in the learning process. During this event student teams presented their projects and answered the questions asked by experts and stakeholders.

The Municipality of Ivrea awarded the student teams who developed the best projects, appointing for that a specific commission (composed of some people representing

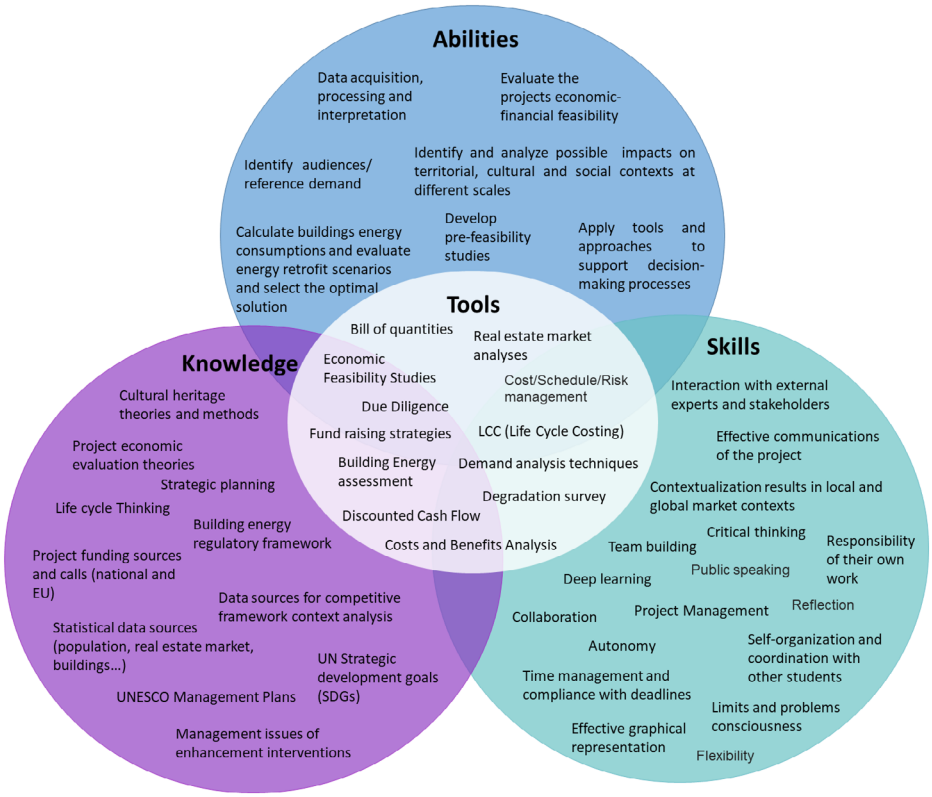


Figure 7: Knowledge, skill sets, and tools acquisition scheme (Source: Elaboration of the Authors)

the Municipality, the working group for the WHL UNESCO candidature, the association Confindustria Canavese, and the assets' owners and managers). At the end of the presentations, the commission selected the winners on the basis of the quality of the project, the coherence of the hypothesized new function with the buildings' features and the related context, the design innovation level, and the project's economic-financial feasibility. In particular the criteria utilized for the evaluation of projects in the competition were quite different from the evaluation at the end of the atelier, which in general included: maturation along the course of the atelier and growth of awareness, personal contribution to the final product and the equilibrium of competencies in each group, originality of the project, harmonization of the principles of restoration and economic enhancement, graphic and oral exhibition skill, correct application of tools, adherence to the initial goals, and demonstrable sustainability of the project (in terms of both energy and economics) (Figure 8).

Students really appreciated this final interaction with experts and stakeholders since their results were disseminated in a real context. Moreover, this event represented a good chance for the Municipality of Ivrea to reactivate a public debate on the criticalities and potentialities related to the future enhancement and management of the UNESCO site.

Conclusions

The educational procedure illustrated in this paper focuses on the potentialities of the problem-based learning (PBL) approach and highlights how the continuous interaction and dialogue between students, teachers, and stakeholders can improve the economic and cultural value of enhancement projects developed in architecture and planning schools.

The application of the proposed educational procedure during the atelier "Heritage Preservation and Enhancement" carried out at the Politecnico di Torino can be considered a successful experience since emblematic and concrete results were achieved at the end of each step of the educational procedure. Starting from the identification and definition of a real main problem, the active involvement of stakeholders and experts was scheduled and activated in numerous steps of the learning process. The active role of the stakeholders during

Figure 8: The public event "Beyond Olivetti. Scenarios for the future of Ivrea. The heritage as urban regeneration and development chance" at the "Salone dei 2000" – 16 June 2017 (Source: Photos of the Authors).

the course and their numerous interactions with teachers and student teams demonstrated the positive impacts on the learning process as well as on the development of multidisciplinary, concrete, and sustainable redevelopment projects. Thanks to these numerous interactions the students were actively involved in the learning process and felt responsible, collaborative, and active within a real community. The role of the teachers was initially difficult, since the students' reaction time to the new didactic approach (PBL) was slightly longer and teachers had to stimulate dialogue and interaction several times. Therefore, it was evident how teachers can play a primary role not only with educational purposes, but also as mediators among the involved stakeholders and the student teams, in order to activate decision processes and to analyze and solve real problems connected to a sustainable urban development.

An ex-post reflection on the entire problem-solving process underlined that the participation of students was enhanced during the atelier; tools such as brainstorming and focus groups worked very well to foster and encourage discussion between them.

Furthermore, a meeting between teachers and stakeholders after the end of the module was very useful to design the module for the next academic year, trying to improve and make more effective the learning process. In particular, for the future runs the following issues will be taken into account in order to improve the learning process:

- involving "active" external players (for example owners) regarding data collection, including building accessibility. This is mainly due to the "private" nature of the data requested for the student teams' work;
- considering the specific stakeholders' role, their hierarchy, their interests in the plan/project/action;
- each stakeholder represents its own specific interest, in many cases in contrast with the other actors. Their interests may be in conflict and may not satisfy community (represented by public administrations) needs;
- in general, it is easier to involve public players—specifically in public projects—than private ones:
- it is important to schedule the milestones in advance;
- prepare the involved stakeholders to the work in the classroom and train students to be more active in questioning and interacting: these are necessary preliminary steps that facilitate the process.

At the end of the atelier students demonstrated they could gain the capability to deepen different aspects of the same real problem, and furthermore, as future architects, successfully collaborated with experts and external actors, developed key competencies in sustainability, including problem-solving skills, as required in the professional work.

Moreover, good feedback came both from the community and from the stakeholders about the public event, during which participants appreciated the followed didactic approach and the projects developed by the student teams. Thanks to this event, 12 projects were presented and disseminated and, in parallel, the nomination of the site for its inclusion in the UNESCO WHL was promoted. At the moment, the redevelopment of the site is almost blocked due to a series of technical and political reasons; nevertheless, the projects developed by student teams during the last years played an important role in activating and maintaining an active debate on criticalities and potentialities related to the future enhancement and management of the UNESCO site.

Although the atelier can be considered a successful module, some recommendations can support teachers in eventually replicating this approach in other contexts. When teachers draw up the "class contract" with the students at the beginning of the module, it is important that they explain very well the principles at the basis of the didactic approach, highlighting its innovative aspects. For example, students must be aware that the educational objectives go beyond knowledge and specific tools, since also soft skills and abilities have to be acquired during the learning process. Furthermore, it is fundamental to carefully schedule and organize the principal phases of the educational procedure and the specific lessons, so that students are always involved in interactive activities and their role is never passive.

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