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Chapter

ArDIn. Art, Design, and Engineering Merging in a New Method

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Abstract

Teaching technical drawing to fine arts students in 2001 is the beginning of an idea that searches for an integration of different fields of knowledge. Life brings you then to teach artistic drawing to industrial design engineering students and, therefore, to face again the difficulty of merging into one concept: art and science as a whole. So let's introduce a better connection with the professional world into our teaching-learning process. In 2011, Silvia Nuere created a scientist journal called *ArDIn, Art, Design, and Engineering* to promote the STEAM approach to learning. Art, design, and engineering must configure the basic elements of a new way of understanding not only the teaching-learning process but the way of being in the twenty-first century. ArDIn becomes then their method to involve students in the necessary integration of art and science through a constant dialog and critical thinking. Between the educational contexts, we want to point out transmedia narratives as a movement that enhances the creative process. We need to be opened to new proposals as well as going further looking for connections beyond media. Through this project working interdisciplinary, we prepare students remotely for their story in a possible transmedia format.

Keywords: ArDIn [ˈɑːrˈdiːn], art, design, engineering, STEAM, visual thinking

1. Introduction

The authors have designed this methodological paradigm. Their identity is a set of three things closely or especially linked to each other with a background as artists, teachers, and researchers [1]. Thanks to their teaching experience in engineering at the university, they have naturally configured a way to proceed in the classroom intimately related to the artistic and researcher dimension. Graphic expression and creativity subjects conform the beginning of a new thinking process.

On the one hand, the artistic dimension coming from their study background promotes the creative development of teaching materials as maps, visual statements, or presentations. On the other hand, the researcher essence deals with the concern of improving their teaching work immersed in various educational innovation projects. These projects are related to the ArDIn approach, as well as the generation tools, to encourage students' self-evaluation. The rubric self-assessment

tool is created as a tool for spreading their practice in contrast to other patterns and workshops.

As previously mentioned, this work has been developed in class within the design field. Nevertheless, doing so in different knowledge specialties has given them a teaching global vision, highlighting interdisciplinary nature. The interconnection of disciplines, when it comes to connecting learning with life and the future professional performance of students, is worth it.

After more than 18 years of teaching, the authors have been able to create an educational intervention model that raises the image importance in all their teaching-learning process. It is also important integrating artistic poetics and movements. Diverse creative advancing approaches can be transferred to a design project. Students can understand art creation as a bunch of possible solutions and the wheel that can help to innovate and converge into a good design.

Lately, the visual presence in these educational experiences has been important to forge student's view inside their knowledge improvement. But teachers have also transformed their students' reciprocal relationship widening their approach. Images are essential for understanding the concepts taught in the different subjects.

Projects offered in the different subjects taught during these years have been adapted to the profile of each group, to their educational level. The works collected in this long period are what today has become a real shared learning process evidence. According to Pence (2012), transmedia in education can be not just the use of a variety of media but also the need for the students to interact with the narrative. Framework transmedia is not only a new way to involve audience but also a favorable scenario to promote new interactions and ways of the teaching-learning process [2].

The main points will be illustrated by different experiences done all over the years. This will be the way to understand at a glance the ArDIn methodological paradigm. Selected experiences will then be presented as different visual results [3], giving importance to the visual to be faithful to how these proposals were presented and developed by teachers and students.

2. Research method

Thinking about design, it is interesting to deepen in its characteristics to find some aspects that could guide the specific methodology for this investigation. As Conde [4] specify, there is a clear relation between design and creativity. The characteristic of their nature determines this relation. He continues specifying that practicing creativity must be a transversal and multifaceted phenomenon and must not be reduced to a simple group of techniques. The most important is to encourage critical minds, to follow a divergent model of thinking, that is to think outside the box to deal with problems.

The UNESCO [5] recommends education to follow a creative and renovated model. Creativity and innovation are essential tools for the twenty-first century.

As designers, artists, or engineers, there is a common behavior. When a problem arises, they will have to face it and look for the best solution. As a parallelism, taking into account design thinking, we can face problems following this method. Experiences in classroom become a field of research. Diverse problems arise every day. Try to define the problems. Think about specific characteristics, about your students and their needs, and define, according to your taught subject, possible solutions. And finally put it into action.

This method is proposed to solve problems in a wide range of areas and companies [6].

The method followed is qualitative; deepen in the personal world of people in order to interpret their situations, what do they mean for them, and what are their intentions, their beliefs, and their motivations. These motivations and expectations of the education process can be studied through this method [7].

The main characteristics of this method are the following according to Bernardo and Calderero [7]:

- Inductive: conclusions are obtained through particular information.
- Ideographic: specification and particularity are really important.
- Descriptive: any data is important (words).
- Realistic: must understand reality with its values.
- Humanistic: knowledge and particular lives are taken into account.
- Interactive: it is natural to interact with all the persons involved in the process.
- Rigorous: what is heard or watched is checked with the data written down.
- Genuine: every researcher creates its own research process. They follow general orientations not concrete rules.

Following this thread, a holistic model emerges to put into practice in the classroom. Holistic education becomes an axis of human being development [8]. Even though the authors promote the holistic education research in the field of art, it can be extrapolated to the design field. The main objective is that “students can examine, identify, approach, analyze and live with intensity to establish a link with another spheres that have never dealt with” [8]. Students can become the main subject of the innovation process; they can participate and be part of a new way of teaching.

3. Educational context and skills

The context where the authors have included their proposal is in Europe as a global space where education will take place.

In the general information about the Erasmus+ Program, tackle socioeconomic changes that can be afforded through education [9]. As one important clue, education can enhance intercultural understanding and a sense of belonging to a community. It is also mentioned that young people should participate actively in society, in line with the provisions of the Lisbon Treaty to “encourage to participate young people in democratic life in Europe” [9]. Youth is essential for the future, as they will become the workforce of every country, and therefore they should participate more actively in their studies. Cooperation across different fields and levels must also be introduced in the process of learning.

Following the European transparency and recognition all over the countries, some tools have been created, as the European Credit Transfer and Accumulation System (ECTS), to facilitate recognition, better understood, within and across national borders.

The framework will be focused on the Key Action 2 of the Erasmus+ Program: cooperation for innovation and the exchange of good practices [9].

This key action supports transnational strategic partnerships that aim to develop initiatives addressing one or more fields of education training and youth and promote innovation. It promotes knowledge alliances between higher education institutions and enterprises to foster innovation, entrepreneurship, and creativity.

Another framework will be the Spanish laws referring to higher education. From time to time, the Spanish Ministry of Education, Culture and Sport publishes and updates the so-called *Libro Blanco* [white paper] that indicates the general actions and results about specific matters. In this particular example, it refers to higher education in general and engineering in industrial design in particular. One of the main contents refers to the general and specific competencies [10]. Competence is defined as the knowledge, capacity, ability, or acquired skill, which gives place at an adequate and optimal level of professional performance of engineering in the field of industrial design.

Between the specific disciplinary competencies, there is one that deals directly with the capacity of using manual and electronic tools for the artistic and industrial expression. Other competencies related to the cross techniques are problem solving, oral communication, capacity to organize and plan, or decision-making. Related to the systemic ones, students need to learn and work in an autonomous way, adapt to new situations, and be creative. Finally in the group of personal and participatory competencies, they will face critical reasoning, work in group, and communicate with professionals.

Analyzing the fine arts Spanish White Book [11], we find similarities with some competencies as they are related to general concepts, as, for example, be autonomous in their learning or be creative. In general, the ones exposed for industrial design, are more or less the same, just with some differences in their writing.

Approaching the particularity of competencies adopted by the Polytechnic University of Madrid (UPM), where the research takes place, creativity is between others, common to all their degrees [12]. Creativity is defined in an engineer way as the capacity of solving, in a new and original way, problems or situations of the engineering field. Even though they define it in an engineering field, there are different ways to face problems, and design thinking can be one of them.

Connecting to creativity, we also focus on the transmedia narratives as a way to promote new ways of learning, outside classrooms and in consonance with the twenty-first-century technologies. Making a parallelism with Henry Jenkins (2003) statements, “the current structure is hierarchical and we need a model for co-creation rather than adaptation of content that crosses media” [13], so there is a lack of common language or vision that could unify high education old models with new media [13].

In a wide sense, we can consider the definition given by Laura Fleming (2013), “transmedia learning is the application of storytelling techniques combined with the use of multiple platforms to create an immersive learning landscape which enables multivarious entry and exit points for learning and teaching.” But this new model can go beyond the classroom, taking the pedagogical principles from constructivism and letting students build new personal learning frameworks.

4. ArDIn paradigm

ArDIn proposes a paradigm with artistic procedures organized and inter-related with engineering and design fields to promote new knowledge contexts. Teachers and students will work in a horizontal and collaborative way in engineering concerns.

An image of a molecule is a perfect way to represent visually the proposal. The organization is a set of atoms attached through chemical bonds that result in a stable set.

ArDIn is presented with a form that can remind this molecular organization, albeit with its own singularities.

The first singularity refers to the contexts in which ArDIn is given. These are areas of teaching in which design is present, since the challenges faced by their students force them to act transversally between theory, technique, creation, usefulness, and innovation from the first day of class. Configuring the profile thinking of these students, necessarily divergent, must predispose them to keep an attitude to explore, know, analyze, combine, and, above all, learn. This motivation is essential to activate ArDIn method as “creative confidence.” This means facing the challenge without fear of being wrong, with certainty in their possibilities, and being aware of their limits and virtues.

The second singularity is about teachers from fine arts matters proposing activities to their students that guarantee a playful experience. The aim is to connect them with their reality and force them to work creatively and in an interdisciplinary way to make meaningful learning [14].

Another unique characteristic of the ArDIn molecule is that it can be fragmented and configured in new arrangements keeping its balance, contrary to what happens to chemical molecule (**Figure 1**). In these cases, the new arrangements are subject to the contexts in which they occur, adapting to the profiles of the people who live them. Therefore with each educational experience, a new shape of the ArDIn molecule is created.

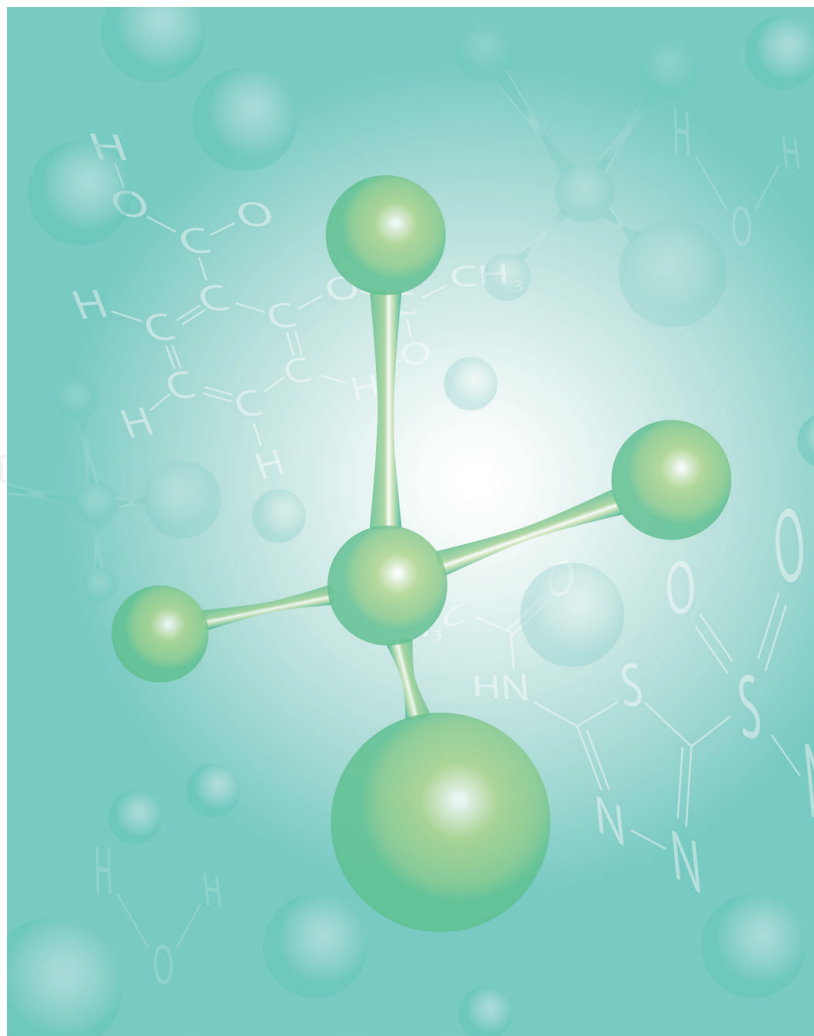


Figure 1.
Three-dimensional computer graphic simulation of a molecule (Silvia Nuere).

5. ArDIn work diagram

After years of teaching in different studies concerned as fine arts, fashion design, architecture, engineering in industrial design, and product development, some main concepts have arose as fundamental in the teaching methods. These main ideas related to the process of teaching and learning are the following ones (**Figure 2**).

First, whenever you are teaching, you may consider different matters of knowledge to strengthen learning. **Interdisciplinary nature** is essential, and searching new connections while teaching will enrich the process. This means, whenever possible, try to organize mixed classes between different subjects thought in your university school.

Thinking about teaching-learning experience, both actors in action, teachers and students, may be situated equally, which means in a **horizontal** plane. Obviously teachers are expected to have more knowledge due to their experience, but students are freshly in contact with the present moment, so they can benefit on each other.

In continuity with the previous aspect, we also propose a **collaborative** teaching-learning experience. It is not only a collaboration between teachers and students or different subjects in the same university school. It must also include different university studies. Last year took place an innovation project where teachers from architecture, fashion design, and industrial design worked together with all their students mixed into one unique goal.

And finally, it is supposed that when students leave university, they will start their professional career. Nevertheless, we find there is a big gap between what they learn and what they will be asked to manage afterward. So let introduce a better **connection** with the professional world into our teaching-learning process. They will face different approaches through different projects proposed by companies.



Figure 2.
General ArDIn work diagram (Silvia Nuere).

All this background must take into consideration that a **fun environment** is essential to create a good atmosphere. Even though we are reluctant to behaviors similar to children, humans will still play from time to time. Some words from David Elkind are important at this moment:

Adults respond so negatively to play because they define it as simply having fun and, therefore, as a waste of time. But though play can be fun, as one of the three essential drives—love, play, work—it contributes to the best kind of learning. Play operates as more than a creative urge; it also functions as a fundamental mode of learning. [15]

The exhibition “The Game of Art. Pedagogies, Art and Design” held in the Fundación Juan March in Madrid, starting in March 2019, emphasizes the importance of playing while learning. Ellen Key forewarned about the way children were taught in schools, with their rigid organization. Another study done by George Land and Beth Jarman in 1992 [16] pointed out the divergent thinking children have at an early age and how they lose it while growing up. This ability of inventing many and different answers must be adopted as a strategy to learn and innovate in design.

Pat Kane, musician and cultural commentator, always repeats that, in the twentieth century, game will do the same function as work did during the industrial era: it is going to be the predominant way of knowing, making, and creating value [17]. As McLuhan said, “Anyone who tries to make the distinction between education and entertainment doesn’t know the first things about either” [18].

As a clear example of a fun environment, it can be showed a color exercise made in a drawing class. It related to the expressionism approach where they face some big blank papers, using their bodies and getting familiar with mixing colors. The following is the link to one of these experiences done in three consecutive years, 2017, 2018, and 2019 (Video: <https://www.youtube.com/watch?v=hTRi72q4k88&feature=youtu.be>).



Transmedia narrative is also essential as a background to take into consideration. Students are constantly in contact with media and will not let them besides. Teachers, no matter their age, will need to face new ways of teaching using new technologies, not as mere tools, but as fundamental part of their strategies into the classrooms (and also outside them).

And other important strategy to manage this new era is to use student works as evidence for future students. The projects already done by them conform the real textbooks for future courses. Their experiences and their research while doing them deem essential for others, and in the future, students could become occasionally

teachers. The ETSIDI Design Association has already collaborated with the authors in teaching and assessing.

After exposing the main fundamentals of the ArDIn method, always surrounded by a fun and relaxed ambience, the different outlined concepts will be expound. Some real examples developed in the classroom, or outside it, will illustrate them.

6. ArDIn basis

All the ideas exposed are shown independently, they make up of the whole ArDIn concept method, though. This is not a closed structure, but as said in the introduction, they can change, adapt, grow, and sum up as they need while they carry out in a more complex molecule.

6.1 Interdisciplinary nature

Since 2001, facing the need of transferring technical drawing ideas to fine arts students, the idea of making teaching subjects in a wide range has been essential and compulsory. Fine arts students were reluctant to face technical issues, as for example axonometric perspective or other more difficult as dihedral system. The interest then was not only teaching the main concepts of the descriptive geometry but also showing the interest of introducing this way of seeing in their personal artistic work. They could learn how oriental artists are more prone to use axonometric drawing in their paints or cubist artists opted for the dihedral system.

Later on, at Universidad Nebrija, in 2005, the experience was inverted dealing with engineers facing a subject related to artistic drawing, as well as in the Polytechnic University of Madrid, in 2010 with a specific subject called “Artistic drawing.” The main purpose was to introduce a different way of facing their studies in a more creative way.

In any case, the main goal wasn't teaching these artistic concepts in an isolated way but integrating the essence of each one in the other. From the beginning, the **interdisciplinary nature** was essential to better deal with any matter (**Figure 3**). Nowadays we try to integrate other subjects or approaches into one. The authors have worked with architects, engineers, chemists, and fashion designers, always following the STEAM mainstream, introduced by the Massachusetts Institute of Technology. Art has found a place between the other starting concepts like science, technology, engineering, and mathematics. They believe that art is essential to the creative environment.

Related with art, we propose sketch drawing as a fundamental tool to transmit ideas and the image as a worth value to understand the world surroundings. Thinking can be afforded by a visual process instead of dealing with words.

Since 2017 the authors have carried on three innovative projects. One of them is a narrow collaboration with the Fashion Design degree at the fashion design school of Madrid and the Architecture Fundamentals degree at the Polytechnic University of Madrid. All approaches were project-based learning, project-based challenge, and service-based learning, integrating students from different degrees and different year courses.

In one of them, students from architecture, fashion, and engineering in industrial design had to organize a fashion show, starting from choosing the fashion designer to their specific collection. They propose an architectural space to take

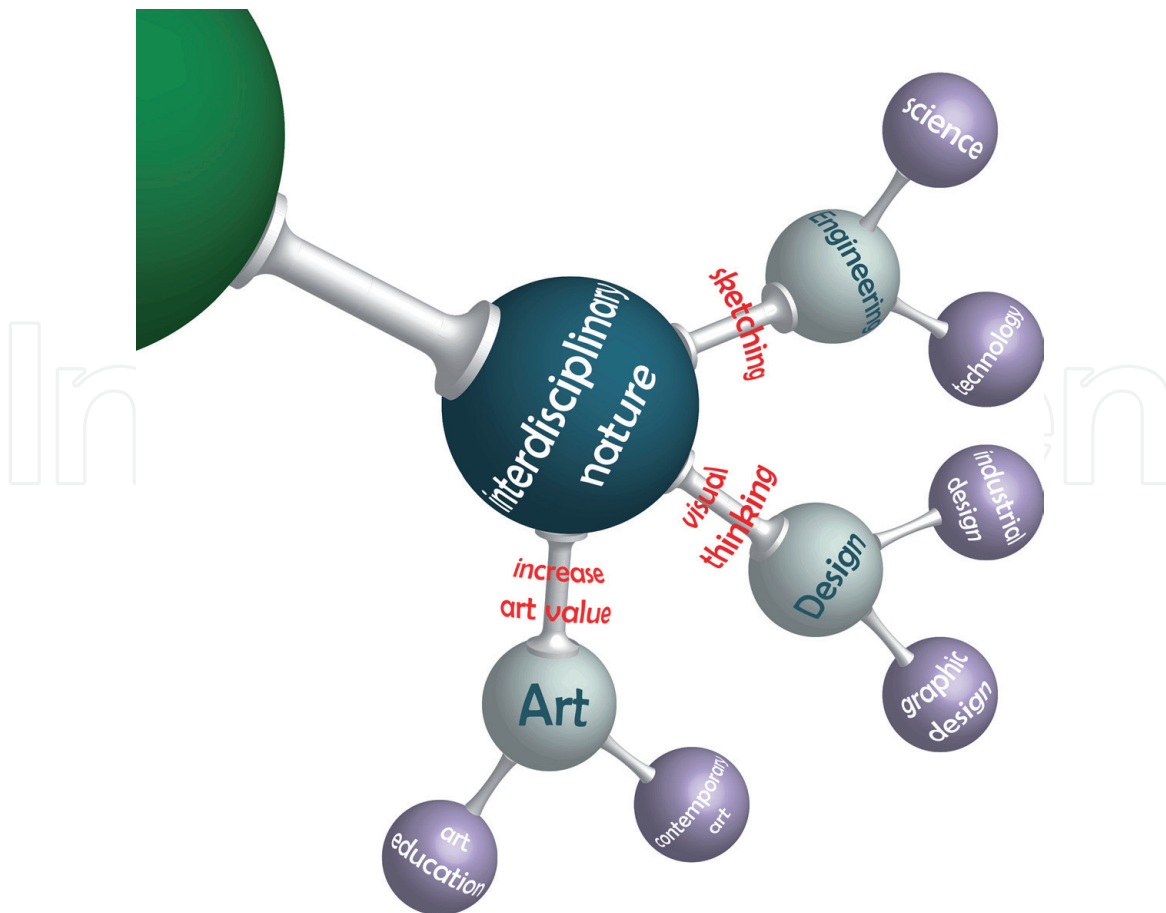


Figure 3.
Interdisciplinary nature diagram (Silvia Nuere).

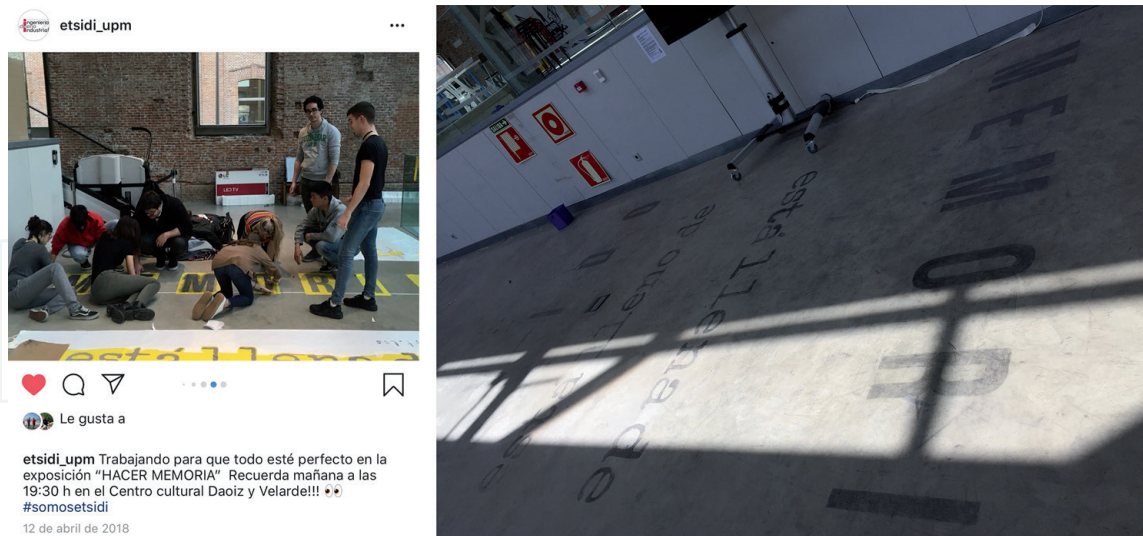


Figure 4.
Art piece process and final work (Etsidi and Silvia Nuere).

place and also design some furniture or element for the event. Students worked in an autonomous way in mixed groups. In the end, the Madrid Fashion Design Week Director assessed all the projects during a group activity.

In 2018, some students participated in great collaboration with a teacher proposing an artistic piece to be shown in a cultural center in Madrid. For most of them, it was a new experience, and in the end they enjoyed it a lot (**Figure 4**).

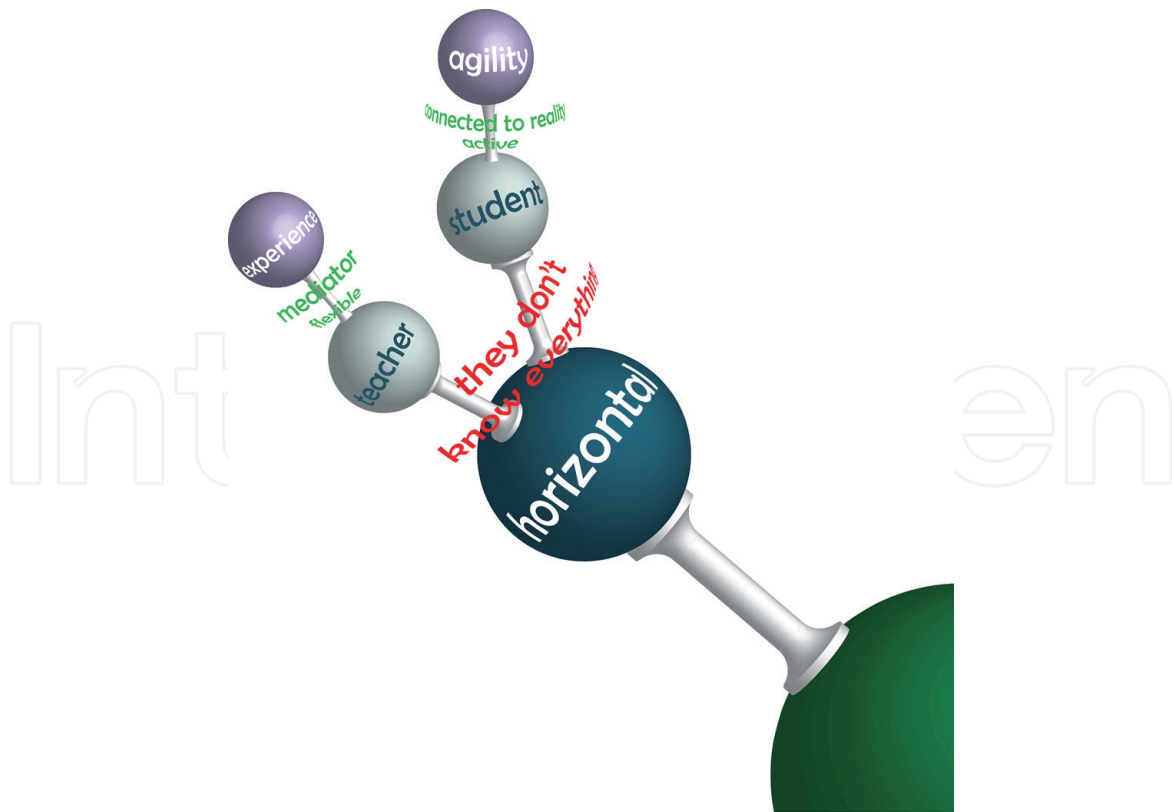


Figure 5.
Horizontal teaching-learning diagram (Silvia Nuere).

6.2 Horizontal teaching-learning

Teaching in the twentieth century brings new ways of facing our job because of the facility access to information through the Internet. Our students, nowadays called digital natives, are well communicated and connected to the world through social media, and they use the Internet as part of their social environment and life. Obviously, teachers can have more knowledge because of their experience but sometimes are far from reality or are out-of-date.

Teacher experience will work as a mediator in the student learning process and must be open to new challenges, be flexible, and be far from the classic master classes. An interaction between both of them will bring new expectations. More than transferring knowledge, teachers must make sure that every student has enough curiosity to deal with new experiences and the knowledge inquisitiveness (**Figure 5**).

Some of the most explanatory examples are the ETSIDI Design Association [19] managed by some students of the Engineering in Industrial Design degree at the Polytechnic University of Madrid. In 2012 through another Educational Innovation Project, a design blog was created. This blog has evolved to a professional design blog where students are the only people in charge. They elaborate all the information published, in the fields of industrial design, creativity, and visual culture (**Figure 6**). They have not set barriers to the industrial design concept and have gone further considering visual culture as a whole immerse in a creative world.

This experience and post production as a design blog can be seen as a learning extension, inside a transmedia narrative, where students manage their own blog, related to school, but with complete freedom to upload the contents. Teachers are no longer in charge of the blog, and as new students are told about it, they become new members and new content generators.

This association also organizes silk-screen printing workshops for the school students and courses related to technical skills as the use of specific drawing



Figure 6.
ETSIDI Design main webpage.

software. They start teaching while being students, and they reinforce the classes received from teachers.

6.3 Collaborative teaching-learning

In a close relation with the previous theme, there is a collaborative proposal in different ways. The horizontal teaching must also include synergetic approaches. We have also mentioned working with other degrees, but it is also interesting to look into your own school to force intersubject working combinations. As we defend cross discipline, we have to find synergies between subjects taught in our school (**Figure 7**). Only in that way, they will understand the importance of the interdisciplinary nature.

In the year 2013, in the basic design subject, we proposed to design a dinosaur 13 meters long by 7 meters high. It was an exercise dealing with making a figure made only with cardboard triangles with no structure inside. Students worked in groups, and for the final assembly, we rely on the mechanical resistance teachers to secure the figure. Some days after, this dinosaur made part of a fashion show (**Figures 8 and 9**). Two years later, we built, in the same way, a giant octopus that occupied the whole entrance of the school. An engineer teacher made a 3D movie scanner to visualize the animal, showing the power of this technology and a way to spread the work done by the students (**Figures 10 and 11**).

This year, chemistry teachers have taught a ceramic color master class to our design students, in order to understand the close relation between both subjects, chemistry and industrial design. They can approach color theory from different points of view, the artistic one and the chemical one, in order to connect both concepts (**Figure 12**).

6.4 Teaching: professional career connection

In the engineering in Industrial Design degree from the Polytechnic University of Madrid, there is a competency that is common to all the degrees. It is also implemented in the Superior Technical School of Engineering and Industrial Design.

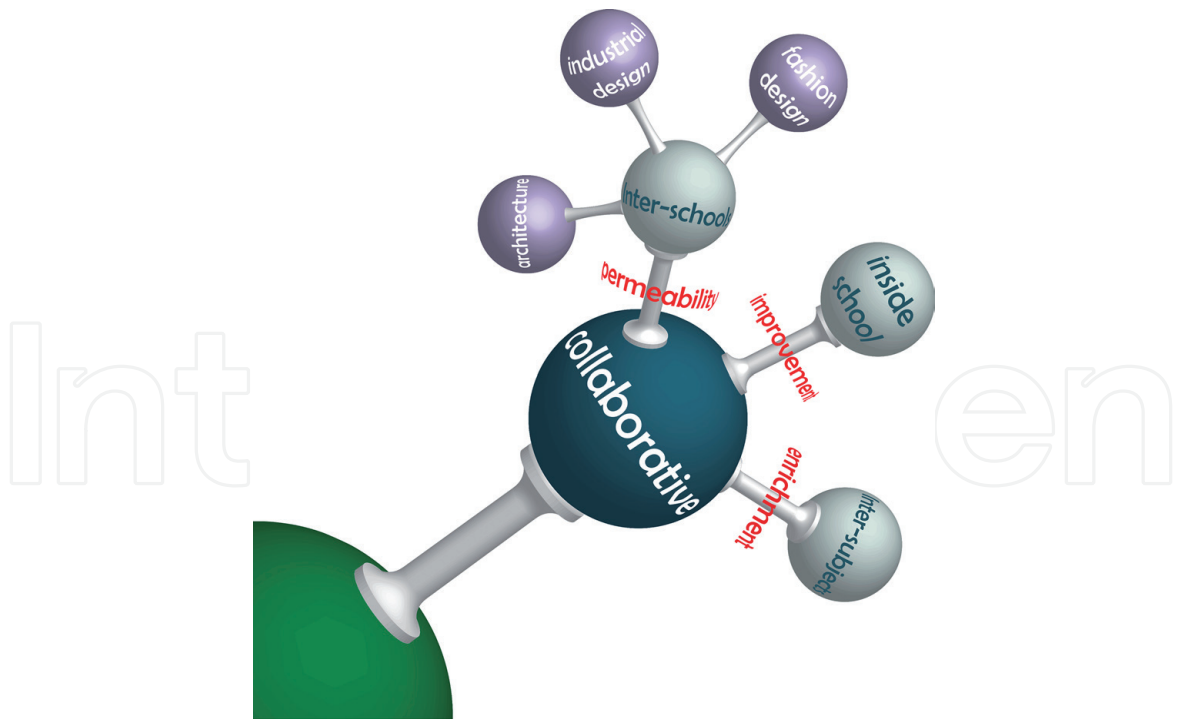


Figure 7.
Collaborative diagram (Silvia Nuere).



Figure 8.
Dinosaur assembly 2014.



Figure 9.
Fashion show 2014.



Figure 10.
Octopus cardboard sculpture 2015.



Figure 11.
3D Octopus scanner 2015.



Figure 12.
Chemistry teachers color class.

This is the Specific Competency number 27 referring to the capacity of introducing in their Final Degree Work a professional-based project integrating all their acquired knowledge (**Figure 13**).

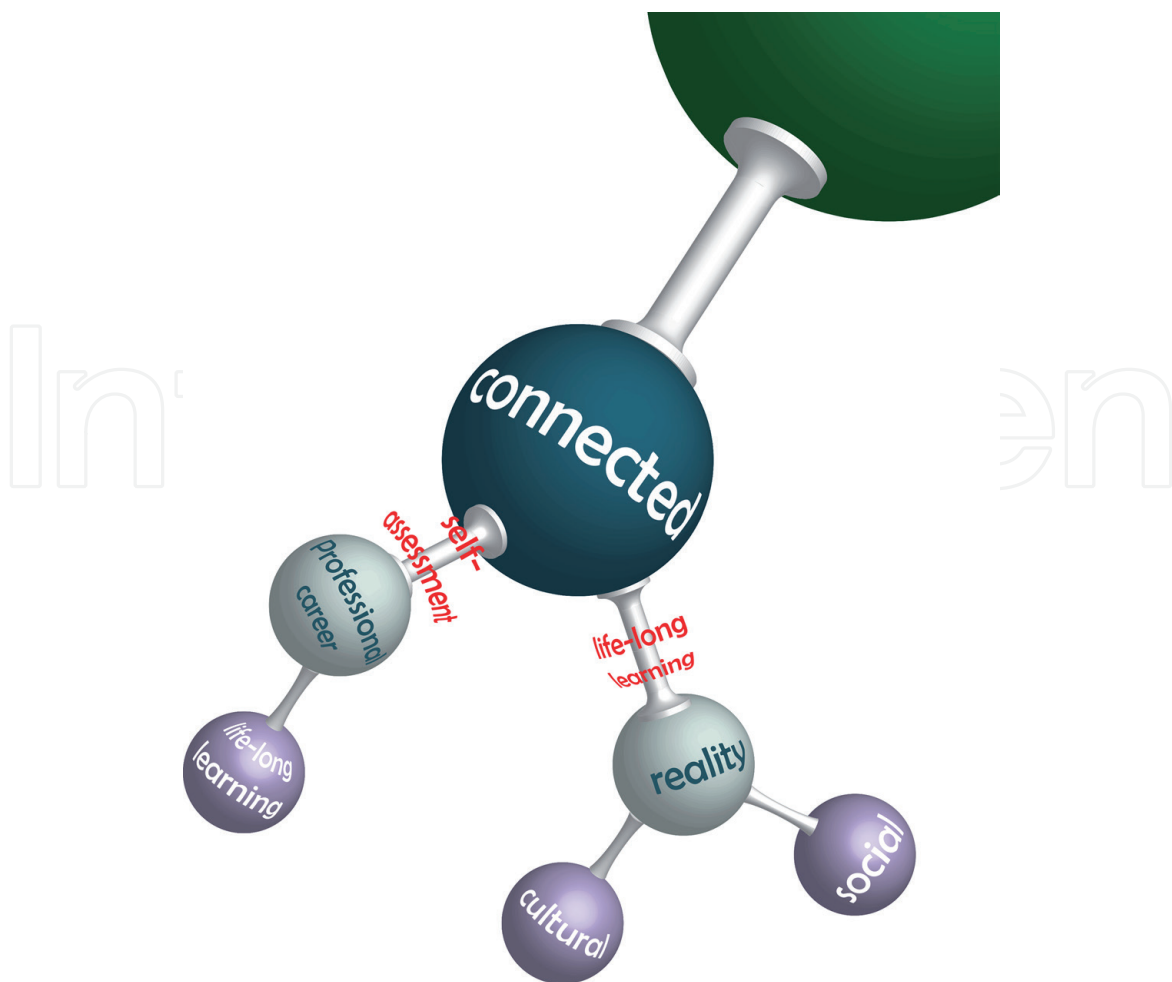


Figure 13.
Reality and professional career diagram (Silvia Nuere).

Students will need to be effective while using media technologies as consumers or generators of content and information [18]. It is not only a question of interacting and using different media while learning but also a new mentality in order to be able to go beyond classrooms, old teaching-learning methodologies, and traditional text materials. Students, while facing their Final Degree Work, will surf the web looking for information. They will need a better knowledge of the media to be accurate in the information they will find.

Finally, thinking about the end of their degree, it is essential to connect studies with the labor market. They learn from different subjects but hardly ever they are in contact with real enterprises to better know what they will ask afterward. It is then necessary to introduce some connections with professional matters so they will be able to face real projects. The question there is to make approaches to real situations asked by companies, sometimes related to some specific contest. As the company wants to launch a new product, they contact the school to propose a real project as one of the exercise they will face in class. This way, companies get new and fresh ideas, and students work on real projects. The authors have already worked with companies related to lamps, bathroom fittings, video games, and others.

In a close relation with the school management team, some students were involved to face new projects. One of the examples was the different intervention in the school spaces to modernize them in an esthetic way. Collaborating in this project, on the one hand, students have considered it more comfortable and friendly, and on the other hand, they have felt like part of the school interests. They

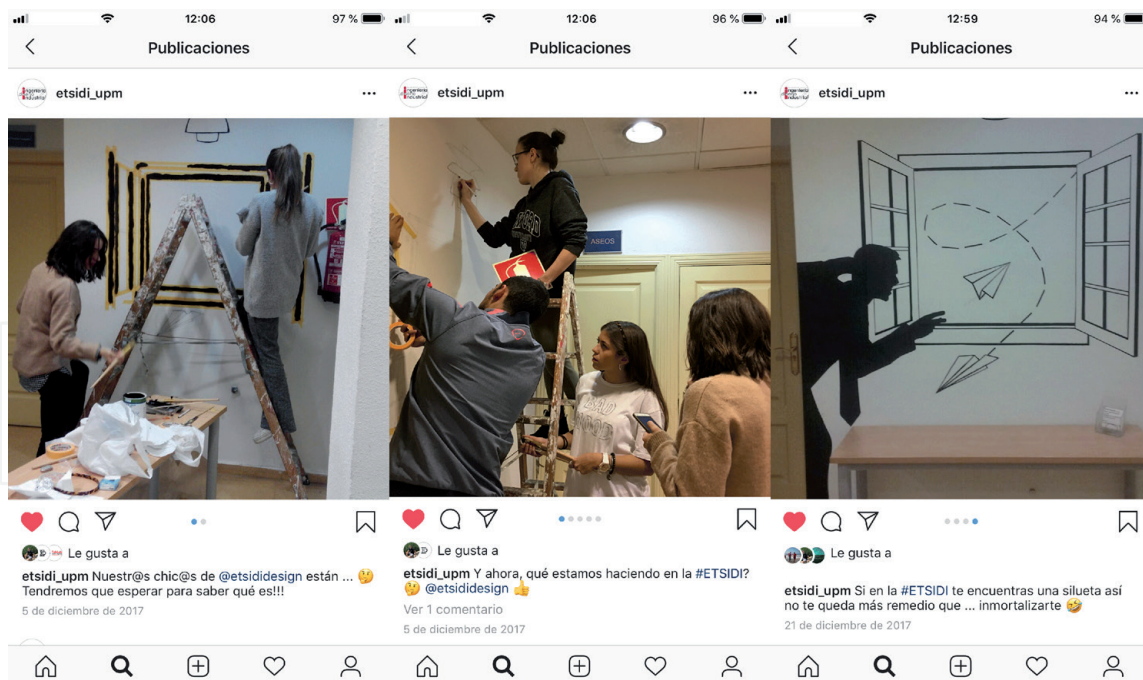


Figure 14.
Murals designed and materialized by students (Francisco Santos).



Figure 15.
Mural work in progress (Silvia Nuere).

have proposed the design to be done in order to improve the different spaces in the school to be updated. They have worked hand in hand with the management team and have materialized their proposals (**Figures 14–16**).

Things done inside the school must be spread outside to show to their mates, on the one hand, what students do during the academic course and, on the other, to show other people what is going on and how things change inside the school. New social networks are essential to communicate and to make visible what is occurring inside the school (**Figure 17**).

Something really important too, while working for others, is the ability of self-assess about what they are doing. When they jump into the labor market, they will need confidence and some training for knowing the rightness of their work. According to this matter, the authors introduce, from the first-degree course, self-assessment through rubrics (**Figures 18 and 19**) in every subject they teach.

The innovation learning projects also become a good platform to connect student learning to the professional field, as, in the end, a person from labor market



Figure 16.
Mural designed by students (Silvia Nuere).



Figure 17.
Instagram official site of the School (@etsidi_upm).



Figure 18.
Student self-assessing (Fashion Design School. Laura de Miguel).



Figure 19.
Students self-assessing (Fashion Design School. Laura de Miguel).

will assess their work. Once, as said, was the Director of the Mercedes-Benz Madrid Fashion Week who assessed students and, in the last one, a city council representative did the work.

7. Conclusions

According to the main four points, **interdisciplinary nature**, **horizontal** and **collaborative** teaching-learning process, and the fundamental **connection** to the labor market, it can be said that the ArDIn method has been working in a healthy environment through the past years. The ambiance generated in contact with the transmedia narratives, in a fun environment and taking into account the importance of the well-done work by students as an evidence and reference, makes up the perfect scenario for a different way of teaching.

Related to the first point, **interdisciplinary nature** means that cross discipline must ease the teaching-learning enrichment by integrating other knowledge that can benefit one another. Art and visual thinking will also be part of the teaching background. The intention is to cover with this proposal the competencies shown above through the different exercises students will have to deal with.

According to the recommendations given in both white papers, industrial design and fine arts, there are important similarities in the competencies students must arise once they leave their studies. Art and engineering and design benefit from similar concepts and can work side by side.

Student freshness and teachers wisdom, due to many years of experience, must merge in a **collaborative** and equal step to go further in their teaching-learning experience. The interdisciplinary nature must be taught not only during our classes and our subjects, but we need to interact with other teachers and subjects as the master class taught by chemistry teachers or the interaction with other fields of knowledge as architecture, fashion design, or others.

Both teachers and students must be receptive, be open-minded, and prepare to learn from mistakes while introducing new ways of teaching. This will lead them to the opportunity of lifelong learning. Student and teacher will learn from one another in a **horizontal** level, making profitable all the experiences done in school. Teachers and students make part of a research tandem, sometimes tacit, others in a clear way, but they can both benefit from the process placing them in the same level. There have been some cases where students have become teacher, hand in hand with the teacher or by themselves.

The confluence of subjects and disciplines in which ethical, egalitarian, and humanistic values are always present is one of the most valuable parameters. One of the results of this attitude was creating a scientific journal named *ArDIn* (*ArDIn* stands for art, design, and engineering in Spanish words) that intends to attract researchers interested in the same field of knowledge and following the importance of Art in any teaching-learning experience. The authors constitute the working group *ArDIn*, named after the scientific journal, the fruition of teaching experience in fine arts, design in industrial engineering, graphic design, architecture, and fashion design. They support educational innovation in a continuous dialog with the professional world, in which creativity and art are a fundamental part.

As said, the proposed *ArDIn* method is like a molecule but with the particularity that it can change its arrangement, admit new relations, create new connections, and evolve throughout time. Obviously, teaching, as life, must be open to new challenges and new methods and must be able to face additional “molecules” in this *ArDIn* method (**Figure 20**).

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