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INTERDISCIPLINARY AND INTERNATIONAL WORKSHOP AS TECHNOLOGICAL DESIGN METHOD FOCUSED ON THE EUROPEAN ODS STRATEGY

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Abstract

The innovative rules of the Europe 2020 Strategy, which follow the Lisbon Strategy (2000) and the Copenhagen Declaration (2002), promote smart and sustainable growth through the promotion of low-pollutant, resource-efficient and effective project strategies for improving human, social and environmental conditions. This paper illustrates the workshop design experience conducted in collaboration between the Escuela Superior de Edificacion (ETSEM) of the Universidad Politecnica de Madrid, the Department of Civil, Building and Environmental Engineering (DICEA) of Università di Napoli "Federico II" and the Department of Architecture and Industrial Design (DADI) of Università della Campania "L. Vanvitelli", focusing on the added value for the three research groups to integrate different teaching methods according that strategies.

Keywords: Educational Opportunities, Knowledge/Competence, Learning Process, Functional/Energy, Retrofit, Technological Design.

1 THE DIDACTIC EXPERIENCE OF THE DESIGN WORKSHOP

The almost forty-year teaching experience at the University of Naples, the oldest Italian secular University founded by Federico II of Svevia, has allowed to define innovative methods for academic education, based on the close relationship between theoretical learning and practical application on the territory. In recent decades, the European Erasmus and Erasmus Mundus programmes have facilitated the creation of exchange networks not only for students, but also for teachers, encouraging the comparison of training methods and strategies and paving the way for new teaching perspectives and wider partnerships. It was from an agreement between University of Naples and Polytechnic University of Madrid that the first exchanges of lecturers began, starting with the departments DICEA of Naples and ETS de Edificacion, involving colleagues from the University of Campania and the Architecture Department of UPM, to whom scientific collaborations were already active.

The link between research and teaching in the University is very close and should not be underestimated because the collaborative network between scholars, that is created from common interests and research goals, can easily extend to educational activities for the transfer of knowledge, without losing the innovative spirit that always characterizes research activities. New ways of transferring knowledge and new strategies for motivated student engagement can be excellent goals for senior researchers interested in dissemination: working in interdisciplinary and international groups is definitely a strong motivation to work well and learn faster.

The paper presents the experience of the workshop "Energy and functional redevelopment of a primary school" in which students and professors from the Universities of Naples and Madrid participated and cooperated that took place in Madrid from 19th to 21th September 2019.

The project topic faced starts from the scientific and technical skills of the teachers involved and from the idea of applying them on a practical case study: considering the ever-increasing climate emergency, we are now witnessing an important campaign to raise awareness of environmental issues that has invested the new construction industry towards sustainable design and production. In this atmosphere of attention and innovation, the vast school building heritage of the 60s and 70s needs redevelopment in order to meet the required standards.

The aim of this workshop was to demonstrate what economic and environmental benefits can be had through the energy and functional redevelopment of an existing building and the context in which it is

located. The choice of the primary school of the "Colegio Estudio" as a practical case, expresses the desire to act not only at the design level, but also and above all at the social level as an educating building. The workshop developed over three days and included the drawing up of a poster:

19/09 Day 1 – Morning: presentation of the issues, goals and possible design paths, edited by Professors Fumo, Violano, Cennamo, Lopez-Izquierdo, Palmero, Izquierdo Botin. The introductory seminars were followed by a guided technical tour of the chosen primary school, which is an architecture of great formal interest, born from an innovative teaching concept that saw the collaboration between the architect and the three pioneer teachers. Afternoon: Start of work in team

20/09 Day 2 – Teamwork

21/09 Day 3 – Morning: Completion of teamwork. Afternoon: Presentation of the drawns.

2 METHODOLOGICAL EXPERIMENTATION

The workshop held in Madrid in September 2019 was organized according to a format devised by the writer and characterized by a sequence of activities that follow according to a strict logic of approach to the topic:

1) indirect cognitive phase in the classroom: the workshop starts with the presentation of the topic and goals by experts - not obligatory University professors, but rather specialists on fundamental aspects of the subject of the workshop - that carry out brief information seminars from different points of view;

2) direct on-site cognitive phase: the survey for direct understanding of the sites is essential, especially during their exercise (in the case of Colegio Estudio, during school hours) so that we can observe, in addition to the building, the behaviours and to interview some users belonging to various categories (teachers, janitors, children, parents...) to collect their perception of the critical issues as well as any suggestions on possible design choices;

3) organizing phase: all the participants exchange impressions and reflections during a guided briefing that takes into account both what is heard in the classroom and what they personally saw and noted in order to expand the data available to everyone before starting the project activity; then the organizers provide the training of the working groups, starting from the participant list with the specific training courses, forming groups of 3-4 people of different origin in order to optimize the contribution of each one to the project and the synthesis of individual contributions;

4) on-site design phase: this stage is the one that occupies the majority of the workshop – whose lasted total can vary from 3 to 5 days - and allows the young participants to work in the same place for which, in a few hours, they must devising sustainable solutions improving the lives of users and that of the building; it is essential that the activity takes place on site in order to have the opportunity to reflect on-site on possible solutions by studying both the building construction and the user's behaviours;

5) communicative phase: the project proposals designed are represented with a poster and also, generally, with a power point screen presentation so that the individual groups (having the same set time available) can make what themes of the project have focused and what solutions have been devised publicly understood; the dissemination of workshops results does not end with the public presentation at the conclusion of the work in groups, but it is desirable that both introductory seminars and project proposals are published in print for more effective dissemination and implementation of some of the emerged ideas.

The Fumo workshop format has been refined over a decade and has shown that it can activate beneficial synergies between participants who develop creative and communicative skills just because of the limited time and cooperation with unknown people. [13] The action of tutors is essential to direct the design of participating students, encourage them to quickly finalize the specific focus of each group and possibly mediate situations of imbalance or individualism within the group. It is widely verified that in a few days to produce great results starting from a design activity in groups of people who don't know each other and who aren't used to working together, it's possible. Also, the language code used to communicate the own ideas within the working group may be alien to the participants, as happened in Madrid among the Italian and Spanish students who communicated in English.

The final satisfaction of young participants is always evident and the enthusiasm that activates the adrenaline and creativity does not end at the end of the workshop but strengthens the feeling of self-esteem for the design idea exercise carried out in a very short time in full immersion on site.

Figure 1. The students workshop works.

2.1.1 The Europe 2020 Strategy

The training activity has been designed according to the innovative rules of the Europe 2020 Strategy, which follows the Lisbon Strategy (2000) and the Copenhagen Declaration (2002). It promotes smart and sustainable growth through the promotion of low-pollutant, resource-efficient and effective project strategies for improving human, social and environmental conditions. "Education, and in particular higher education and its links with research and innovation, plays a crucial role in individual and societal advancement, and in providing the highly skilled human capital and the articulate citizens that Europe needs to create jobs, economic growth and prosperity." (Supporting growth and jobs - An agenda for the modernisation of Europe's higher education systems COM (2011) 567 final, European Union, 2011). The need to train professionals able to act and interact in the European scene encourage the promotion of educational experiences in which linguistic and cultural differences between foreign students and visiting professors are combined. The aim of this particular didactic methodology is to promote the exchange of skills and experiences and develop the ability to move "within a complex network of multidisciplinary and multicultural relationships" [11].

This kind of educative activity, makes the principles of Malcolm Knowles' Andragogy Theory, and it has indeed been noted that the most satisfactory results for learning new knowledge, come out when the student feels the need to develop a practical and immediate solution to a real problem, this is possible through direct experience in a problem-solving logic. The starting point, therefore, is always the direct experience on site aimed at offering tools close to the real professional practice and, thanks

to the use of a case study, students are given the opportunity to immerse themselves in the identity issues and in the political and social context of the reference area, starting from an analysis of the context and identifying the critical issues and needs through interviews and on-site visits; this translates into the acquisition of the ability to design in response to specific social needs always taking into account technical and technological requirements. The teaching methodology defined, according with the Career Development Program Adkins Life Skills, identifies and pursues four phases defined as follows: "1) Stimulus: introduction of the problem, representation of the difficulty (phase of the instinct); 2) Evocation: discussion about the problem in order to identify the elements (phase of emotions); 3) Objective investigation: reaching a conceptual awareness through dialogue and exchange (phase of the reason); 4) Application: practical experience, in both classrooms and situations of the real world to define the behaviour (phase of acting)". [11].

The practical development of these phases is concretized in the combination of the theoretical part, through seminars, lectures and discussions with students, with the practical part in which knowledge is transferred through the definition of Best Practices. In this part it is essential that students are at the centre of the action, in a context of organisational autonomy, from ideas to the management of time to the definition of the work; in this sense, the teacher plays the role of a guide who leads them in the critical and creative process. The result of this approach is teamwork, developed in a very short time and presented to teachers, other students and local authorities and associations. This moment of great satisfaction for the students, involves not only an awareness and responsibility towards the work to be done, but also teaches them to define roles and tasks within the group, to share ideas and rework them in a critical way taking into account many aspects and many points of view and finally allows to develop a series of "non-cognitive skills" such as self-confidence, persistence, consciousness, motivation, which are fundamental for the training of tomorrow's European professionals.

3 RESULTS: FROM THE ANALYSIS TO THE PROJECT

The importance of observation as the origin of artistic creation, respect for the environment and nature, cult of tradition, love for materials and experimentation with them are the basic elements of the design concept of the Colegio Estudio in Aravaca, a singular School designed by the architect Fernando Higueras in the 60s wich currently is protected and cataloged by the city of Madrid. This building has been chosen as a case study for its constructive and spatial peculiarities. The basic colours of the school are the grey of the reinforced concrete, the green of the tiles and the yellow of all the external metal elements. The interior dividing walls that separate the classrooms are made of Oregon pine, forming small shelves, drawers or cupboards. At the same time, at the height of the teacher's eye, a continuous glazed window evens out all interior spaces with transparency. In the exposed concrete outer shells, the formwork outlines the openings designed in the shutter box with an inverted U-shaped reinforced concrete beam that acts as a double edge. Tiled roofs evacuate water by natural gravity and collect it from the ground in gardens and flowerbeds.

3.1 Energy technological design experience

The shift of attention from the teaching process to the learning process enhances the didactic experience of the Design Workshop as a tool for dynamic and proactive comparison: in a very short time (3 days), the main challenge was to move from the phase of constructive, functional, energy and structural knowledge of the building to the focus on strengths and weaknesses, in order to elaborate a meta-design based on real data, complex evaluations and needs gained through direct interviews in the field. Regarding the type of case study chosen for the didactic experimentation, it is necessary to make a social as well as a technical reflection. From the social point of view, school buildings represent an important typology in which raising awareness of energy issues can be particularly effective for two substantial reasons: they are public buildings, with a demonstrative role of good energy practices; they have an "extended" use to a significant number of subjects which are the future generations of citizens who will have to manage the existing environmental and human heritage. The aim is to give public buildings a demonstrative role in demonstrating good practice with regard to energy and the environment more generally. In addition, thermo-hygrometric, light and environmental comfort conditions determine the quality of the study space and stimulate learning [5]. Analyzing the types of needs of these buildings, they consume energy mainly for heating/cooling, domestic hot water, lighting and the use of equipment (among all: computers and office equipment), but the real problem is often the envelope that does not meet the minimum requirements of the regulatory standard.

Figure 2. Colegio Estudio Aravaca

The didactic experience conducted on the case study of the Collegio Estudio concerns precisely the analysis of the energy performance of the envelope of this school building, which is very valuable from an architectural point of view, but extremely inadequate from an energy one. The evaluation of the main parameters in order to make appropriate technological choices for energy requalification was the starting point of the design considerations made by the students.

The method of energy-environmental diagnosis that starts from the Energy Audit, through the analysis of the building system (in particular of the opaque and transparent envelope elements) and the assessment of the Energy Footprint of the building, comes to the re-design of the entire system or parts of it, with the primary objective of enhancing the propensity for integration with the main active and passive environmental control systems.

From the methodological point of view, during the Seminar the theoretical foundations were defined: regulatory requirements, evaluation tools and main technological design solutions that can be implemented in order to obtain the required performance. In accordance with the Career Development Program Adkins Life Skills, the four phases were:

1) Stimulus: on site analysis of the main construction deficiencies (visible technological analysis);

2) Evocation: sharing of theoretical knowledge and verification of skills acquired during the Seminar;

3) Objective investigation: conceptual awareness through the comparison of theoretical data acquired through the use of specialized software (phase of the reason);

4) Application: elaboration of project tables (phase of acting).

From a more technical point of view, the analyses revealed a serious deficiency in the exposed concrete envelope. With regard to the building-plant system, the primary energy requirements for heating, cooling, lighting and DHW production are high as the energy performance of the envelope is well below the minimum requirements and, in addition, there is no use of renewable energy sources. The stratigraphy of the vertical perimeter walls is, in fact, made up of 20 cm in-situ concrete partitions without external and internal plaster and without thermal insulation. Despite it has a mass of 480 kg/m2 which guarantees good thermal inertia (moreover, periodic thermal transmittance testing is not required), it has a transmittance of 3.64 W/m²K in winter and 3.293W/m²K in summer, which are values well above the mandatory regulatory requirements. The thermal parameter values of the building components were evaluated during the workshop using PAN 7.0 software for the opaque envelope and Pilkington Spectrum software for the performance of the glass in the transparent envelope. The data deduced are shown in Figure 3 and were the basis for the retrofitting design considerations formulated by the students during the meta-project phase.

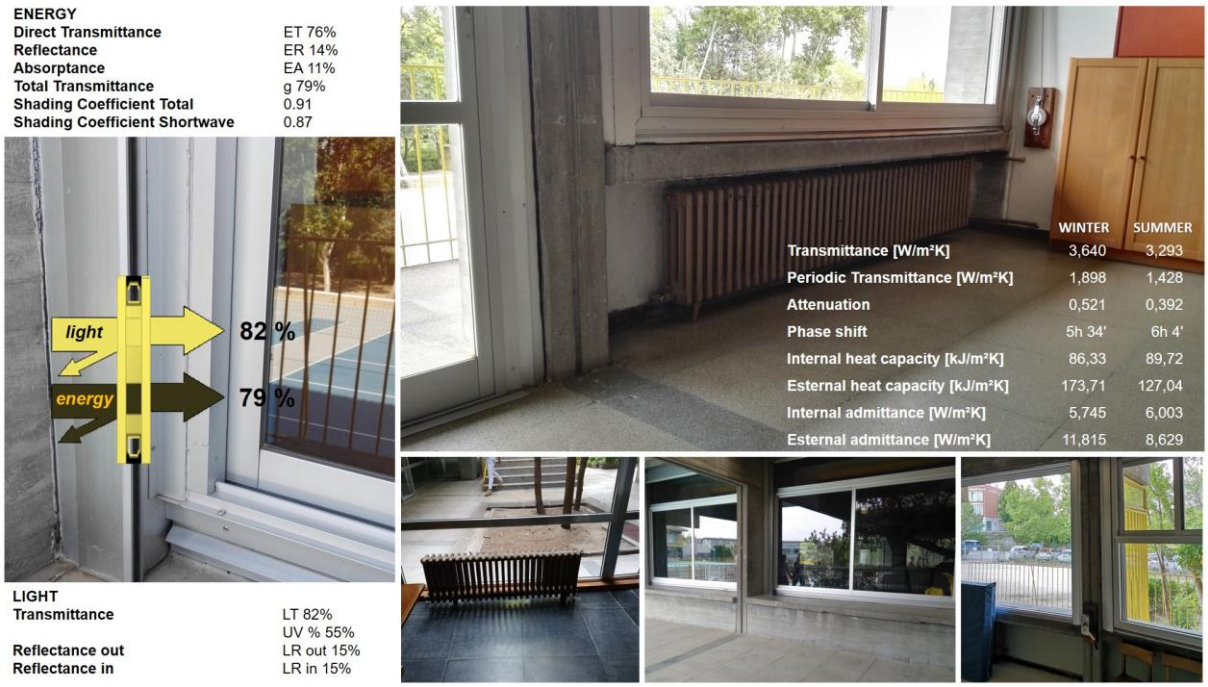

Figure 3. Energy performance of transparent and opaque envelope of the Colegio Estudio Aravaca.

3.2 Structural experience

The low environmental impact, efficient from resource point of view and effective to improve human strategies and social and environmental conditions, can help to achieve structural safety optimization.

The events that mainly undermine structural safety are both earthquakes, land subsidence, natural disasters (landslides, floods, hurricanes), both degradation, neglect and lack of maintenance, or even inappropriate maintenance. To discuss the first point, it should be pointed out that in Spain seismic hazard is rather underestimated and that the legislation on earthquake-proof construction has not been updated since the Lorca earthquake in 2011, despite the fact that many provinces, such as Granada and Murcia, have a non-negligible seismic risk (source: Seismic hazard map of the Spanish Instituto Geografico Nacional). As is well known, seismic risk is a quantifiable factor, calculated from the product of three probabilistic indices: seismic hazard, i.e. the probability of a seismic event occurring, seismic vulnerability, i.e. the probability of exceeding the seismic capacity of the structure, and the exposure of the building, i.e. the economic/social value of the content of the structure (probable object of damage). This first part of the seminar intended:

a) to bring to the attention of students the importance of prevention, especially with regard to buildings open to the public, such as schools, for which it is essential not only the safety of structural elements, but also that of non-structural elements such as installations, false ceilings, windows, shelves, etc., which can cause considerable damage to people. To this end, there are shown italian case studies occurred in the last 20 years. On October 31, 2002, the Iovine primary school (San Giuliano di Puglia, Molise) collapsed during the seismic event (a few months earlier, a heavy reinforced concrete elevation had been built on the pre-existing masonry structure). In 2008, the Darwin High School in Rivoli (Turin) suffered a serious collapse of the light brick false ceiling, with the fall of the overlying cast iron pipe: fragile collapse, no premonitory signs (the undersized tie rods had given in progressively), no seismic event (starting from the following year in Italy people started talking about ways to control the vulnerability of non-structural elements in schools). During the earthquake of 2009, the Faculty of Engineering in L'Aquila suffered the fragile failure of the heavy windows of the large classrooms and sandwich walls [3].

b) to highlight how completely sustainable anti-seismic strategies already existed in the past, and why it is not always necessary to implement invasive actions to protect buildings, but rather it is always essential to act with respect and deep knowledge of the original construction. It is well known that modern anti-seismic strategies are based on three fundamental concepts: dissipation, realized with the use of energy dissipators (active control of the structures), insulation, realized with the insertion of seismic insulators in the foundations, ductility, realized with innovative materials such as fiber-reinforced materials, etc.. It has been shown that in ancient times the same results were obtained with sustainable and zero environmental impact methods. As an example of dissipation is remembered: the Greek masonry with wooden trunks (1500 b.C.), the houses with wood drowned in the masonry (*case baraccate*, 1700 a.C.); as an example of insulation: the Alhambra complex (1300-1400 a.C.), the temple of Diana at Ephesus (600 b.C.), the walls of Troy (1500 b.C.); as an example of ductility: Japanese wooden temples (1200-1300 a.C.) [4].

However, earthquakes aren't the only responsible for buildings collapsing. Some structural failures, occurred in the city of Naples, are connected to the characteristics of its subsoil permeated by underground cavities that can turn into huge "holes" swallowing the foundations of buildings. In 2015, in the center of Naples, an historic building used as the Faculty of Veterinary Medicine of the Federico II University collapsed. Few premonitory signs (creaks during the night) precede the disaster. Same fate for an elegant building, located on the Riviera di Chiaia. Is it the fault of the works for the new underground station? Blame for the aquifers? Or a concomitance of causes always generated by the "original sin" of a city built on empty and full spaces? In this case too, there is a discussion in retrospect of how a policy of environmental prevention would have averted disasters [1].

For the third point we bring, as an example of inadequate manipulation, the case of the dome of the Basilica of San Francesco di Paola in Naples (1816), which has capillary lesions and stains of moisture inside the huge dome. The flowers in the dome are damaged and dangerous for visitors in case of fall. The vertical lesions affect most of the lining of the drum. The causes are to be found in the clasp with bricks of some areas of the circular tunnel passing above the drum, originally conceived as a natural ventilation system, blocking in this way the recirculation of air [2].

This overview of multiple information proved fundamental for the students of the workshop, as it provided them with a different point of view to deal with the experience of the Colegio Estudio in Aravaca. The complex, a redundant reinforced concrete structure from the 1940s, well compartmentalized although suffering in some localized areas of interesting structural problems, provided an excellent study ground for the application of what was learned in theory.

The students isolated the structural part from the functional partitions and thus managed to focus the discourse on sustainability according to the various elements of architecture (structure, function and form).

3.3 The role of colour for the rehabilitation

The objective pursued in the workshop was to improve the human, social and environmental conditions, in order to optimize the development of the educational mission of the Estudio school in Madrid. To do so, an analysis of the functional, constructive and energetic realities was carried out, proposing measures and interventions focused on achieving these objectives. From the TECA research group, we envisioned innovative and unusual alternatives, using color as ther key tool in our architecture, in order to give “unconventional” answers to the problems raised. It is an interdisciplinary

field of knowledge, currently in its initial stage, aimed at achieving the ideal conditions for the development of the activity and the learning environment needed.

With the use of color, the goal pursued was to provide spaces with the appropriate sensory environment, intervening on two different levels:

- Indirectly they act as energy rehabilitation measures. That is, they reduce the demands for lighting, heating and cooling.

- They Modify the behavior of teachers and students, improving learning conditions.

About the aims pursued, the starting point was the Reggiana pedagogy hypothesis, which conceives the school building not only as an aesthetic area, but also as an educational space consistent with the pedagogical project that expresses and facilitates its development. Our proposal aims to follow this thesis, proposing the creation of environments and aesthetic landscapes, in which color plays a fundamental role. In order to collaborate in the educational project of the Estudio school, and seeking for a more appropriate sensory environment, we propose the perceptive chromatic experiences to provoke responses in students with the objectives of enhancing the communication and motivation in the school, as well as improving its sensory and physical conditions. To accomplish this task, a conference was given on the contents and abilities of color, gathered in the Enactive theory of color for architecture, along with the rest of the theoretical contents of the workshop. About the results of the proposals, in the projects carried out by the students, several points must be highlighted, specifically focused on three aspects:

1. Interventions in the energy environment
2. Interventions in the light environment
3. Interventions in the sensory environment.

Color was part of all the proposals, which reflects that their knowledge is relatively intuitive and easy to reach. The chromatic proposals were very creative, extending their application outside the limits contemplated in the conference. Which demonstrates a "natural" tendency to use color in unconventional ways.

The use of color was generalized for two different purposes:

1. As a means of communication, aimed at: organization the activity; as an element that reinforces the sense of belonging to your class and school; as signage.

2. Modifying the student's behavior, in two ways: varying the dimensions of spaces and classes and introducing qualities of the natural environment into space.

Figure 4. The workshop work phases

All this, causing low cost and innovative chromatic experiences, easy to implement.

In conclusion, when you have a training on the Enactive Theory of Color, even if it is at a basic level, and having the freedom to act, the use of color in architecture is applied with great spontaneity, intuition and creativity. Hence, we think that the teaching has to be introduced decisively in the training of all the agents involved. The solutions at the sensory level, have great repercussions on “levels Of comfort” that the user perceives, hence the color can indirectly be considered as one of the measures to be applied in energy rehabilitation projects. The application of color has a response that is not proportional but exponential in the benefits it reports on people. Color should not be left out of the mechanisms that are applied and used in the rehabilitation of buildings that are of social interest, because it infuses and permeates our experiences of the place.

4 CONCLUSIONS

The workshop,carried out in the “Colegio Estudio” had several strong points. In this space students from seven different european and latin american universities received classes and training, and also worked and collaborated in groups within a field of linguistic and cultural diversity that contributed to enriching their experience hugely. The training activity designed in accordance with the innovative rules of the Europe 2020 Strategy, which follows the Lisbon Strategy (2000) and the Copenhagen Declaration (2002), integrate different teaching methods according that strategies.

The three research groups transferred to the students not so much specific knowledge on the topics: design, construction, energy and structures, but rather the method of expeditious specialized analysis that allowed the students to produce meaningful project proposals based on the process of integrated knowledge of the case study. The objective pursued in the workshop was to improve the human, social and environmental conditions, in order to optimize the development of the educational mission of the Estudio school in Madrid. To do so, an analysis of the functional, constructive and energetic realities was carried out, proposing measures and interventions focused on achieving these objectives. In a very short time (3 days), the students were distributed in different groups in wich they worked, shared ideas, critically reworked them and carried out a group work with their proposals that was exposed to the teachers and the rest of the students.

We believe that this workshop has been a so interesting experience in which students have expanded their technical knowledge and have been able to develop non-cognitive skills such as self-confidence, persistence, awareness, motivation, but it’s important also to keep in mind the fact that the students during this period have moved in a network of exchange of skills and experiences that has allowed them to develop also their ability to move "within a complex network of multidisciplinary and multicultural relationships" and that’s essential for the training of our professionals in today's world.

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