DESIGN IN EDUCATION

Systemic analysis of AI-based Educational Technologies (EdTech), to design supportive tools for teachers.

Daniela Nossa Díaz

Polytechnic of Turin - Master's Degree Thesis in Systemic Design
2018-2019

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DEPARTMENT OF ARCHITECTURE AND DESIGN

Master of Science Degree

Thesis in Systemic Design

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ABSTRACT

Educational Technologies (EdTech) have changed teaching-learning methodologies, challenging the actors involved in education systems (government, private entities, parents, institution leaders) but especially students and teacher's skills. During the last decades, the biggest impact has been the implementation of artificial intelligence (AI) in most of the industries innovation, but in education is still a concept with mixed opinions. Then, EdTech designers have the liability to understand the technology, the system purposes, and especially the user involve on the project.

The research approach was inspired by the experience obtained on CHECK project, an AI technology experimental work sponsored by the Alta Scuola Politecnica and IBM. The direction of the project was mainly an exploration from the computer science aspect, leading to the recognition of some key elements missing on the research by a designer's perspective.

Therefore, the guideline of the research on this thesis was a systemic analysis of the components inside education systems, the characteristics around pedagogic methodologies, and the implementation of new technological methods, in order to structure a research based on theoretical information and user analysis. As a result, the aim of the project is to identify the connections between all the elements of the research to hierarchically establish the components and the requirements that designers of Educational Technologies (EdTech) for teachers, specially AI-Based instruments, need to considerate. Thus, teachers will be provided with supportive tools capable of facilitating their work and parallel willing to prepare educators to confront the challenges of AI technology, by motivating them to reinforce those skills that characterize human intelligence over any technology developed.

Consequently, it is important to recognize the social and ethical responsibility of designers on the introduction of new technologies to the market, since the idea is to find solutions that answer investors desires but without forgetting to generate a positive impact on the present a future society.

CHAPTER 1

RESEARCH AND ANALYSIS

Background Information

User Research: Teachers.

PROJECT APPROACH

Project Scenario

Project Boundaries

DESIGN CONCEPT

CONCLUSIONS AND RECOMMENDATIONS

BIBLIOGRAPHY

INTRODUCTION

The exponential growth of digital information and communication technologies during the last decades has challenge experts on computer science to explore, develop and include the power of Artificial Intelligence (AI) technology. A large group of industries (from medical solutions to production-monitoring) are using AI systems for internal data management and analytics, decision-making processes, and the development of products and services AI-based.

Therefore, the education industry is not the exception, at the same level of some other industries, technologies of communication have been introducing a "paradigm shift" on teaching and learning processes. As a result, teachers are being challenged and request to implement new tools and platforms (EdTech) that facilitate their work and enhance their class methods while enriching the contents of their lectures, in order to preserve students' attention and impulse them to amplify their knowledge and skills.

In this context, in order to achieve coherent-justified solutions for the improvement of education's quality, the thesis research was made from a macro perspective to some specific aspects inside the topic. This process exposed some of the problems of education systems, their main causes, and the impact they represent to the actors around it. One of the most relevant drawbacks identified is the low motivation of teachers to improve their role as tutors and innovate on the methodologies of teaching implemented. However, motivation can be reached from different strategies such as monetary incentives, recognition of a well-done work or by providing the right instruments that facilitate their work without reducing the important value of their presence on the learning environments.

Therefore, EdTech developers have been producing solutions for teachers with functions to manage the information, evaluate and optimize the communication channels with their students. Nevertheless, with the introduction of AI to the education industry, it has been more evidenced that the main role of a teacher is not the transmission of information or a basic construction of knowledge for their students, but is their capability of inspiring and impulse students to become critical thinkers of the real world based on life experiences (interaction with the context) and the connections with the knowledge acquired.

Consequently, the result of this thesis is to propose a series of elements to be considered for the design process of supportive tools for teachers but especially which are the actual key features that should be included to improve their performance and reinforce their role on education.

In this respect, the document is structured on four chapters and each one is segmented according to the information that contains. The first chapter is focused, in the first place, on the multidisciplinary theoretical research, where is argued and structured the concepts around education (from a pedagogical perspective), the elements and connections inside an education system, the current impact of technologies on education (from the educators side), and the role of designers on this field; and secondly, the user research material that enclose the role and responsibilities of educators on the system from a conceptual perspective but also from the personal experience of the user itself.

Chapter II, explain the analysis done by the connections of the background information in order to expose the components of the system, the interaction between the parts and the problematics found. This way was possible to construct a scenario of the current situation, analysis of the activities inside the teaching-learning spaces, its limits, and opportunities for improvement. Finally, on the Chapters III and IV is proposed a design concept and some recommendations for future professionals with interest on the topic.

Photo by NeONBRAND on Unsplash

METHODOLOGY

Design methodologies are tools that allow an organized and well-structured work to every project. In fact, there is a variety of authors and studies on the topic, looking forward to achieving the right path for designers that need to be followed. However, these methodologies are guidelines to enhance in professionals the construction of their own instruments that provide coherence and order to the process of design, reducing the risk of missing information or relevant steps before getting to a final solution. Consequently, for the thesis project, it was taken as a reference to the methodology proposed by the Innovation Design Lab of Politecnico di Torino, lead by professor Paolo Tamborrini.

According to the basic steps and general structure of the methodology, it was adapted in coherence with the project requirements and structured on four phases: research and analysis, project approach, design concept and future development (figure 1).

The mentioned phases have the aim to achieve those main components analyzed and developed during the thesis which, likewise, are supported by different strategies of analysis such as brainstorming, surveys, concept mapping and complex systems visualization. This methodology is proposed to finish on a design concept which means is not included prototype trials and a final design solution, but they were considerate for professionals with the interest of continuing the project approach.

Firstly, the research and analysis process is the base that argues the project approach and all the decisions taken along the thesis development. This phase was divided into two kinds of information, background information that examines the theoretical information that supports the investigation and the user research which incorporate the characteristics and requirements of the teachers, based on observation processes and collected data through a survey.

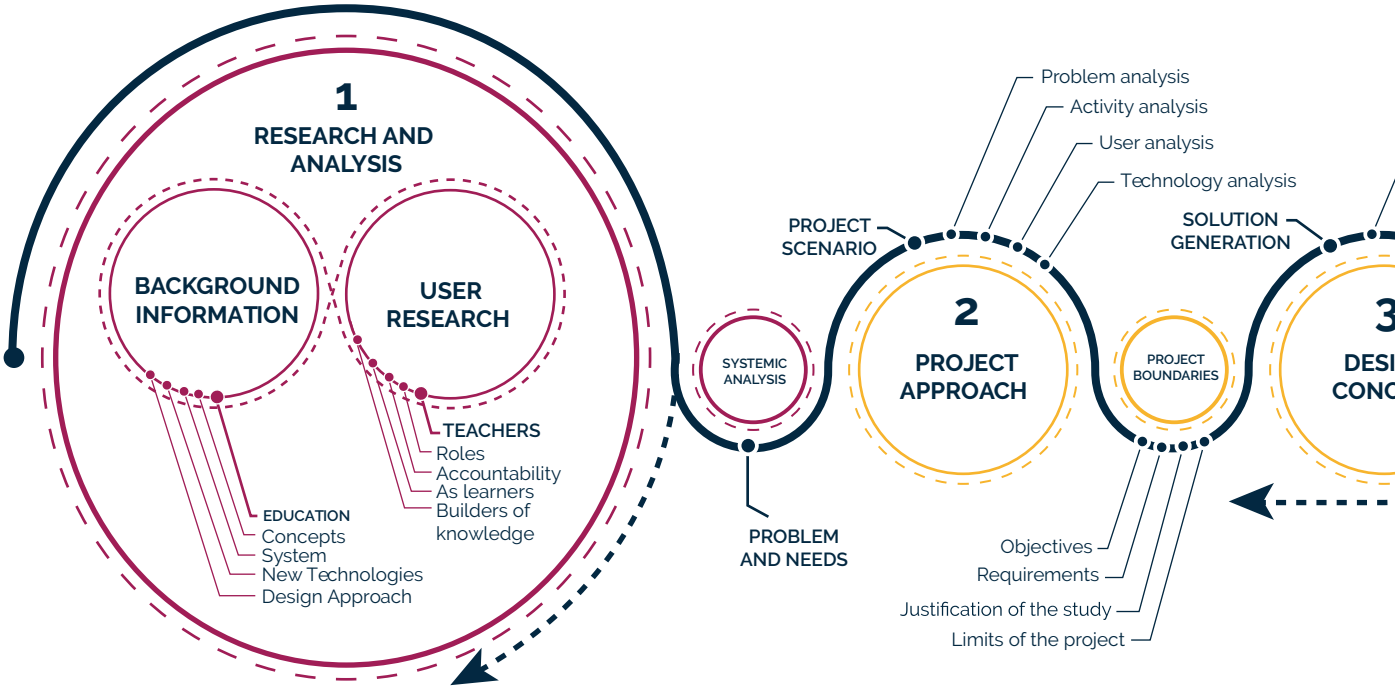
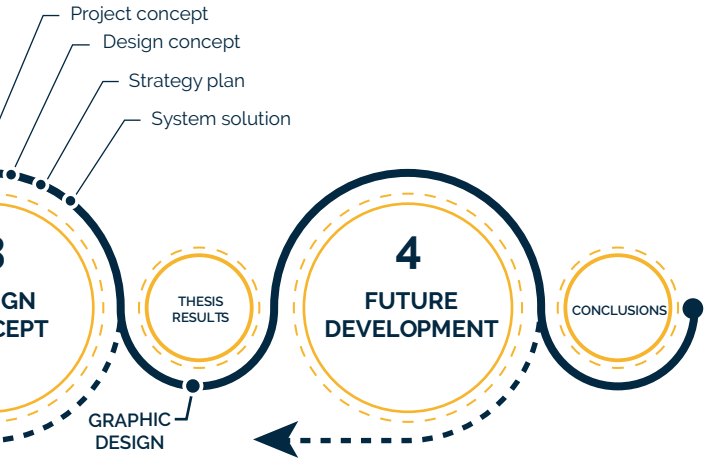


Figure 1. Thesis project methodology

Source: adapted from methodology proposed by the Innovation Design Lab of Politecnico di Torino, lead by professor Paolo Tamborrini 2018.



As a matter of fact, the state of art combines multidisciplinary research from different points of view such as education, pedagogy, psychology, economy, design, communication and computing systems engineering. Inevitably, the process implemented in this part had several feedback processes between the different stages, to consequently remain with the accurate information necessary for the project (figure 2). Therefore, the result of this phase was a systemic design visualization that represents the pieces of the scenario in which the project is immersed, and subsequently lead to the definition of the problematics of the system and opportunities where the project is involved.

The second phase starts with the construction of an overall system that reflects the connections between the parts and underlines the problems founded on the different stages, followed by that it was done a specific analysis of the components inside the system. The first component analyzed was the center of the project, teachers, through the interpretation of the information collected on the user research, allowing an updated description of the user characteristics, needs, opinion, and requirements related to the topic. Continuing this path, it was also done an activity analysis that

combines the information collected on the state of art with the results of the user research in order to structure the process of teaching and the features required to its success.

Then, there was a technology analysis, focus on understanding the types of technology around the project to recognize the advantages and disadvantages that they provoke on the system. As a consequence, this segmented but at the same time integrated analysis, lead to a decision making process in which was currently established the goals, requirements, and boundaries of the project.

The next step is the construction of the design concept where is synthesize all the information of the research with the proposal of a strategic plan that might guide future developers of EdTech for educators. This phase presents the desired system, evidencing the main components of it, their interactions and the outcomes are willing to achieve. In the end, there is a fourth step with a description of the open chances of intervention based on the conclusions of this thesis project.

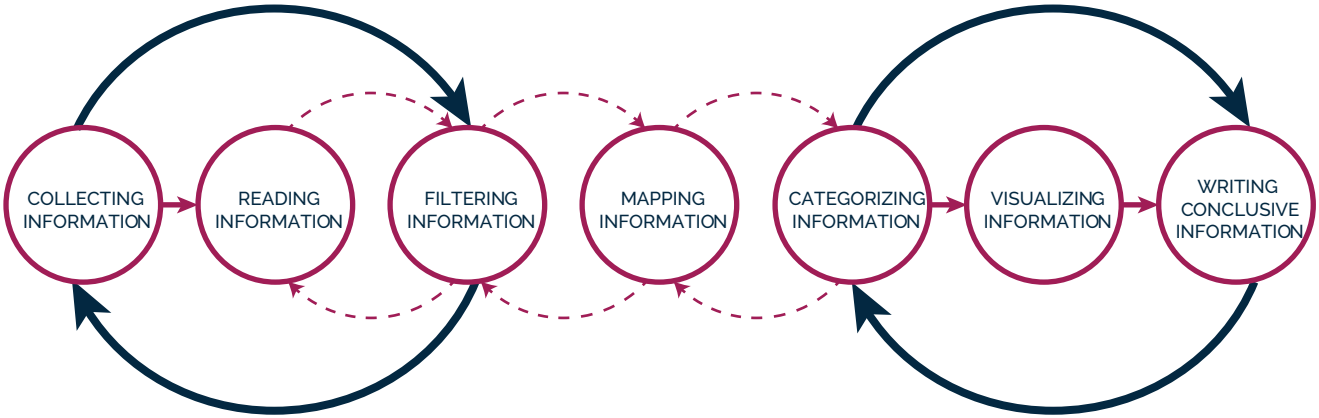


Figure 2. Phase 1 thesis project methodology: research and analysis process implemented
Source: adapted from methodology proposed by the Innovation Design Lab of Politecnico di Torino, lead by professor Paolo Tamborrini 2018.

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CHAPTER 1
RESEARCH AND ANALYSIS

Photo by Susan Yin on Unsplash

BACKGROUND INFORMATION

EDUCATION CONCEPTS

Human Intelligence

Knowledge vs Skills

First of all, is necessary to clarify that the concepts knowledge and skill are different, however, it does not mean they are unlinked one from the other, in fact, is their connection that brought positive economic and social outcomes to societies. The meaning of knowledge is constantly compared with the term information, even though, its aim goes further than that. Knowledge is the rational understanding of the information, which means is obtained after the analysis of the resources collected during the learning process. As a result, knowledge becomes the element that allows every individual to develop their own personal skills.

On the other hand, the term skill refers to the ability that a person has to solve a task properly in order to achieve a goal. These skills evolve during the time and in different ways, according to the path that every person builds, needs or desire which consequently will be catalog as life skills. In this context, life skills are *"a group of psychosocial competencies and interpersonal skills (input) that help people make informed decisions, solve problems, think critically and creatively, communicate effectively, build healthy relationships, empathize with others and cope with and manage their lives in a healthy and productive manner (output)"*[1] (World Health Organization, 2003).

Furthermore, the 2012 Global Monitoring Report indicate the term "livelihood skills" to make reference to those skills needed for employment profiles, which included three categories of skills: foundation, transferable and vocational skills. The first one, foundation skills, include features as numeracy and literacy, basic requirements for working and needed to increase knowledge and continued training on the field. Transferable skills are those that permit to retain employment as they adapt to different work requirements, it contains abilities such as problem-solving, innovation, communication capability, collaboration with team members (socio-emotional skills), and leadership. The third category, vocational or technical skills are focused on higher levels of education in which the knowledge and skills

1 *World Health Organization. 2003. Skills for health: skills-based health education including life skills. Information series on school health. Document 9. Available at https://www.who.int/school_youth_health/media/en/sch_skills4health_03.pdf , (2/12/2018).*

acquired goes to a specific discipline. In a broader perspective, according to the professor of Work and Education Economics (University College of London), Francis Green (2011), skills are individual qualities with three key features[2] :

i. Productive: using a skill is productive of value;
ii. Expandable: skills are enhanced by training and development.
iii. Social: skills are socially determined.

Until this point, the concepts have been centered on the meaning of skills as a requirement for humans wellbeing and employment profiles. However, in order to understand the way the human brain works on learning processes, it is pertinent to understand the connections between all these skills mentioned. Therefore, the World Bank (2018) suggests an interaction scheme between three main categories of skills, which through their interaction will provide the desired results of education processes that according to the other authors cited before, provide other types of skills (figure 3). Then, on a more punctual description:

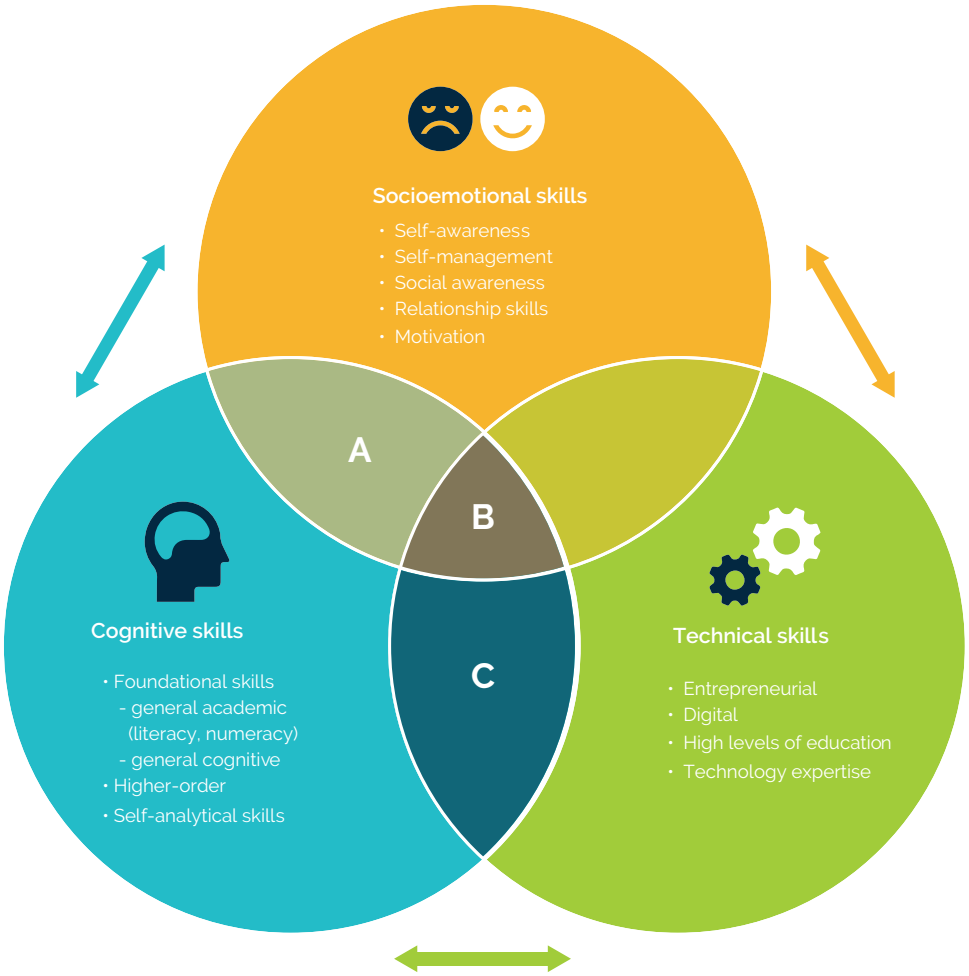
i. Socio-emotional skills: are those actions that an individual does adequately on interpersonal terms and social situations. It includes specific features like communication skills, social interaction skills or group working skills.

ii. Cognitive skills: are related to the quality of adaptability on an environment full of changes, reasoning about complex problems and learning from experience in order to be able to overcome the difficulties. It requires other elements such as foundational skills, regulation skills, and self-analytical skills.

iii. Technical skills: refers to the ability of good execution of an action proposed to a specific task, as a result of the knowledge and experience previously acquired.

Consequently, the process of mixing this different type of skills provide more complex abilities such as transferable skills (area A) and vocational skills (area B).

2 Green, Francis. 2011. What is Skill? An Inter-Disciplinary Synthesis. LLAKES Research paper 20. Institute of Education University of London. Available at https://www.researchgate.net/publication/264874441_What_is_Skill_An_Inter-Disciplinary_Synthesis ,(2/12/2018).



Livelihood skills

A: Decision making, communication, grit, regulation skills (self-control),
B: Problem-solving, organizational skills, judgament-based skills
C: Mid-level technical, high-level technical

Figure 3 . Cognitive, socioemotional and technical skills interact

Source: World Bank. 2018. Adapted from World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. http://www.worldbank.org/en/publication/wdr2018

Inevitably, is evident the existence of a large variety of skills categories, however, its measure on the society relies on social, political and economic aspects which means people are constantly required to improve. In other words, *"promoting a breadth of skills means educating for mastery of a wide range of competencies that will help mitigate the challenges posed by our changing world context."*[3] (Winthrop and McGivney, 2016).

Conclusively, the connection between the two concepts (knowledge and skills) is what will be consequently understood as human intelligence. In this perspective, *"we need knowledge in order to become skilled, and we need skills in order to acquire knowledge"*[4] (Luckin, R. 2018), as their continuous and parallel improvement provide individuals a better response to life situations. In fact, our 21st-century society is constantly measuring and requiring professionals to amplify their range of knowledge, become multi- and interdisciplinary skilled and be prepared to respond especially the exponential growth that technologies have been experiencing during the last decades.

Interwoven intelligence

So far, it has been presented a general overview of the human intelligence concept. However, there is a higher level of complexity on the way human brain works and the elements that represent its good performance. For this reason, and in context with the thesis topic, it is pertinent to take a reference on professor Rosemary Luckin, who had structured human brain functionality on what she expressed as an Interwoven Intelligence.

It consists of a model that divides human intelligence into three main sections: Academic Intelligence, Social Intelligence, and Meta-Intelligence. However, it is composed of seven elements, in which five of them make part of the Meta-Intelligence section (figure 4). The features inside every section are based on the ability of every individual according to the different type of skills, some of them already defined on the previous section (figure 3).

3 *India Development Gateway (InDG) 2018. Teaching and learning. Available at http://vikaspedia.in/education/teachers-corner/teaching-and-learning , (28/11/2018).*

4 *Luckin Rosemary. 2018. Machine learning and human intelligence: the future of education for the 21st century. UCL Institute of Education Press, University College London. 160 pages.*

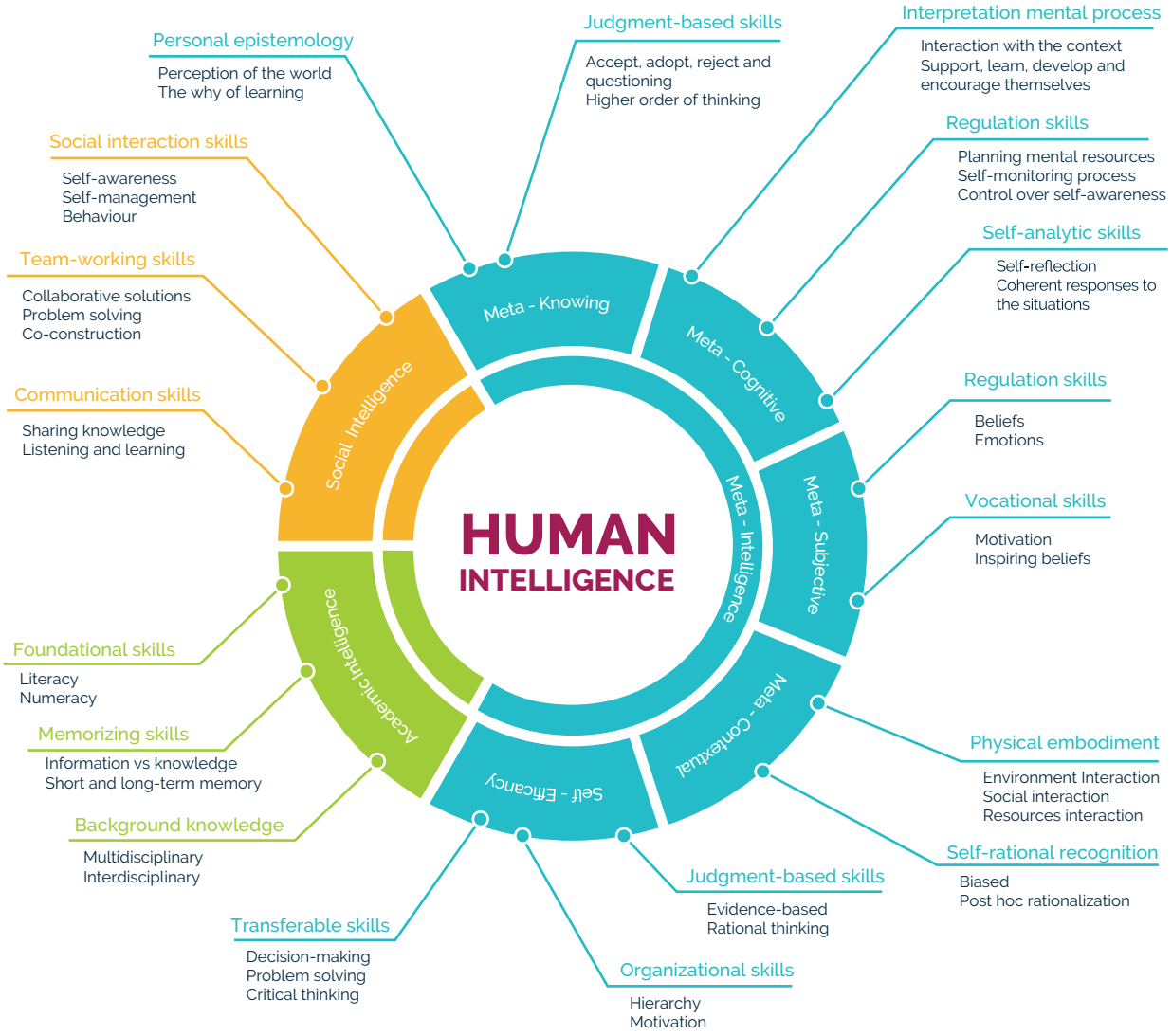


Figure 4. Interwoven Intelligence structure

Source: created based on Luckin Rosemary. 2018. Machine learning and human intelligence: the future of education for the 21st century. UCL Institute of Education Press, University College London.

Each section represents a different way of reasoning, this means those become pieces of the puzzle that construct the complexity of the human brain. Nevertheless, *"the developmental nature of interwoven intelligence reflects that we all develop the form and sophistication of these seven intelligence elements at different rates and times and to different extents"*[5] which means every person is able to increment their knowledge and optimize their work (on each element) justified on their personal interactions with the world. Thus, this cannot be catalog as a linear process, indeed, its variability is uncertain and depends on every individual purpose and abilities.

Furthermore, the power of Interwoven Intelligence is not on its single components but on the connection between them (figure 5). The key statement to its success is to recognize its approach as an integrated unit, in other words, find the advantages of combining them and implementing their features on adequate circumstances. For instance, meta-cognitive intelligence refers to the process of *"learning and developing the ability to interpret our own ongoing mental activity, and these interpretations need to be grounded in good evidence about our contextualized interactions in the world"*[6], thereby it has to be directly connected to the meta-contextual intelligence as its aim is to recognize the interactions with the environment, resources, and other people surrounded. In fact, on figure 5 is evidenced that the element of "Perceived Self-Efficacy" is the result of the connections between all seven components of the model, as it is the component that provides decision-making processes and problem-solving (transferable skills).

Generally speaking, for the development of this project is necessary to recognize the components of human intelligence and what is the role of each of them, leading to identify those elements that teachers need to train and reinforce as they are the strength of human intelligence above new technologies in development (es. Artificial Intelligence).

5 *Ibid*
6 *Ibid*

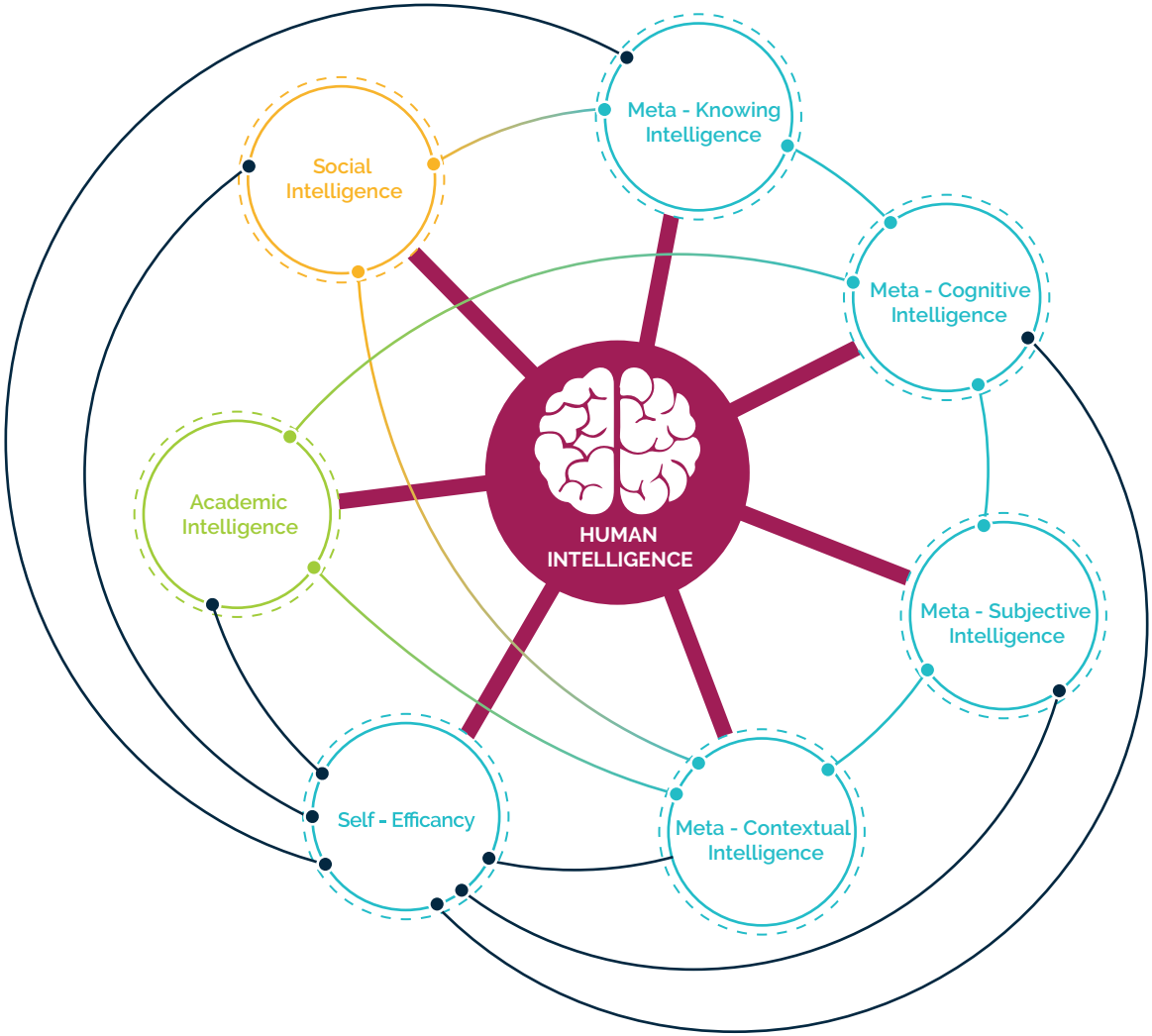


Figure 5. Interwoven Human Intelligence components interaction and connections

Source: created based on Luckin Rosemary. 2018. Machine learning and human intelligence: the future of education for the 21st century. UCL Institute of Education Press, University College London.

Teaching and Learning Concepts

Learning is an intentional process where students have the possibility of creating a background knowledge and improving skills according to their purposes and goals. Then, learning can vary in relation to the elements around the learner, such as the environment, the people directly and indirectly involved in the learning process, and political, economic or cultural scenarios. On the other hand, teaching refers to *"a set of events, outside the learners which are designed to support the internal process of learning"* [7] (Sequeira, A.H. 2012) which means is related to all those resources (academic and motivational) provided to obtain the desired outcomes of the learning process.

Therefore, the concept "teaching and learning" is defined as integrated processes where an educator evaluates learners needs, organize learning objectives, establishes and/or build learning strategies to achieve those goals and finally evaluate learners performance. However, it is a combined process since it is according to students interact with the teachers that the process receives feedback that allows a continuous growth and development on the contents educators are willing to transmit. Consequently, this processes should drive teachers and learners to explore, analyze and interpret all the elements around them. As a result, they would be able to become reflective, critical and creative individuals, by using the knowledge and skills they have gained providing society with more effective decision-makers.

Constructivist Theory

Constructivism is a learning theory that refers to a methodology where students build their own body of knowledge and skills based on prior learning and new information acquired. In this theory presented by J. Bruner (1966), teachers have the role of mentoring students to find and construct their paths of learning, providing data, sources, and methods to synthesize them. In other terms, in a constructivist approach *"the instructor should try and encourage students to discover principles by themselves"*[8] . These are the four key features mentioned by Bruner:

i. Predisposition towards learning;

7 Sequeira, A.H. 2012. Introduction to concepts of teaching and learning. National Institute of Technology Karnataka, Surathkal, India. Available at https://www.researchgate.net/publication/272620585_INTRODUCTION_TO_CONCEPTS_OF_TEACHING_AND_LEARNING, (consulted 10/12/2018).

8 India Development Gateway (InDG) 2018. Teaching and learning. Website resource. Available at http://vikaspedia.in/education/teachers-corner/teaching-and-learning , (consulted 12/12/2018).

ii. The ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner;

iii. The most effective sequences in which to present material; and

iv. The nature and pacing of rewards and punishments.

Consequently, this theory should be applied for teachers and students, as it has been stated that teaching and learning processes need continuous training, the construction of knowledge is a strategy that can be seen as a complementary and collaborative process between the actors. Likewise, for educators to be able to encourage students, is necessary to have and preserve motivation during the whole process because it is one of the key elements to transmit the force of constructivism theory aims.

Basic Teaching Model

The model is divided into four main elements that go through a linear path and is modified by the feedback collected at the end of every cycle of the process. The basic teaching model, created by Ian Reece and Stephen Walker starts from understanding what the learner required to set a group of objectives the model is going to follow, then goes to establish the way the teacher is willing to achieve those goals, how and which are going to be the techniques implemented and finally the strategy to evaluate the level of acquirement of knowledge from the students (figure 6). However, the efficiency of this model is affected by a variety of factors that are in continuous changes such as technology development, education systems requirements, diverse generations of students and some others. This process can be synthesized into three phases: planning, implementation, and evaluation (figure 6). These are the basic stages analyzed for the project purposes since is along this process where the technology and instruments for education will take place.

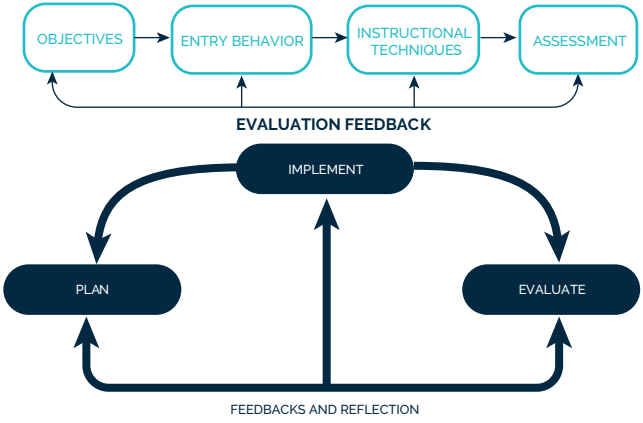


Figure 6. Teaching Model phases and process structure

Source: created based on Ian Reece and Stephen Walker, Teaching, Training and Learning - Business Education Publishers, 1997.

Method vs Methodology

The concept method consists of a procedure or a technique implemented to support the process to reach an objective. For instance, to do research there are several methods to achieve the results desired, in this case, can be quantitative and qualitative such as interviews, photographs, surveys, etc.

On the education perspective, it is related to the strategies used for learning processes that during the last decades are usually connected with the exploration of technology and its application of education tools. For example, learning platforms, digital content of support, virtual libraries, etc.

From the other side, according to the Webster's Third New International Dictionary, the concept methodology refers to a *"body of methods, procedures, working concepts, rules and postulates employed [...] in the solution of a problem or in doing something"*[9]. Then, a methodology is a mix of several methods that contribute to students learning processes to be more cognitive, flexible and reachable.

On education, methodologies are usually divided into two types: traditional (teacher-centered methodology) and modern (student-centered methodology). That eventually, have different guidelines and apply diverse procedures and methods as shown in figure 7 (show characteristics of traditional and modern methodologies).

Consequently, this categorization situates the project as a method included in modern methodologies for learning processes due to the implementation of technology, and strategies centered on the student.

Image retrieved from https://prideschools.edu.pk/academics-trainings.php

9 *Boumová Viera. 2008.Traditional vs modern teaching methods: Advantages and disadvantages on each. Master diploma thesis. Masaryk University faculty of Arts. Available at https://is.muni.cz/th/f62v8/MgrDiplomkaBoumova.pdf , (consulted 12/12/2018) .*

Figure 7 . Teaching Methodologies Features.

Source: created based on Boumová Viera. 2008.Traditional vs modern teaching methods: advantages and disadvantages on each. Master diploma thesis. Masaryk University faculty of Arts. https://is.muni.cz/th/f62v8/MgrDiplomkaBoumova.pdf ; and Essays, UK. 2013. TRADITIONAL VERSUS MODERN METHODS OF EFFECTIVE TEACHING. Retrieved from Available at https://www.ukessays.com/essays/education/traditional-versus- modern-methods-of-effective-teaching-education-essay.php?vref=1, (consulted 12/12/2018)

Teaching and Learning Strategies

6E+S Model of Instruction

This model is based on a 5-E Model of science instruction created by Trowbridge and Bybee (1990)[10], that included the stages of Engage, Explore, Explain, Extend and Evaluate. Nevertheless, during the last years, a group of teachers supported by faculty from schools of education had created a new model of teaching based on the constructivist theory and is now called 6E+S Model of Instruction. In contrast to the first model, it includes two more steps: Elaborate and Standards. From this point of view, every stage has a purpose for the students and a specific role for teachers (figure 8).

In this perspective, is necessary to recognize what are the teacher's roles in a constructivist model, this way it is possible to identify and consequently estimate the requirements of the project and the points in which the solution needs to be focused on.

STUDENT PERSPECTIVE

Students should become mentally engaged in the concept, process, or skill to be learned.

Here the student investigates the topic more thoroughly. What is important is that the students are given the opportunity to 'free wheel' their way through the materials and not be over directed.

This phase helps students explain the concepts they have been exploring. They have opportunities to verbalise their conceptual understanding or to demonstrate new skills or behaviours.

Here the students are expected to work directly on the given assignment. It is their opportunity to demonstrate their application of new information and to present their findings or conclusions to others.

Students normally submit their work or assignments at this point. It is very important at this stage that the students be encouraged to engage in self-evaluation, group evaluation and develop their own tools to do so.

This section contains some suggestions for taking the students beyond the lesson. The purpose is to examine ways in which they can bring their findings to others or apply their understanding to new and unfamiliar circumstances.

10 *Gejda, L. M; LaRocco, D.J. (2006, October). Inquiry-based instruction in secondary science classrooms: A survey of teacher practice. Research paper presented at the 37th annual Northeast Educational Research Association Conference, Kerhonkson, NY. Available at https://files.eric.ed.gov/fulltext/ED501253.pdf , (consulted 13/12/2018).*

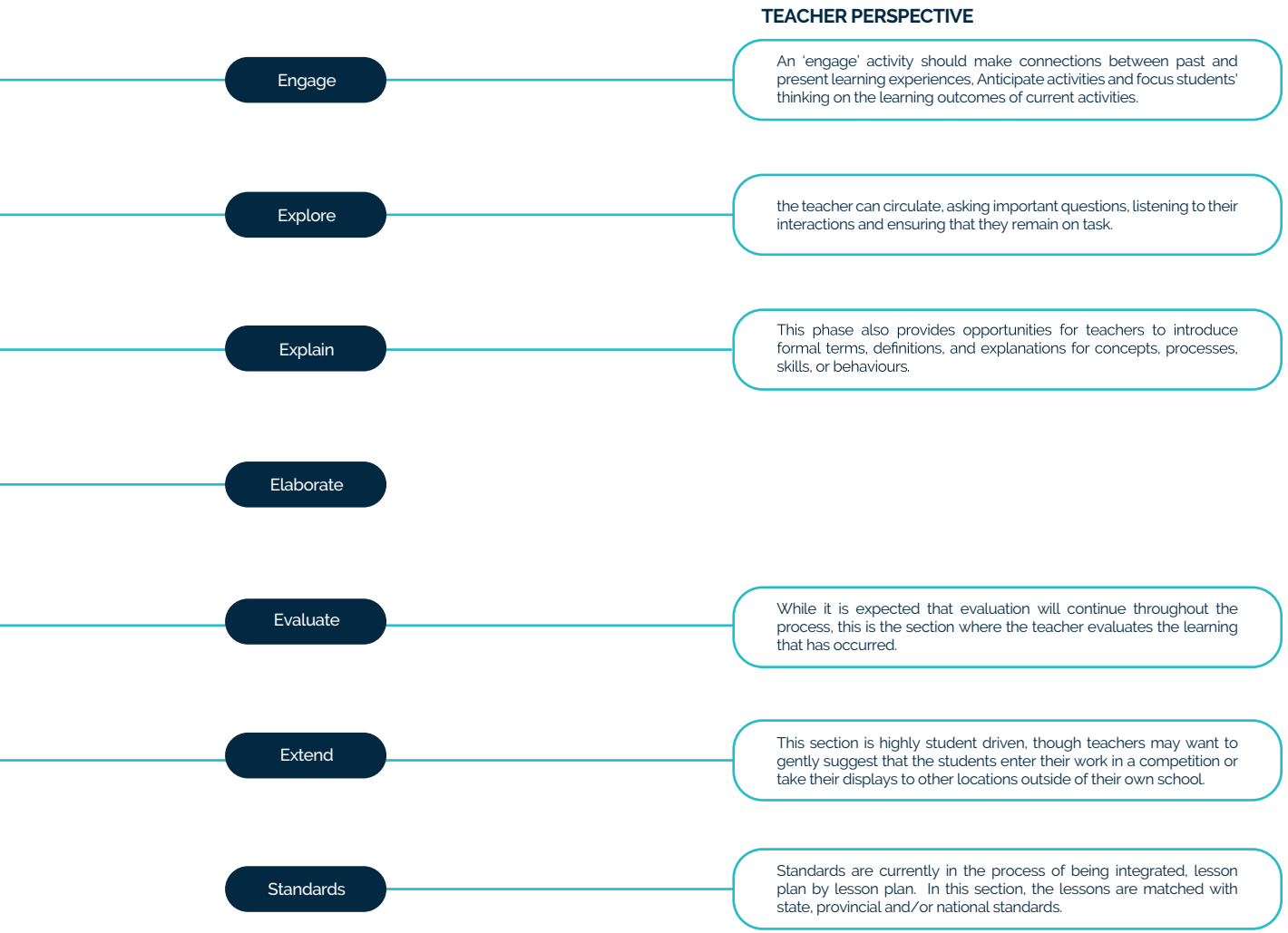


Figure 8. 6E+S Model of Instruction components

Source: created based India Development Gateway (InDG) 2018. Teaching and learnin g. Website resource. Retrieved at http://vikaspedia.in/education/teachers-corner/teaching-and-learning

Universal Design for Learning (UDL)

Universal Design for Learning (UDL) is a guiding tool to improve and enhance teaching and learning processes. It is based on scientific insights that rely on theories and research focused on the way humans learn and the student's needs. This methodology is strongly connected to the use of digital resources and its approach increase students academic performance and assist teachers labor. In fact, this framework can be used by educators, researchers, developers of new technologies or any other person with the interest in intervening in a learning environment.

UDL consist on three key elements that activate a different part of the human brain, these are (Figure 9): recognition networks (the "what" of learning), strategic networks (the "how" of learning) and affective networks (the "why" of learning). In order to achieve them, UDL establishes at the same time three main principles that need to be implemented in learning environments to succeed. The principles of UDL model are: provide multiple means of representation; provide multiple means of action and expression; and provide multiple means of engagement.

In this terms, the project will be focusing on instruments that facilitate and motivate teachers to the improvement the process of construction of lectures and courses contents that are optimal for students learning, which means the component to intervene with the design solution will be the recognition networks.

RECOGNITION NETWORKS

The "What" of learning

STRATEGIC NETWORKS

The "How" of learning

AFFECTIVE NETWORKS

The "Why" of learning

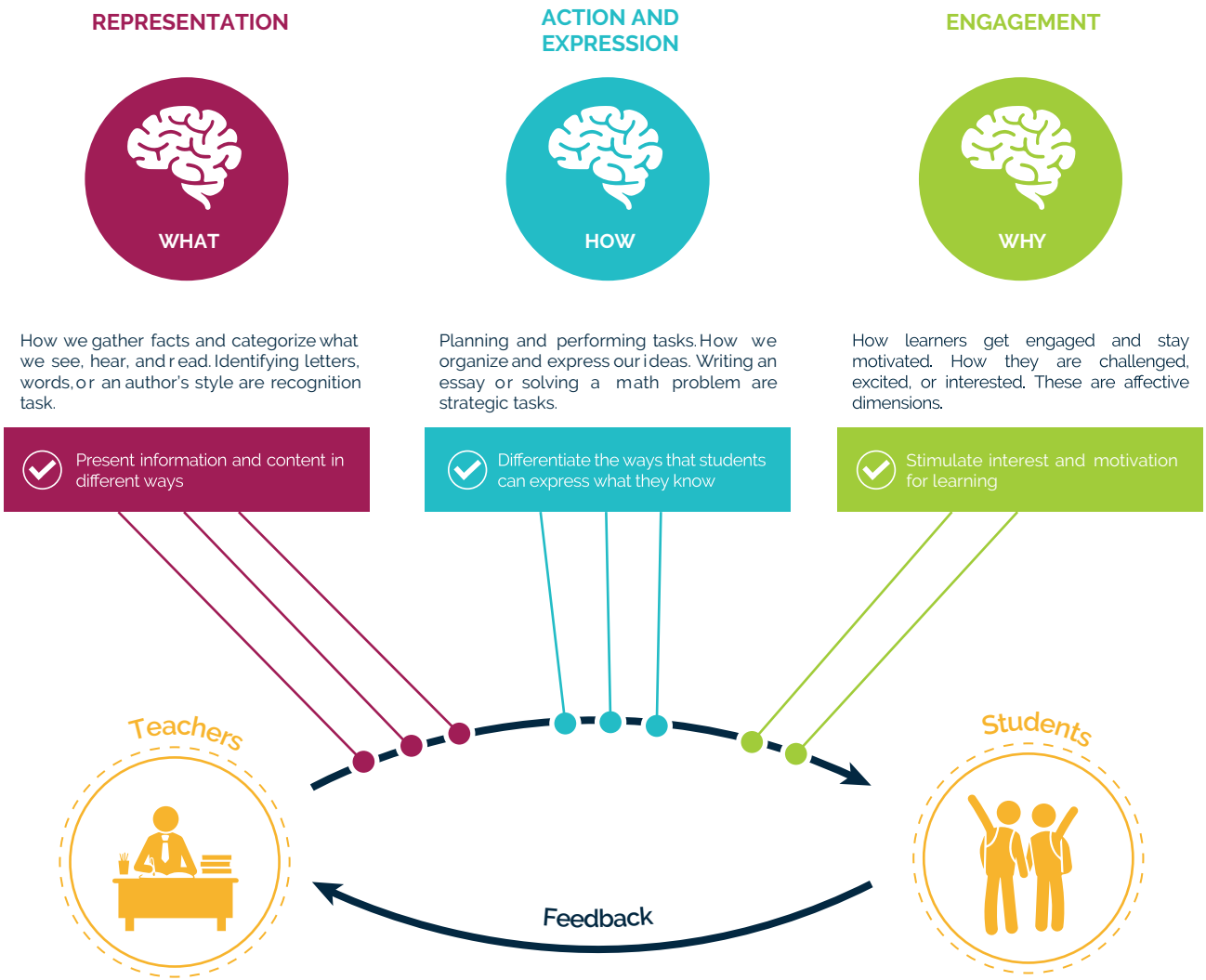


Figure 9. Universal Design for Learning (UDL) interaction on teaching and learning processes

Source: created based on content available at http://www.cast.org/our-work/about-udl.html#.XE0oY6MZPox

Photo by Nathan Dumlao on Unsplash

BACKGROUND INFORMATION

EDUCATION SYSTEM

Concept of education system

Education system concept is highly complex to define, then in order to understand the meaning is necessary to conceptualize both words separately. The term system born as a desire for interpreting the movement of the living world, trying to untie the complexity that is inside each element around us. In fact, *"the systemic thinking was initially proposed by biologists, which brought to light the idea of living organisms as integrated systemic totalities"*[11] (Capra, F. and Luisi, P.L. 2014).

In other words, it is mandatory to analyze the surrounding phenomenon as systems that have complexity in extrinsic and intrinsic terms. Hence, the concept system refers to *"an interconnected set of elements that is coherently organized in a way that achieves something (...) and consists of three kinds of things: elements, interconnections, and a function or purpose"*[12] (Meadows, D. 2008). The elements of a system, for instance, can be categorized in actors and physical and non-physical resources (components) that through their connections (processes and relations) will construct the context scenario of a phenomenon.

Likewise, they can be divided into different levels in order to have an amplified outlook of the whole system. However, as designers and in general as professionals, it is necessary to first understand which are those common goals that the system is willing to achieve, this way will be known exactly where to intervene (a coherent and argued project aim) and how the interconnections inside the system can affect our design or the feasibility of the project.

On the other hand, the term education neither is simple itself. According to professor Mark K Smith, (an expert on the development of learning environments and leader of a research department on education field at YMCA George Williams College in London) education is *"the wise, hopeful and respectful cultivation of learning undertaken in the belief that all should have the chance to share in life"*[13] (Smith, M.K. 2015). This way, education

11 *Capra, F. and Luisi, P.L. 2014. Vita e natura: Una visione sistemica. Aboca Edizioni . Available at http://www.comitatoscientifico.org/temi%20SD/documents/CAPRA%20Vita%20e%20natura%2015.pdf , (consulted 13/12/2018)*

12 *Meadows, Donella H. (2008). Thinking in Systems: A Primer. White River Junction: Chelsea Green Publishing. Available at https://sustainability-dictionary.com/2005/12/04/systems-thinking/ ,(consulted 13/12/2018).*

13 *Smith, M. K. (2015). What is education? A definition and discussion. The encyclopedia of informal education. Available at http://infed.org/mobi/what-is-education-a-definition-and-discussion/. (consulted 07/11/2018).*

cannot be catalog only as the transmission of wisdom or knowledge but also as a social process that constructs individuals able to interact with others and respond wisely to real-life situations.

Consequently, the process of education is characterized by structured guidance, transmitted as an interaction with the components at learners disposition and reflected on the praxis, as shown in Figure 10.

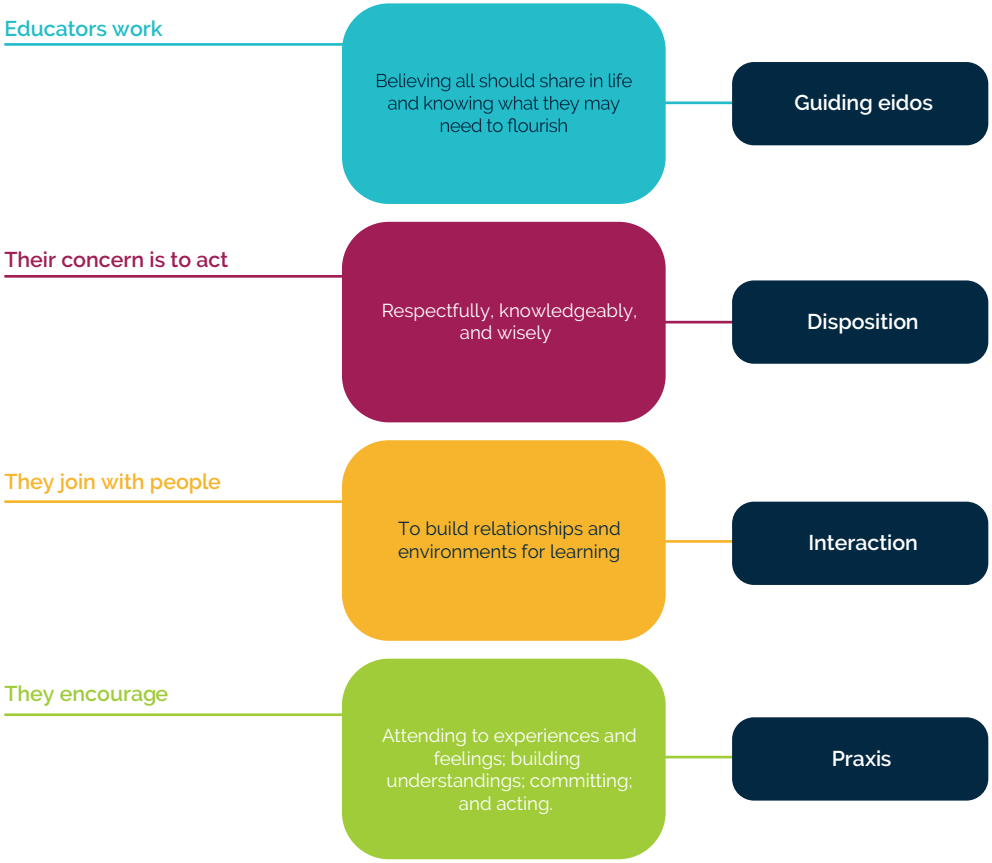


Figure 10. The process of education.

Source: Smith, M. K. (2015). What is education? A definition and discussion. The encyclopaedia of informal education.. Available at http://infed.org/mobi/what-is-education-a-definition-and-discussion/.

Therefore, an education system is a group of elements interconnected to provide individuals the capacity of acting coherently, in order to overcome challenges and difficulties of their life realities. In this sense, the first element inside an education system are the actors involved in it, such as governmental entities, private agents, schools managers, teachers, students, etc. Parallel, there are the physical and non-physical resources which are the inputs and tools with the aim of supporting the processes stipulated to obtain the desired outcomes of the education system. This means that if those main goals are well decided and precisely agreed between all the elements inside, the system should be able to produce, develop and adapt properly the tools needed for the process of teaching and learning and provide the right modifications (from political, economic, technological and social point of view) to maintain its balance and reduce its drawbacks (Figure 11).

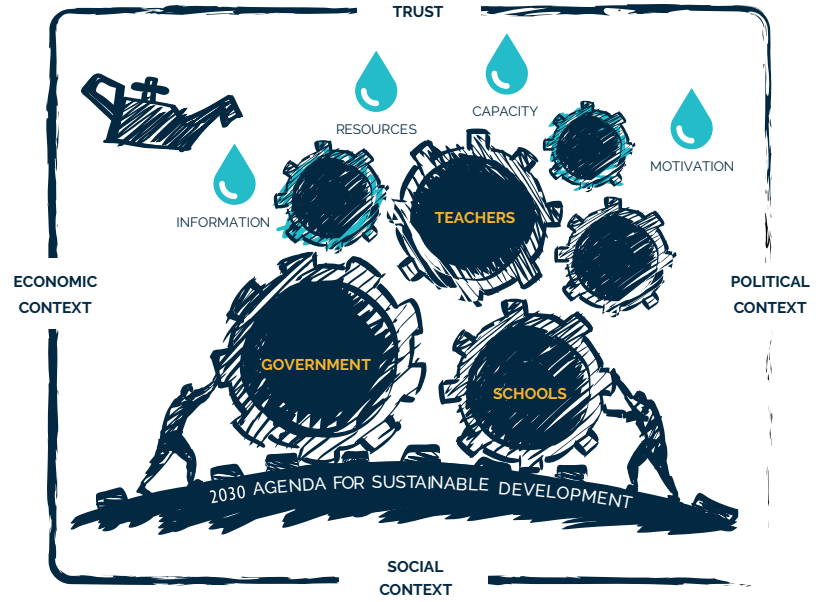
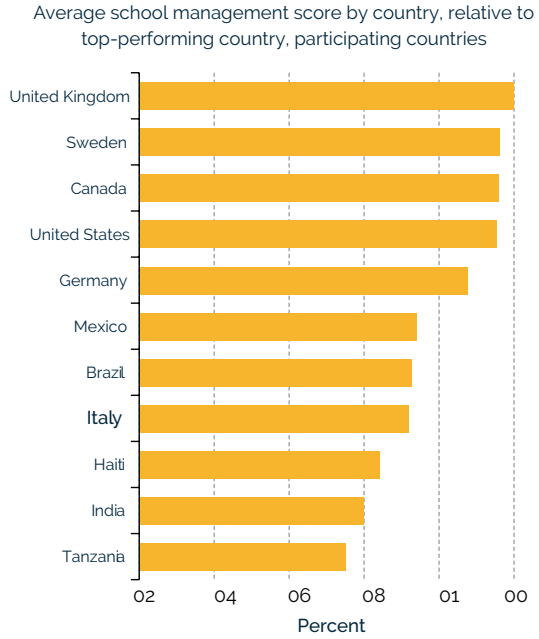


Figure 11. Actors are interdependent in achieving inclusive, equitable, good-quality education

Source: GEM Report team. Reached from UNESCO. 2017. Accountability in education: meeting our commitments. Global Education Monitoring Report 2017-2018. United Nations Educational. Available at http://unesdoc.unesco.org/images/0025/002593/259338e.pdf

There are worldwide organizations that yearly evaluate and analyze education systems of different countries to identify general guidelines and objectives that should be drawn in on every education system around the world, based on the positive and negative aspects founded on the current cases. and provide some general guides to be taken into account. Nonetheless, each government has to organize and structure their own education systems, giving priority to their diverse cultural features and socio-economic realities, which eventually reflect the quality of management and organization that each system has according to the performance obtained (Figure 12). In consequence, it is relevant to understand the material around a system, either from the intrinsic as an extrinsic level leading to reduce the risks of failure.

As it has been argued so far, *"education systems are, by nature, extremely complex and multifaceted, and the challenges entailed in reforming or improving them can be similarly complex and multi-faceted"*[14] (Glossary of education reform). This means that the possibility of reaching significant changes inside an education system cannot be simplified on one single settlement but through the interconnections of smart and wisely strategies located coherently inside the multiple levels and processes in which the system is segmented. In addition, part of its complexity is the continuous and fast movement within the surrounded world, that conduct to the inclusion of other relevant characteristics, the flexibility and adaptability of the developing solutions. In fact, the intervention or solutions (new policies,



Note: The school management score is a combination of 14 basic management practices, each rated from 1 to 5. Schools with higher scores have more structured management practices.

Figure 12. Schools vary significantly in management quality.
Source: World Bank. WDR, 2018. Bloom and others (2015). Reached from World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. Available at http://www.worldbank.org/en/publication/wdr2018

14 Great Schools Partnership. 2013. The glossary of education reform. Systemic Reform. Available at https://www.edglossary.org/education-system/ , (consulted 24/09/2018).

projects, technologies, etc) usually explore in this level of complexity in systems require extensive and continuous monitoring-evaluating processes due to the variability of the system scenario through the time (Figure 13).

In conclusion, the purpose of understanding the education system where the project is going to be included allows to have a higher complexity of reasoning about the decisions that need to be taken throughout the design process. Particularly, identifying the elements that are connected with it, which will put in evidence the ways they can affect the project or the outcomes it might be able to achieve. Indeed, this systemic thinking analysis will build the foundations that will support the feasibility of the project and the value of its future development.

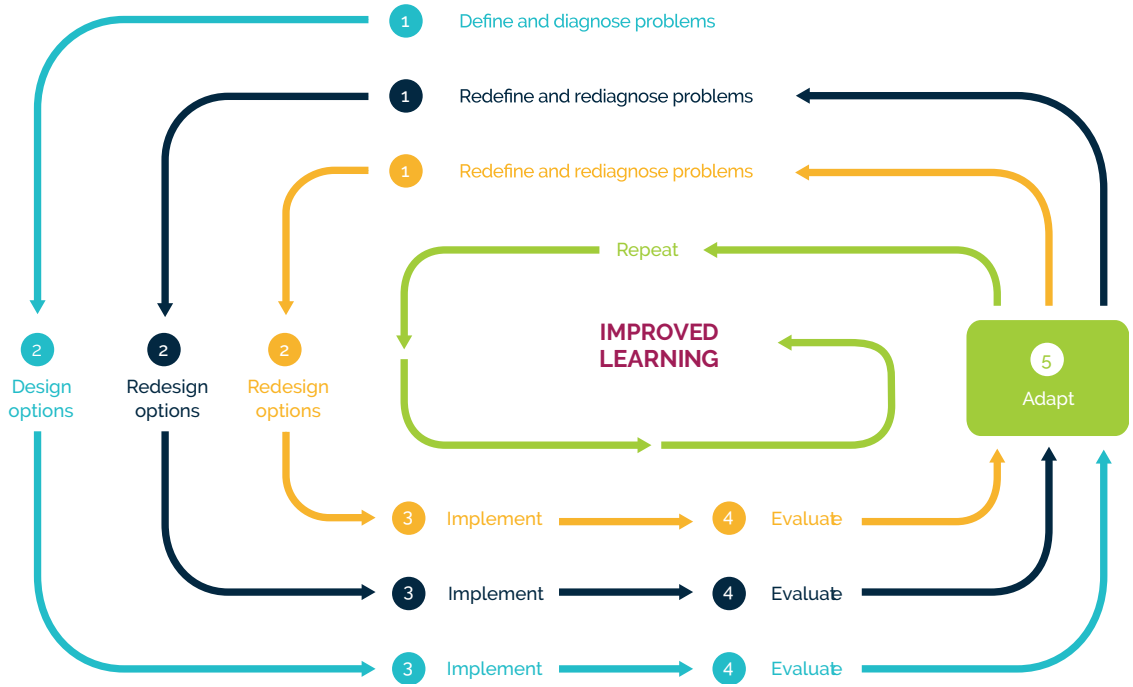


Figure 13. Problem-driven iterative adaptation drives successful reforms.

Source: World Bank. WDR, 2018. Adapted from Andrews, Pritchett, and Woolcock (2017). Reached from World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. Available at http://www.worldbank.org/en/publication/wdr2018

Nowadays education scenario

Education improvements are the result of systems with a strong settlement of goals, and due to the continuous monitoring and evaluating processes that nowadays are implemented (data recollection, detailed tests, new technologies of data analysis, etc). As a result, international entities are able to suggest some relevant and common challenges that education systems need to overcome, for instance, the strategies focus on education quality. According to UNESCO (2015), *"the quality and availability of teacher training, scarcity of textbooks and resources, and class size remain serious challenges affecting education quality"*[15].

The mentioned challenges, have several causes and consequences on learners in the future if there is not a control and an implementation of possible solutions to solve them, which impulse the construction of strategies inside the education systems. Nevertheless, as it has been explained before is extremely necessary to align the system goals with the actions and role of each piece of the puzzle (Figure 14).

For the case analyzed in this thesis, it has been taken special attention to the first challenge mentioned, the availability of teacher training which is also one of the four goals that the European Commission addressed to the EU strategies for education and training until 2020. However, this deficiency involves a variety of aspects that influence and restrict its solution, either from the way in which teachers are being evaluated to their motivations, which consequently questions how the corresponding entities feed, maintain and increase these last ones, through economic and/or non-economic incentives. For example, from the professional motivation perspective, in a group of European countries *"outstanding performance teachers more frequently receive one-off bonuses, as is the case in Bulgaria, Denmark, Estonia, Italy, Austria, Poland, Slovakia, Montenegro and Serbia"*[16] (European Commission, 2018).

Furthermore, a report focused on the access, progression and support of UE teachers, identify the importance of career guidance for teachers:

15 UNESCO. 2015. Education for all 2000-2015: achievements and challenges. EFA Global Monitoring Report. United Nations Educational. Available at http://unesdoc.unesco.org/images/0023/002322/232205e.pdf , (consulted 10/10/2018)

16 European Commission/EACEA/Eurydice, 2018. Teachers' and School Heads' Salaries and Allowances in Europe – 2016/17. Eurydice Facts and Figures. Luxembourg: Publications Office of the European Union.

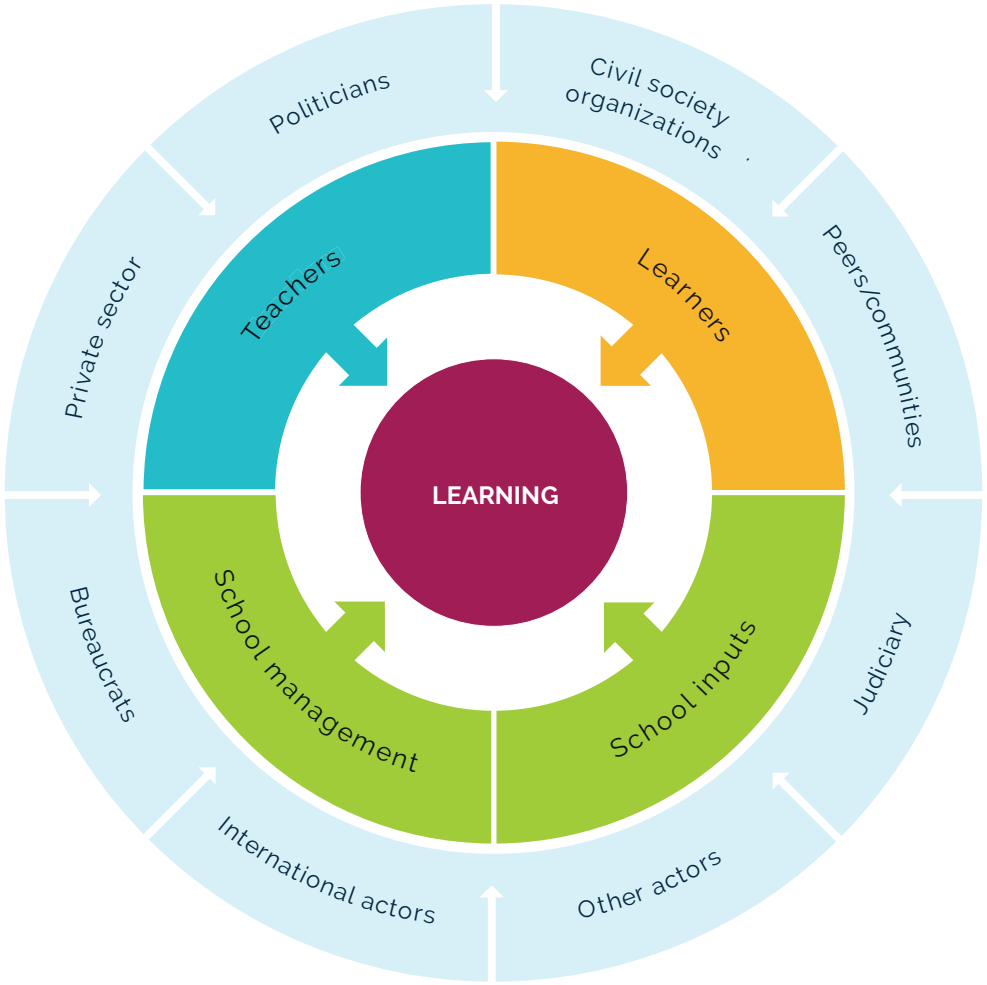


Figure 14. Coherence and alignment toward learning.

Source: World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. Available at http://www.worldbank.org/en/publication/wdr2018

> *"This section focuses on career guidance specifically for teachers in service, which is considered here to mean support for teachers in managing and planning their progression within the teaching profession. It includes the provision of information, coaching or counselling with a view to advancing a teacher's career."*[17] (European Commission, 2018)

Thus, another incentive to improve teachers motivation can be related to the methodologies implemented for teachers tutoring and work assistance, for instance through the use of effective and appropriate technologies that facilitate their labor. For instance, *"to introduce forms of distance education requires that existing organizational structures be reviewed and revised so that institutional regulatory structures cascade down from the top organizational levels to faculty technology plans, with goals and regulations to further assist faculty-based teaching academics"*[18] (Samarawickrema, G; Stacey, E. 2007). In other words, the authorities in charge, government, and school managers are the first and main actors on the system with the responsibility on taking the act to allow the correct implementation of technologies inside modern learning environments.

From this point of view, *"the rapid advancement of emerging technologies presents educators and scholars around the globe with unprecedented opportunities to use these technologies to improve teaching and learning"*[19] (Hsu, Y., Hung, J., & Ching, Y. 2013), which put in evidence another relevant element included on the education systems, the role of technology and its

17 *European Commission/EACEA/Eurydice, 2018. Teaching Careers in Europe: Access, Progression and Support. Eurydice Report. Luxembourg: Publications Office of the European Union. Available at http://eurydice.indire.it/wp-content/uploads/2018/02/Teaching-Careers-in-Europe.pdf , (consulted 12/10/2018).*

18 *Samarawickrema, G; Stacey, E. 2007. Adopting Web-Based Learning and Teaching: A case study in higher education. Deakin University, Melbourne, Australia. Open and Distance Learning Association of Australia, Inc. Vol. 28, No. 3. pp. 313–333.*

19 *Hsu, Y., Hung, J., & Ching, Y. (2013). Trends of educational technology research: More than a decade of international research in six SSCI-indexed refereed journals. Educational Technology Research and Development, 61, 685–705.*

Image retrieved from https://thewarrencentre.org.au/australian-students-need-stem-education/

impact on the processes and stakeholders around. There are several services and technological tools that are being developed to increase education quality (figure 15). On one side, for management processes inside the competent institutions but on the other hand, as a response to the students-teachers needs and demands.

However, this large range of possibilities is becoming a problem either for institutions as for teachers, due to the hard decision of selecting the appropriate instrument to use without affecting students learning processes or teachers job.

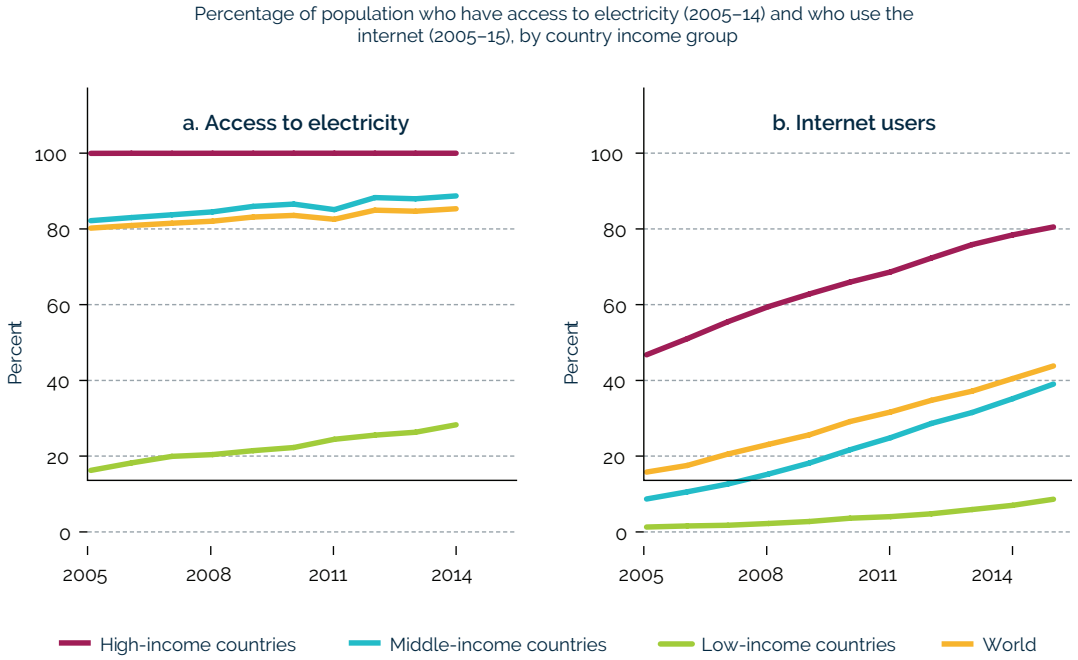


Figure 15. Technology use has increased dramatically over the past decade

Source: WDR 2018 team, using data from World Bank (2017a) for electricity access and ITU (2016a) for internet users. Data at http://bit.do/WDR2018-Fig_S5-1. Reached from World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. http://www.worldbank.org/en/publication/wdr2018

System Structure

In this respect, the structure of a system starts by understanding the common goal stated between the stakeholders, basically putting it at the center of the analysis to propose actions consequent to its approach. From the education perspective, learning should become the center of the system as *"providing education is not enough. What is important, and what generates a real return on investment, is learning and acquiring skills. This is what truly builds human capital"*[20] (World Bank, 2018). In other words, to achieve real outcomes in education, the solution does not remain on providing a service to a large number of students without an accurate quality of it. Which means, the projects and actions from the different perspectives involved in the system should concentrate on finding and solving those key interconnection points where this main purpose is failing.

As mentioned before, one of the characteristics of a system is its complexity which comes from the number of elements inside but mostly due to the several connections between them. Then, to untie its difficulty is necessary to set different levels, with the purpose of organizing and giving a hierarchy to the components. For instance, on the World Development Report of 2018 (World Bank, 2018), the analysis was conducted dividing into two levels of stakeholders that are important on the education systems and that eventually become the key actors for the improvement on the process of learning (figure 16). As a result of this kind of analysis, it is possible to identify which are the main points, actors and connections that will directly impact the project results.

In the same way, according to the methodology proposed by professor Bistagnino (2011), a system is composed by a continuous fluid of inputs and outputs that make possible the different processes inside the system itself, in order to achieve the outcomes established. This means that inside the analysis, is necessary to identify what are those inputs and outputs provided by the stakeholders and the resources that are supporting learning environments, which are intended as human, physical and non-physical inputs and tools required. In this connection, the outcomes of the system

20 World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. doi:10.1596/978-1-4648-1096-1. License: Creative Commons Attribution CC BY 3.0 IGO . Available at http://www.worldbank.org/en/publication/wdr2018 , (consulted 21/11/2018).

can be also categorized on the different levels where the impact will be evident, for instance, an individual impact, the local results, changes on the society and its influence in international areas.

LEARNING TO REALIZE EDUCATION'S PROMISE

Figure 16. The three key points that education systems should start focusing on.

Source: World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. Available at http://www.worldbank.org/en/publication/wdr2018

Resources: Inputs and outputs

In economy, there is a variety of models that categorize the resources needed in every economic scenario which are essential to achieving maintain and deliver products and services to the market. For instance, the Five Capitals Model (FCM) is structure to economies that point to a more sustainable industry, as it includes a perspective of understanding the eventually issues present on the environment and the social circumstances that in a long term might affect the balance of the financial aspect of the business (figure 17). According to the Forum for the Future (2018)[21], the types of capital on the FCM are:

i. Natural Capital: that is related to all the resources provided by the environment such as water, electricity, gas, forest, etc. Likewise, it refers to the waste produced by the companies and the impact they can release on nature.

ii. Financial Capital: are the assets that can be present as the currency that fluid inside the business models, which means that can be seen as the profit of the company or the investment-cost necessary obtain the final purposes of the organization. It is commonly seen as a financial measuring indicator of success inside the companies.

iii. Social Capital: refers to the additional activities from external social relationships based on cooperation and provided generally by public organizations or communities. This type of capital can be reflected internally (values, communication, cultural aspects) and externally from the business model (organizations and entities policies, public services, etc).

iv. Manufactured Capital: is related with all the material goods and infrastructure required for the processes of the economic structure. Besides, in this category are included the buildings, machinery and the technologies used by the company.

v. Human Capital: involves all the features provided and achieved by a human. It includes intellectual inputs-outputs, knowledge, skills, motivations, human relations, and emotions. Furthermore, is an element that works as an input, output that constantly evolve and allow the construction of the other categories mentioned.

21 Forum for the Future. 2018. The Five Capitals Model: a framework for sustainability. Keele University. Available at https://www.forumforthefuture.org/the-five-capitals , (consulted 11/26/2018).

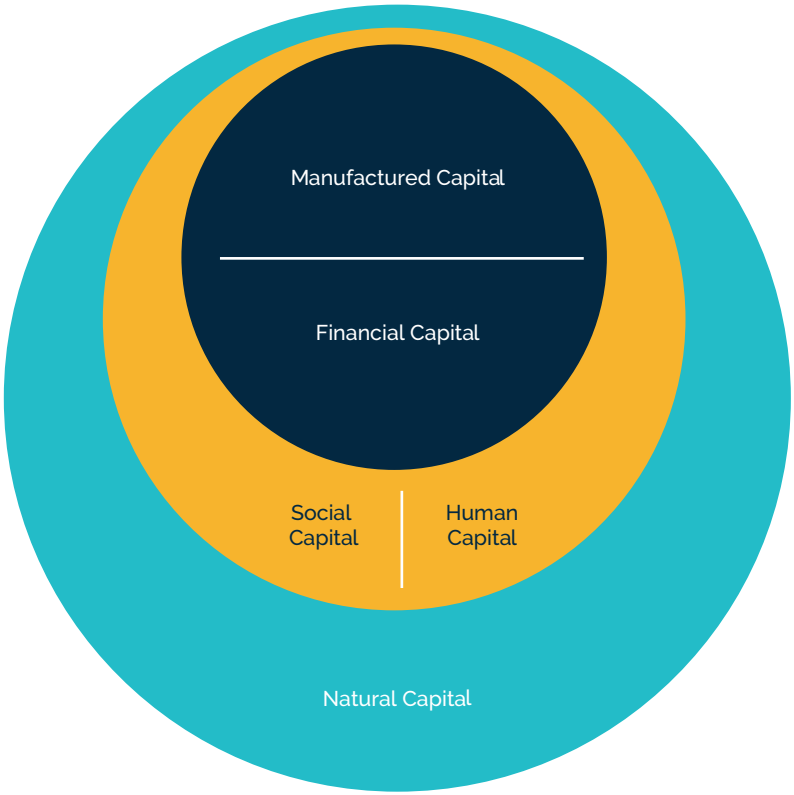


Figure 17. The five Capitals Model to achieve more sustainable economies.
Source: Forum for the Future, 2018. Available at https://www.forumforthefuture.org/the-five-capitals

Nevertheless, from an education perspective not all of the categories listed have the same level of relevance and impact on the system performance. It will be currently noticed on the requirements that the main actors ask for and at the same time the resources they should provide to the system. In this context, those categories can be visualized from an education perspective in the following terms:

i. Natural Capital: it remains on the basic services provided by nature. For instance, the paper use, energy supplies, the waste management on the institutions involve and the resources needed to have an environmental responsibility. For the approach of the project, this is probably the category with a lower relevance.

ii. Financial Capital: this is an important category for the education improvement, is related to all the investments need to sustain all the other capitals, which means it needs to be strategically distributed according to the main goals the system is interesting on achieving. For example, is a fact that *"high-performing systems tend to prioritize higher salaries for teachers"*[22] (OECD, 2013) due to its power of attracting more prepared candidates that at the same time will feel regarded and a more valuable on their professional performance.

iii. Social Capital: it refers to the role of public organizations and their impact not only in financial terms but also in monitoring, evaluating and controlling strategies that provide an order between the other parts of the system. In other words, the implementation of policies, boundaries and coherent goals but supported by inputs that the institutions can apply in order to achieve them. In addition, is necessary to mention the resources needed for monitoring and evaluating processes because through these ones the system might be able to collect some feedback on the positive points and the drawbacks presented.

iv. Manufactured Capital: for education purposes, it was rather divided into physical and non-physical resources. The first one is composed by all the infrastructure elements, such as buildings,

22 *OECD (2013), PISA 2012 Results: What Makes Schools Successful? Resources, Policies and Practices (Volume IV), Pisa, oecd Publishing. Available at http://dx.doi.org/10.1787/9789264201156-en , (consulted 12/1/2018)*

education instruments (books, chairs, tables, notebooks, blackboards, etc), computers and so many others. On the contrary, the second category relies on unmaterial supplies such as technology, data, software, digital contents or supportive tools.

v. Human Capital: is probably the most important element on education systems, as it is thanks to the expertise and the skills of the professionals involved that the learning environments will be improved, from an input point of view. However, as an output, this category becomes an evaluating measure of the level of success on the current education strategies, because it is been referring to a system which the main goal is building human capital. Indeed, *"for individuals and families, education boosts human capital, improves economic opportunities, promotes health, and expands the ability to make effective choices; and for societies, education expands economic opportunities, promotes social mobility, and makes institutions function more effectively"*[23] (World Bank, 2018). In this perspective, it becomes a circular and open system, in which having well-prepared and motivated professionals inside the system will be reflected on learners performance and their achievements, building the new professionals that will bring consequently positive response in the society or eventually on education systems improvement as well. The figures 18 and 19 are some of the examples of the impact that high education systems provide to society.

Image retrieved from http://proyectoaquimica.blogspot.com/p/tecnologia_5.html

23 *Ibid 20.*

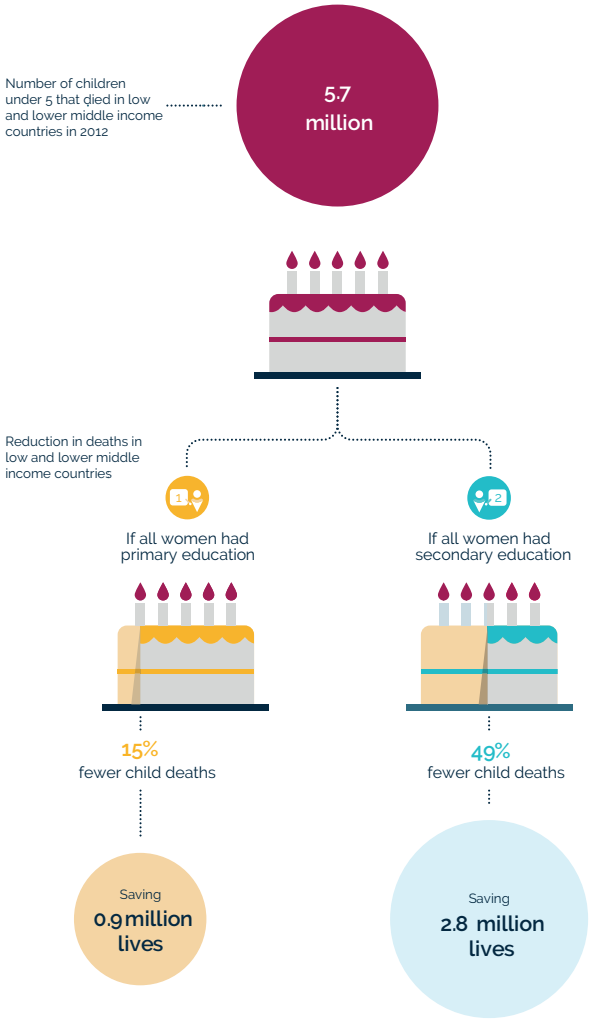


Figure 18. Example education impact on society: Saving children's lives.

Source: Gakidou (2013); Inter-agency Group for Child Mortality Estimation (2013). Reached from UNESCO. 2014. Teaching and Learning: achieving quality for all.

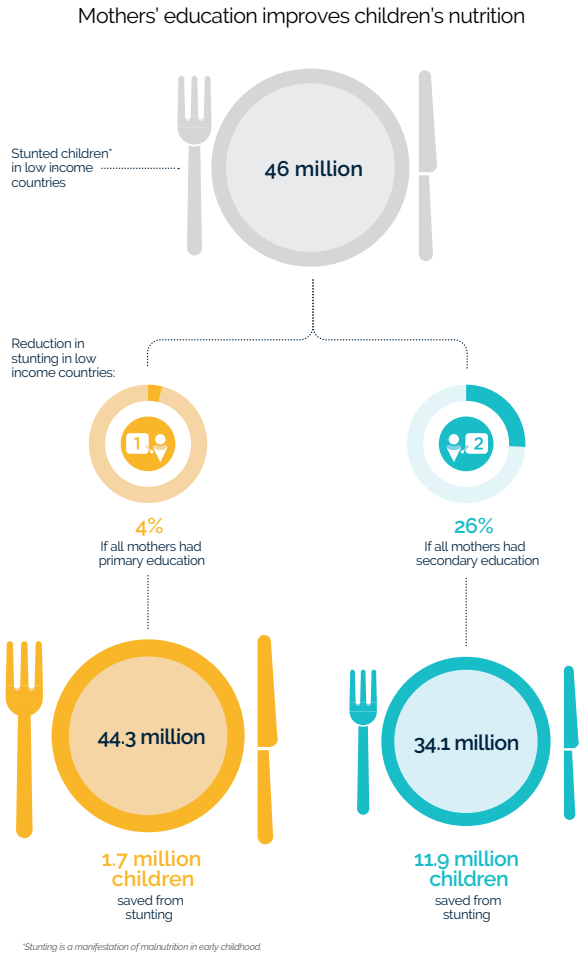


Figure. Example education impact on society: Education keeps hunger away.

Source: EFA Global Monitoring Report team analysis (2013), based on Demographic and Health Survey data from 2005-2011; UNICEF et al. (2013). Reached from UNESCO. 2014. Teaching and Learning: achieving quality for all.

Figure 19. Example education impact on society: Education keeps hunger away.

Source: EFA Global Monitoring Report team analysis (2013), based on Demographic and Health Survey data from 2005-2011; UNICEF et al. (2013). Reached from UNESCO. 2014. Teaching and Learning: achieving quality for all.

Actors involved.

As explained before, the stakeholders play important roles on the system and are through their interconnected work that the objectives on education will be obtained. However, the gossamer start to appear by showing the influence of one stakeholder on another (figure 20). All the actors have an impact on the other stakeholders, either directly or indirectly, this is why the information related to the main goals of the system needs to be well communicated between all of them in order to construct directional routes to the same ending point. On the next pages, it will provide some deeper facts related to the government, schools and teacher roles.

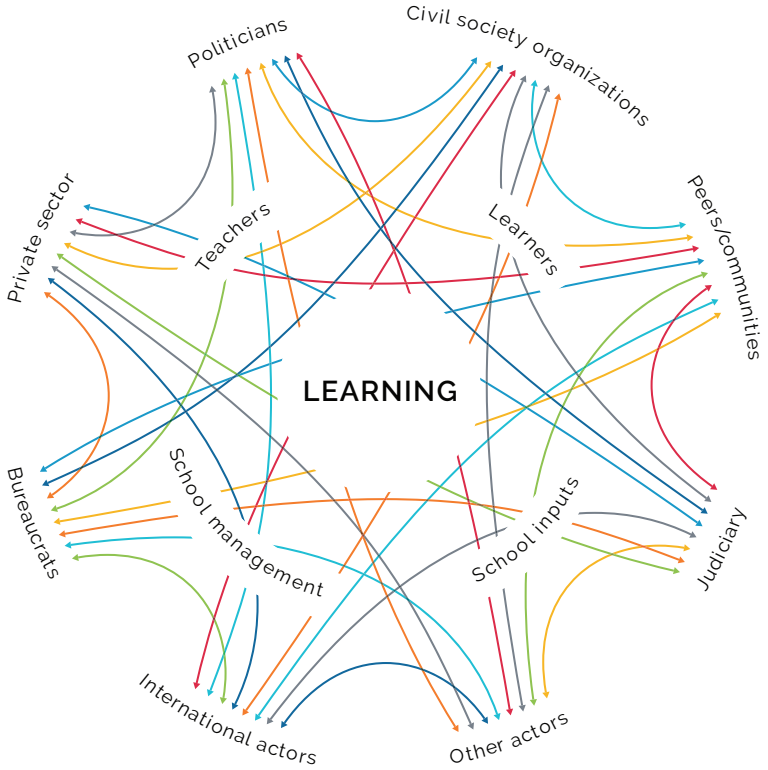


Figure 20. It's more complicated than it looks: People act in reaction to the choices of others throughout the system.
Source: World Bank. WDR, 2018.

Inside every education system, there is an important stakeholder, government, who is in charge of the decision making that structure the education policy and main goals, according to their country scenario. These become the guidelines needed to be followed by the rest of the actors in case of any decision or intervention they might want to do and where is involve education. Therefore, policy-makers should pursue a public financial management cycle (figure 21), providing some reports that contain the results of evaluation related to the system achievements which consequently become the feedback to modify and start the next cycle.

For instance, the reports provided by international entities affirms that *"to attract and retain good teachers, policy-makers need to improve teacher education, deploy teachers more fairly, provide incentives in the form of appropriate salaries, and create attractive career paths"*[24] (UNESCO, 2015). Then, governments might evaluate and identify which are their resources constraints and what are the possible points where the financial investment will have a bigger impact on their own education systems.

On the other hand, there is another relevant stakeholder on the scenario that has a crucial leadership role with a significant impact over the main actors of education, teachers, and students. This way, *"effective leadership means having school principals who are actively involved in helping teachers solve problems, including by providing instructional advice"*[25] (World Bank, 2018) (Robinson, Lloyd and Rowe 2008; Waters, Marzano, and McNulty 2003). In summary, the coherent interconnection between governments and schools should be evidenced on the resources (financial, physical or non-physical) they provide to the system and how they constantly monitor its performance in order to improve over time (figure 22).

Conclusively, for the overall research and connecting the information provided by documents and articles on the field, on figure 23 there is a final scheme that shows the key information related to the stakeholders involved in the system and how their role categorize some of the resources they usually are up to offer.

24 *Ibid 15*

25 *Ibid 20*

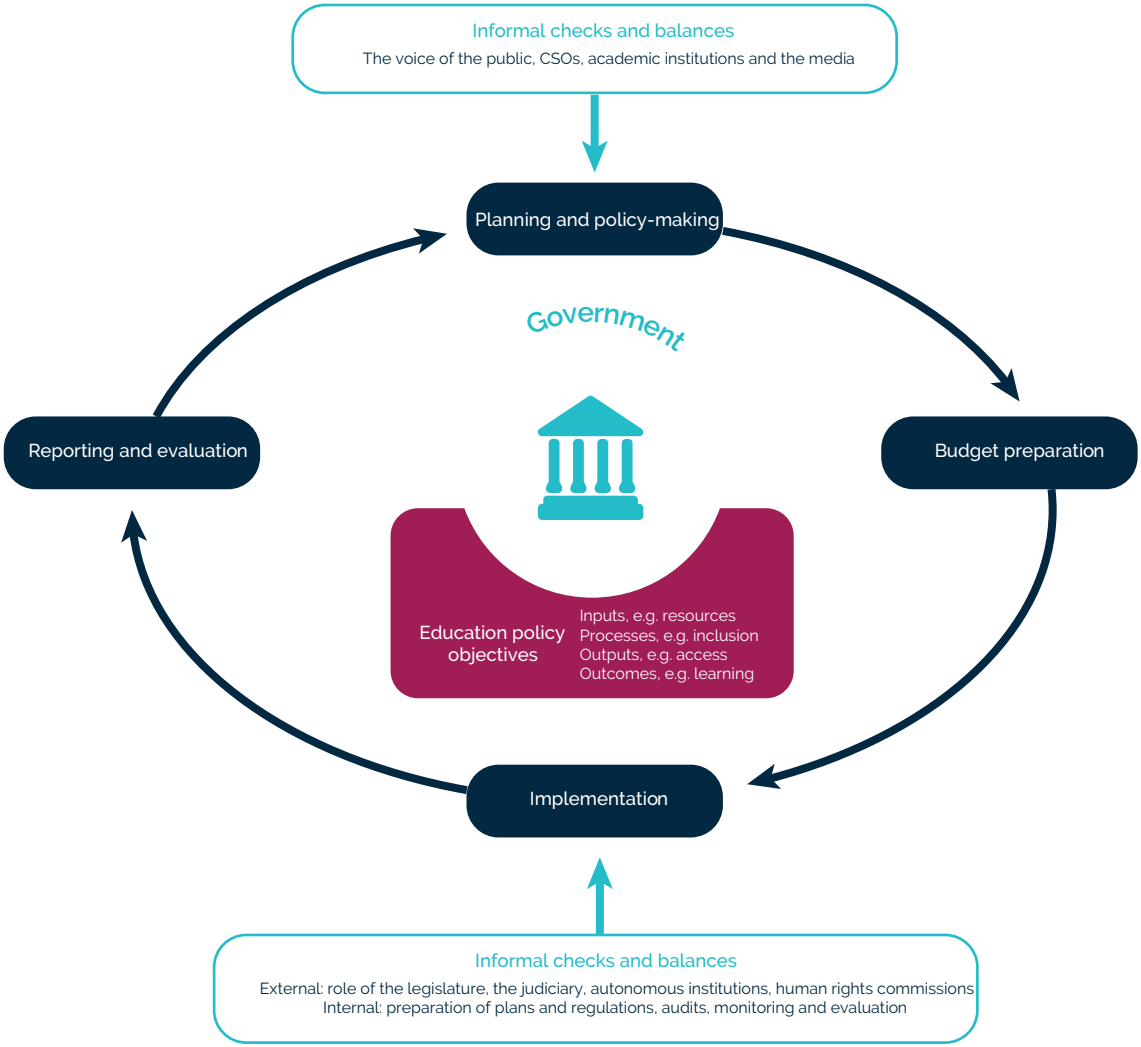


Figure 21. The education policy and budget cycle: Formal and informal checks and balances hold governments to account for their education commitments

Source: adapted from UNESCO. 2017.Accountability in education: meeting our commitments.Global Education Monitoring Report 2017-2018. United Nations Educational. Available at http://unesdoc.unesco.org/images/0025/002593/259338e.pdf

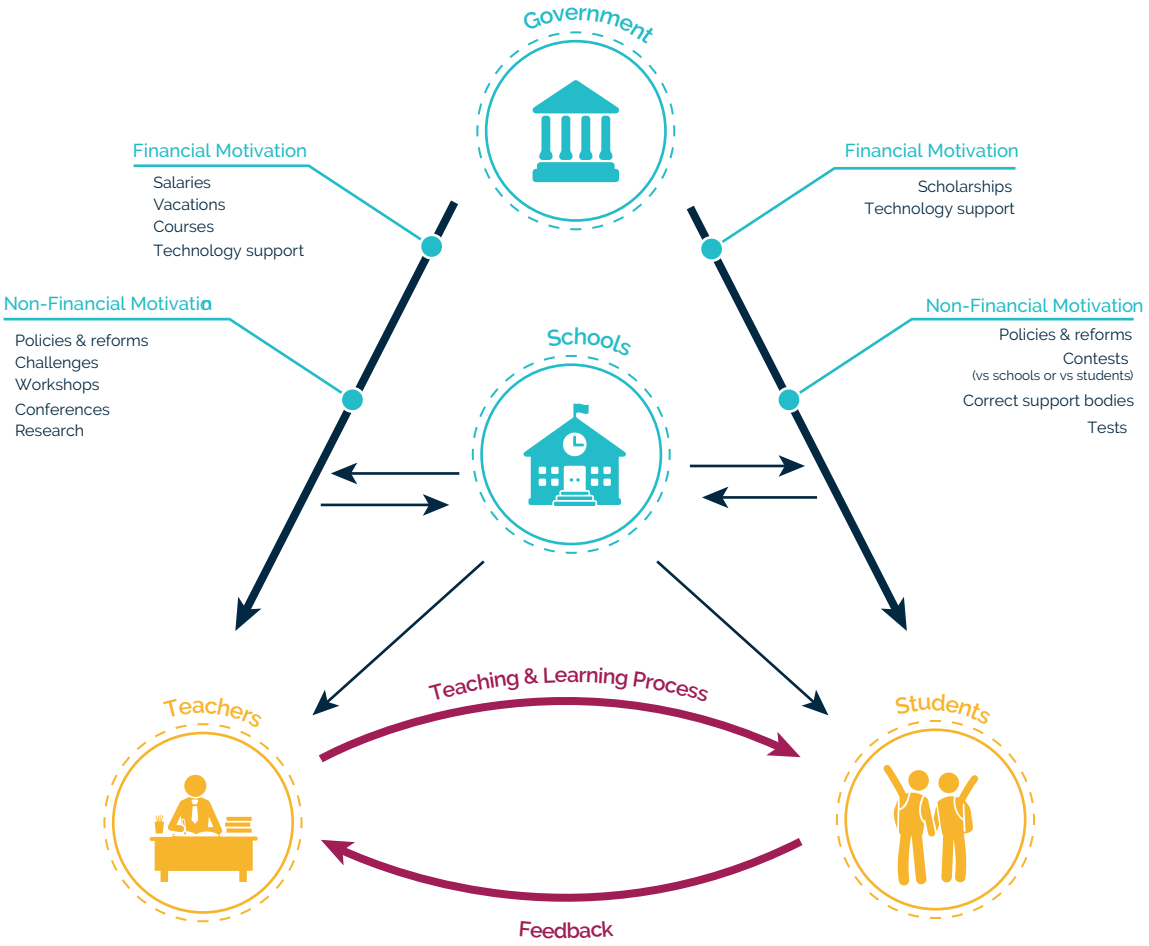


Figure. 22 Connections and key resources provided by government and school to teachers and students to improve quality of education processes.

Source: Information collected from UNESCO. 2017.Accountability in education: meeting our commitments.Global Education Monitoring Report 2017-2018. United Nations Educational.. Available at http://unesdoc.unesco.org/images/0025/002593/259338e.pdf and European Commission/EACEA/Eurydice, 2018.

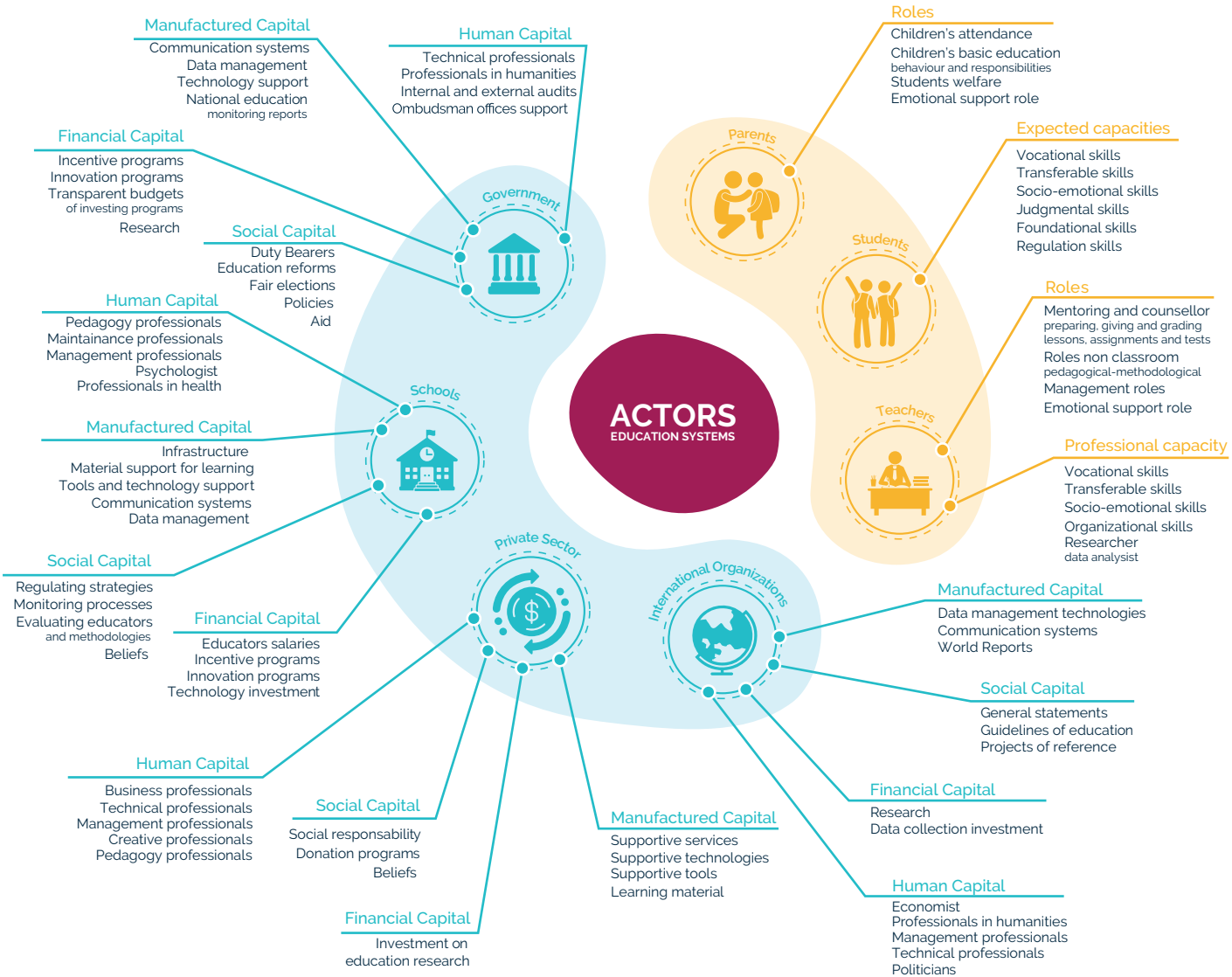


Figure 23. Education system actors: capitals provided and role inside the system

Source: Information collected from UNESCO. 2017.Accountability in education: meeting our commitments.Global Education Monitoring Report 2017-2018. United Nations Educational. Available at http://unesdoc.unesco.org/images/0025/002593/259338e.pdf

Education systems problematics.

As a result of all the factors mentioned before and how an education system is composed, there are some issues that concern a large group of countries around the world. However, thanks to evaluation methods and new technologies advances it is being possible to recognize which are some of the points that mostly affect the outstanding performance of education systems. Consequently, there is enormous accountability on the first level of actors involved on learning processes such as skilled learners, appropriate teaching methodologies and tools and strong management and governance supporting the value behind the concept of education. (Figure 24).

Therefore, the route of the thesis research should keep in mind the inconveniences that are affecting teachers performance which becomes a challenge to overcome and at the same time some requirements to be added on the process of delimiting the design concept of the project. In this perspective, the difficulties teachers presented begins with the motivation and preparation paths on the profession, which along the time has been demonstrated that respected, regarded and supported teachers provide better results to the education systems. However, the solution to this problem represents a big effort from many components that interact on the system. In other words, the short-term scopes need to be small actions that together might strengthen teachers achievements. For instance, education systems can:

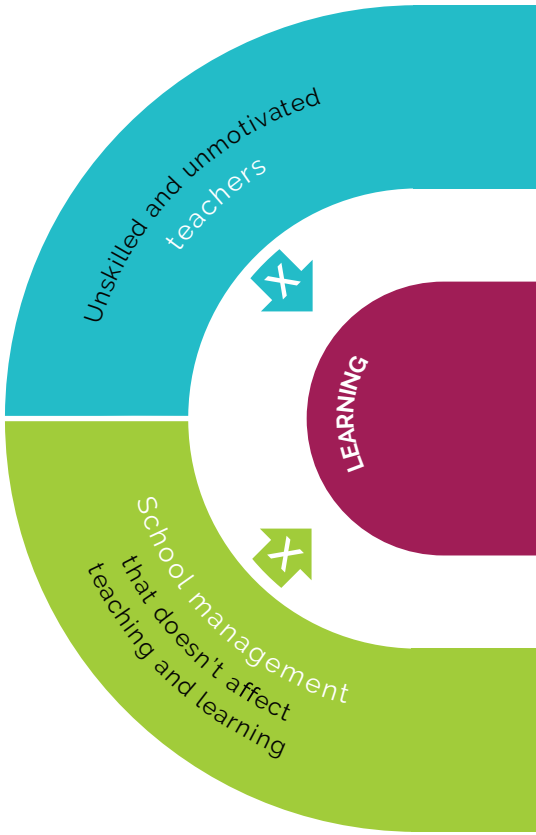
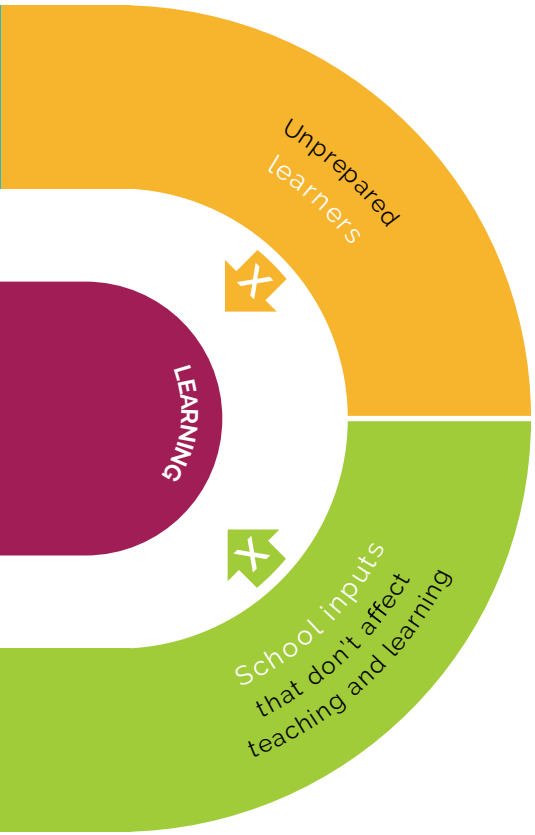


Figure 24. Why learning doesn't happen: Four immediate factors t
Source: World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Wa

"improve the quality of professional development, shifting resources to the kinds of professional development that will change teacher performance in the classroom; can support teachers in teaching to the level of the student; or can provide a professional structure so that teachers feel motivated to apply what they know"[26] (World Bank, 2018). In conclusion, investing in teachers improvement at short and long term is the key for achieving better results in the learning environments. Then, it is the responsibility of the authority actors to guarantee the adequate backed up strategies and likewise an opportunity for private entities to offer the right services that support teachers performance and professional growth. This, inevitably lead us to the second complex inconvenient of education systems which regard to the coherent alignment of the parts, mainly caused by the presence of diverse purposes that frequently become the conflicting points between them.



hat break down

shington, DC: World Bank. . Available at http://www.worldbank.org/en/publication/wdr2018

"A good quality education depends on not just inputs, but also on processes"[27]

(UNESCO, 2015)

26 *Ibid 20*
27 *Ibid 15*

Photo by Markus Spiske on Unsplash

EDUCATION AND NEW TECHNOLOGIES

Importance of new technologies

As evidenced on the previous subtitles, preparing students and teachers to manipulate and understand the power of new technologies is becoming more relevant as its presence increase on every workspace and especially due to the current use of information and communication technologies. Then, is necessary to impulse governments and school leaders to implement the use of technologies related to the challenges the learners might find to compete in the economy of the future. Likewise, teachers need to understand the relevance and the limits that new technologies have above their performance, in order to use them wisely and at the same time, identify the challenges they bring to their role as tutors of a learning process.

This way, this chapter will put in evidence the phenomenon of new technologies on learning and teaching environments, mainly focus on the influence of AI technology.

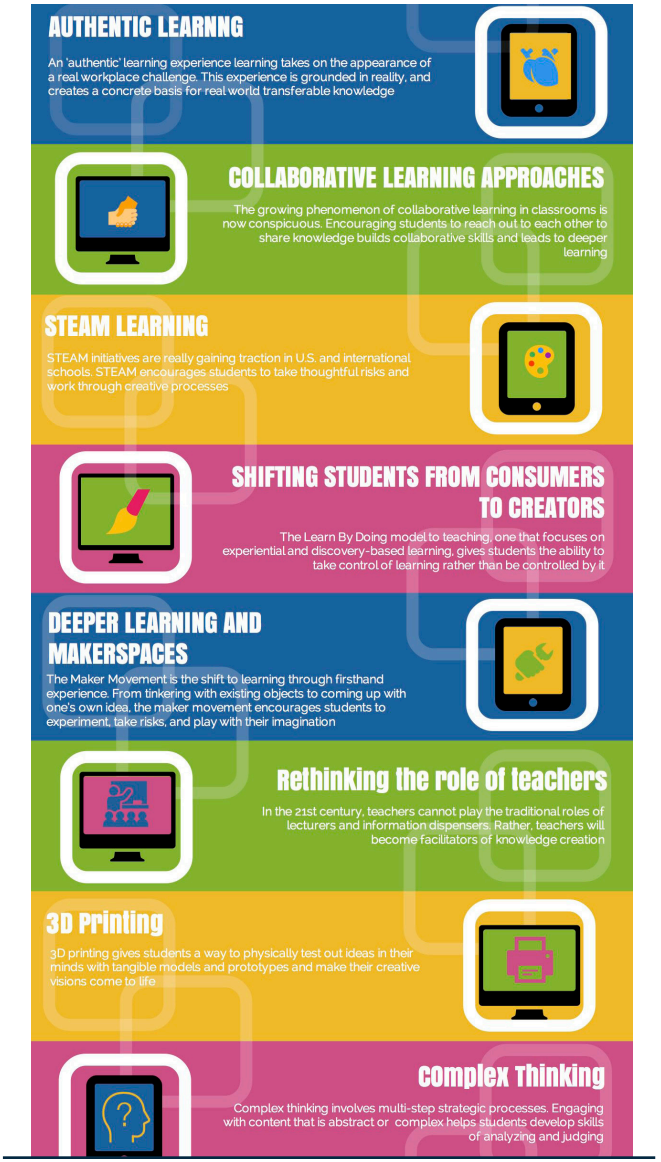


Image retrieved from https://zspace.com/blog/edtech-buyers-guide

EdTech Concept

The terminology around technology and the large number of applications that it has been developing during the years in different industries, promote to developers to assign specific terms of it according to the area where is exposed. In this case, the education industry, the appropriate name is EdTech, that according to the Terminology Committee of the Association for Educational Communications and Technology (AECT) is defined as *"the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources"*[28] (Januszewski and Molenda 2008, p. 1) . In other words, is the way technology provide efficiency to the processes inside learning and teaching environments.

EdTech concept has been known from a long period of time, suffering different modifications and also the objectives or key guidelines on the development of new technologies. As identified by Winn (2002), the evolution of educational technology is divided into four phases: *"(1) the age of instructional design, focusing on content; (2) the age of message design, focusing on format; (3) the age of simulation, focusing on interactions; and (4) the new age of research, focusing on learning environments"*[29] (Hsu, Y; Hung, J; & Ching, Y. 2013). However, even if this process of evolution has presented a stronger objective according to the period of time, each element mentioned in the last four eras continues to develop and improve its performance on education environments. Besides, is necessary to remember that at this moment we are on the era of communication and information which means that technology is also importantly influenced by the management of data and high tech processors able to catch the information and depurate it in order to resolve a specific demand.

On the other hand, EdTech is categorized by three domains focus on its use[30] (Dr. Lazar Stošić. 2015):

i. Technology as a tutor (computer gives instructions and guides the user)
ii. Technology as a teaching tool
iii. Technology as a learning tool.

28 *Hlynka, Denis & Jacobsen, Dr. (2010). What is educational technology, anyway? A commentary on the new AECT definition of the field. Canadian Journal of Learning and Technology / La revue canadienne de l'apprentissage et de la technologie. 35. 10.21432/T2N88P.*

29 *Hsu, Y., Hung, J., & Ching, Y. (2013). Trends of educational technology research: More than a decade of international research in six SSCI-indexed refereed journals. Educational Technology Research and Development, 61, 685–705.*

30 *Lazar Stošić. 2015. THE IMPORTANCE OF EDUCATIONAL TECHNOLOGY IN TEACHING. International Journal of Cognitive Research in Science, Engineering and Education Vol. 3, No.1.*

Nevertheless, this thesis is centered on the technology that support teachers performance and needs, combine with the implementation and how to adopt a cognitive design able to translate the complexity of the language of new technology such as AI, that in this case can be used as a technology tutor but that is based on a real teacher work and that as consequence required a more intuitive level of reading and interaction with the tools. Generally, this style of instrument is catalog as Instructional Design (ID) that take in a variety of disciplines in order to achieve useful results. For instance, ID tools can usually include *"digital learning, pedagogy on-line, learning design, humanism as digital humanism, collaborative learning, user-centered design, and programming language, as well as instructional design models"* [31] (Ipek, I; Ziatdinov, R. 2017).

In a broader perspective, the education industry has shown a relevant impact by the development of new technologies and is an industry in continuous growth around the world. In fact, The global EdTech market globally reached nearly $18 billion in revenues by 2017 (Business Wire) and according to David Bainbridge forecasts, the EdTech industry will reach a global value of $252 billion by the year 2020 (Forbes) expecting at the same time a growth of the student population to $2.7 billion by the year 2035 [32] (Gaille, B. 2018). On figure 25, can be as well evidenced the changes and the impact of EdTech during the last years.

31 *Ipek, I ; Ziatdinov, R. 2017. New Approaches and Trends in the Philosophy of Educational Technology for Learning and Teaching Environments. European Journal of Contemporary Education, 2017, 6(3) 6(3): 381-389. DOI: 10.13187/ejced.2017.3.381*

32 *Gaille, B. 2018. 23 Edtech Industry Statistics and Trends. Available at https://brandongaille.com/23-edtech-industry-statistics-and-trends/ , (consulted 11/15/2018).*

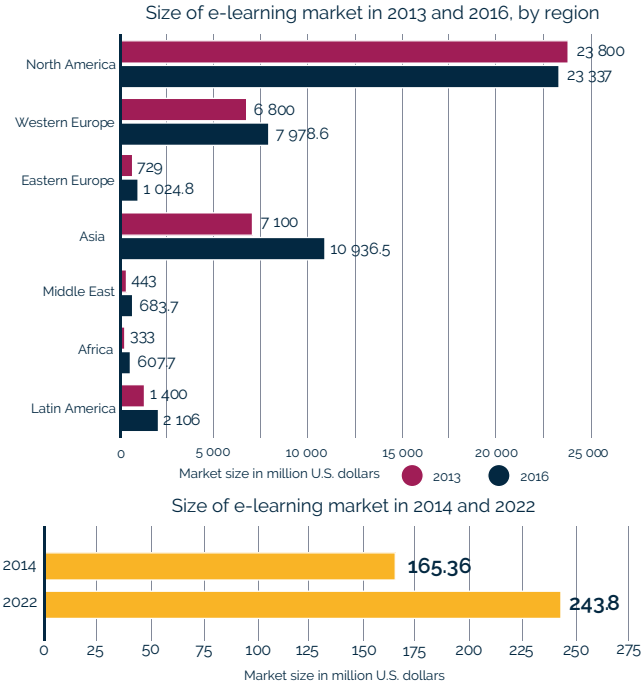


Figure 25. Statistic graphic results of EdTech industry

Source: Gaille, B. 2018. 23 Edtech Industry Statistics and Trends. Available at https://brandongaille.com/23-edtech-industry-statistics-and-trends/

Technology that support the role of teachers

During the last decades, is possible to observe a large number of tools, applications, computer systems that primarily focus on the student interaction or learning strategies centered on the student. For instance, it can be found some role games, tutor interfaces, student networks or interactive platforms with the aim to improve cognitive skills. Then, all the components inside these tools include the work of engineers, designers, educators and so on in order to understand the student and provide a solution centered on the experience of the user.

Likewise, in the same level as students can improve their learning process through the use of technology, teachers also required some support from the technology to improve their performance and their role as tutors on the education system. Conversely, developers are failing on the way the tools are cognitively designed, as their work required management of a big amount of data and information, the language of the technology get more complex than the one implemented for students. As a consequence, when a teacher finds a confusing and unfamiliar group of elements on these tools, they normally abandon it, getting back to their usual strategies. This way is necessary to understand and transform the power of those new technologies on instruments able to be used by the user and design for them.

As a matter of fact, and as mentioned before on the analysis of education systems, an important reason for the failure of teachers performance is the low motivation they have. Eventually, those motivations can be represented as monetary incentives but also related to the supportive instruments, plan, or strategies they received that facilitates their work, helping them to save some time that is also expressed as an element of motivation. In other words, *"To ensure stable adoption of technology, a holistic approach to staff development that is connected to performance management and recognizes individual development has a greater impact than an isolated technology-only approach"* [33] (Samarawickrema, G; Stacey, E. 2007).

In this context, EdTech has been working on tools able to help teachers from different perspectives: data management, strategies for evaluation, communication

33 Samarawickrema, G; Stacey, E. 2007. Adopting Web-Based Learning and Teaching: A case study in higher education. Deakin University, Melbourne, Australia. Open and Distance Learning Association of Australia, Inc. Vol. 28, No. 3. pp. 313–333

tools and tutoring systems. All these categories of technology will be explained on the following pages, in order to recognize its applications and identifying its value and issues from the user perspective.

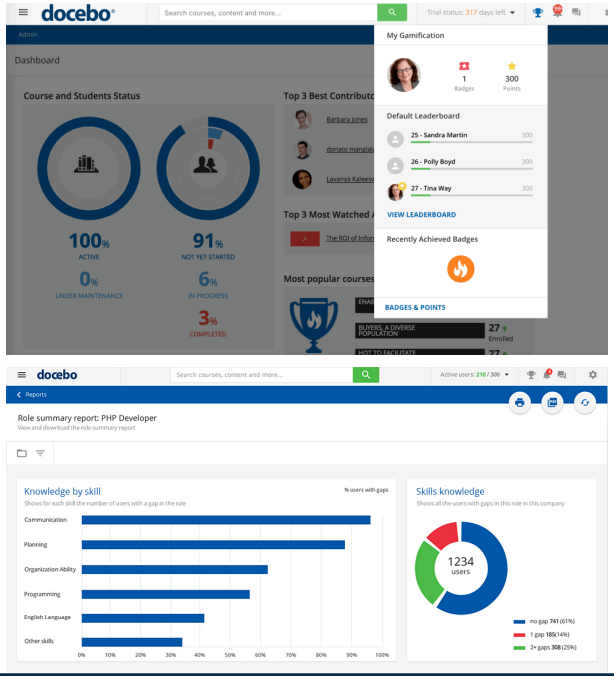
Learning Management Systems

The first type of system presented as a supportive tool for learning and teaching environments is the Learning Management Systems (LMS) that is defined as a *"web-based software used for the delivery, tracking, and managing of education online"*[34] (Islam, A.K.M.N. 2015). Usually, LMS is one of the main providers of distance education but it does not mean that cannot be implemented on traditional teaching, as it includes some features that facilitate in general terms the educator work such as the organizational benefits these platforms provide.

Consequently, during the development of this kind of system is mandatory to include the student and teacher perspective, in order to identify its value from both points of view in order to recognize the features it might include to be efficient. *"Educators can track the progress of their students using such software, while students may submit their assignments, download course materials, and track their grades by logging on to the system. They can interact with others, control their own learning, develop deep thinking skills, and develop a sense of community with other learners"*[35] (Tay et al. 2011). Similarly, LMS has a market that expects to have a

34 *Islam, A.K.M.N. 2015. The moderation effect of user-type (educators vs. students) in learning management system continuance. Behaviour & Information Technology. Vol. 34, No. 12, 1160–1170. Available at http://dx.doi.org/10.1080/0144929X.2015.1004651 , (consulted 11/12/2018).*

35 *Tay,L.Y.,C.P.Lim,S.Y.Lye,K.J.Ng, and S.K.Lim.2011. "Open-source Learning Management System and Web 2.0 Online Social Software Applications as Learning Platforms for an Elementary School in Singapore." Learning, Media and Technology 36 (4): 349–365.*



Images retrieved from https://elearningindustry.com/directory/elearning-software/docebo

valuable increase related to the investment in research and as a business plan. Indeed, *"Global LMS market is expected to grow from US$ 5.05 billion in 2016 to US$ 18.44 billion by 2025 at a CAGR of 15.52% between 2017 and 2025"*[36] (Market Report, 2017). According to the a Global Forecast Market Report (2018), *"increasing the adoption of digital learning, growing inclination towards, Bring Your Own Device (BYOD) policy and enterprise mobility, extensive government initiatives for growth of LMS, growing usage of AI and Machine Learning (ML) in LMS is increasing the significance of eLearning in the corporate and academic setups"*[37] (Market Report, 2018), and predicts an increase on its investment as evidenced on the figure 26. Conclusively, the use of this kind of systems is common on the market, and is not only applied on education environments, is an industry that can be applied in different fields that involve professionals and a large amount of data needed to be processed and organized.

36 *Research and Markets. 2017. Learning Management System (LMS) Market to 2025 Global Analysis and Forecasts. Report. Available at https://www.researchandmarkets.com/research/3g2dlp/18_4_billion?w=5&utm_campaign=elearningindustry.com&utm_source=%2Fthe-20-best-learning-management-systems&utm_medium=link , (consulted 11/12/2018).*

37 *Markets and Markets. 2018. LMS Market by Component (Solution and Services), Delivery Mode (Distance Learning, Instructor-Led Training and Blended Learning), Deployment Type, User Type (Academic and Corporate), and Region - Global Forecast to 2023. Available at https://www.marketsandmarkets.com/Market-Reports/learning-management-systems-market-1266.html?gclid=EAIaIQobChMItKT-ofuI3QIVjcqyCh1PcwdkEAAYASAAEgIfGvD_BwE&utm_campaign=elearningindustry.com&utm_source=%2Fthe-20-best-learning-management-systems&utm_medium=link , (consulted 11/12/2018).*

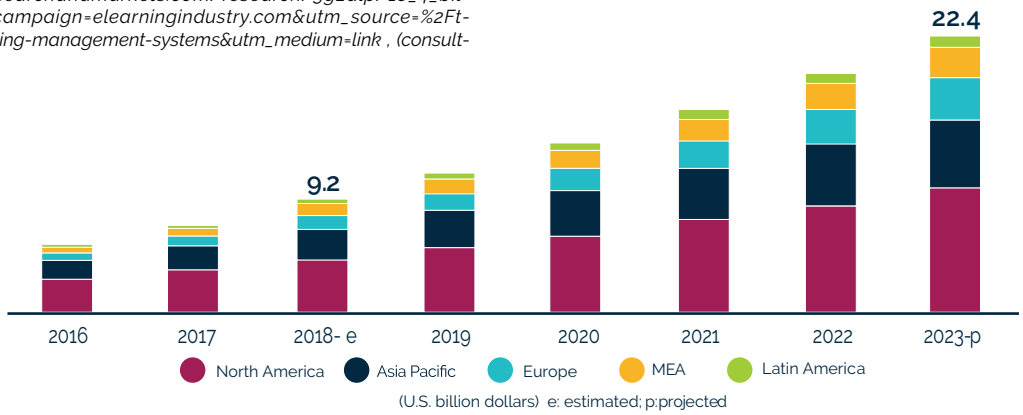


Figure 26. Learning Management System Market, by region (USD billion)

Source:2018. LMS Market by Component (Solution and Services), Delivery Mode (Distance Learning, Instructor-Led Training and Blended Learning), Deployment Type, User Type (Academic and Corporate), and Region - Global Forecast to 2023. Available at https://www.marketsandmarkets.com/Market-Reports/learning-management-systems-market-1266.html?gclid=EAIaIQobChMItKT-ofuI3QIVjcqyCh1PcwdkEAAYASAAEgIfGvD_BwE&utm_campaign=elearningindustry.com&utm_source=%2Fthe-20-best-learning-management-systems&utm_medium=link

Monitoring and Evaluation Systems

A Monitoring and Evaluation System (MES) is created to control the impact that a programmed activity, teaching plan or policy established is able to evidence progress, effectiveness, efficiency, and sustainability. This kind of systems is being developed in order to find the positive features and the issues of the strategies implemented on the education systems, which means it tends to focus on teacher and students performance, providing feedback according to the information collected by the system during its use.

Image retrieved from https://www.vsagar.org/category/online-tests/

MES research has increased in the last decade, as developers continue exploring the features of high technology as AI, that for instance has provided new methods of understanding and recognizing students emotions, and how it affects their performance on learning processes. More specifically, similar work was done by a group of experts that were trying to capture some gestures of the student faces identifying the difficulties they have during the performance[38] (Carvalho et All, 2015).

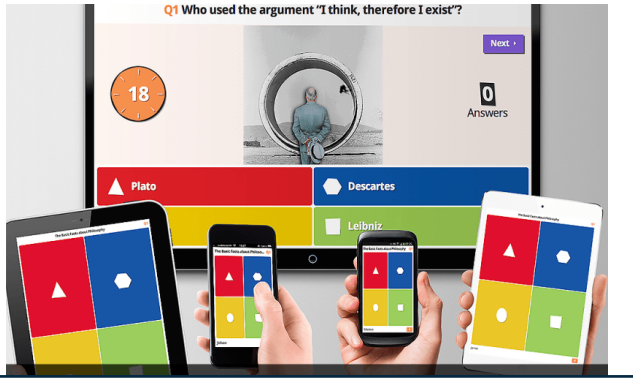


Image retrieved from http://jessejoyner.com/kahoot-a-free-and-easy-platform-with-lots-of-fun-uses-for-learning/

38 *Carvalho,D. et all . 2015. Performance evaluation of gesture-based interaction between different age groups using Fitts' Law. In Proceedings of the XVI International Conference on Human Computer Interaction (Interacción '15). ACM, New York, NY, USA, Article 5, 7 pages. Available at: https://doi.org/10.1145/2829875.2829920 https://dl.acm.org/citation.cfm?id=2829875.2829920 , (consulted 22/12/2018)*

Generally speaking, MES purpose is to provide a higher quality of education by the use of technology as a supportive tool for teachers but also the rest of actors involved in the system, in order to make decisions based on veridical data. However, quality education is an enormous concept that required a variety of disciplines to be connected and strategically situated to achieve the desired objective, then is necessary to *"take into account the quality aspects on input (human, material, and financial), process (teachinglearning and effective management practices), and outputs and outcomes (the learning outcomes and quality of results)"*[39] (UNESCO, 2016). Consequently, a monitoring process has different typology according to the inputs, outputs and processes immerse (figure 27), and parallel is usually to find some of these components inside an MES (figure 28).

39 *UNESCO, 2016. Designing effective monitoring and evaluation of education systems for 2030: A global synthesis of policies and practices. Preliminary version. Available at http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/pdf/me-report.pdf , (consulted 22/12/2018).*

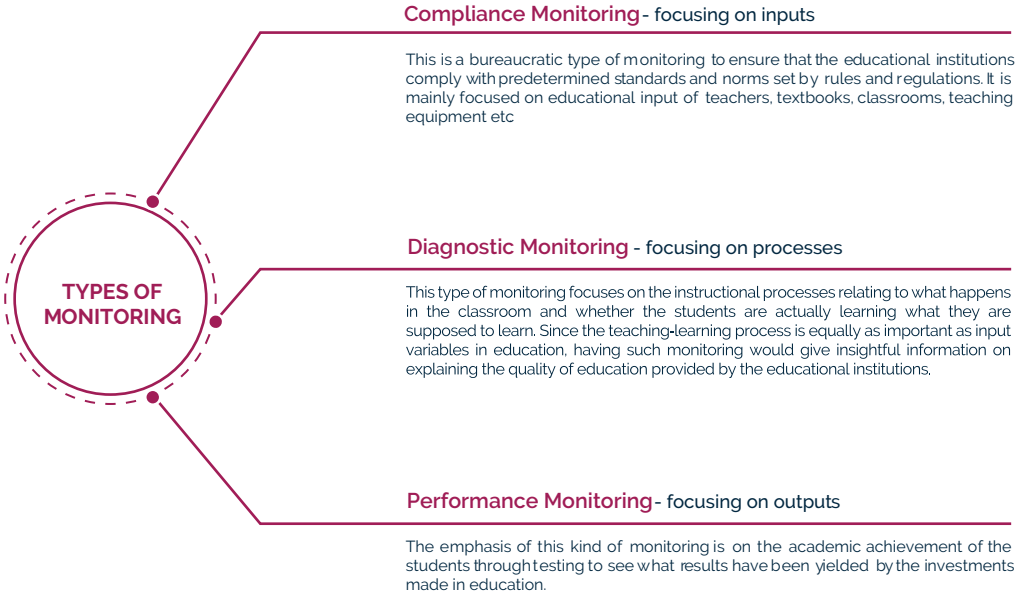


Figure 27. Types of monitoring on education systems.

Source: adapted from UNESCO, 2016. Designing effective monitoring and evaluation of education systems for 2030: A global synthesis of policies and practices. Preliminary version. Available at http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/pdf/me-report.pdf

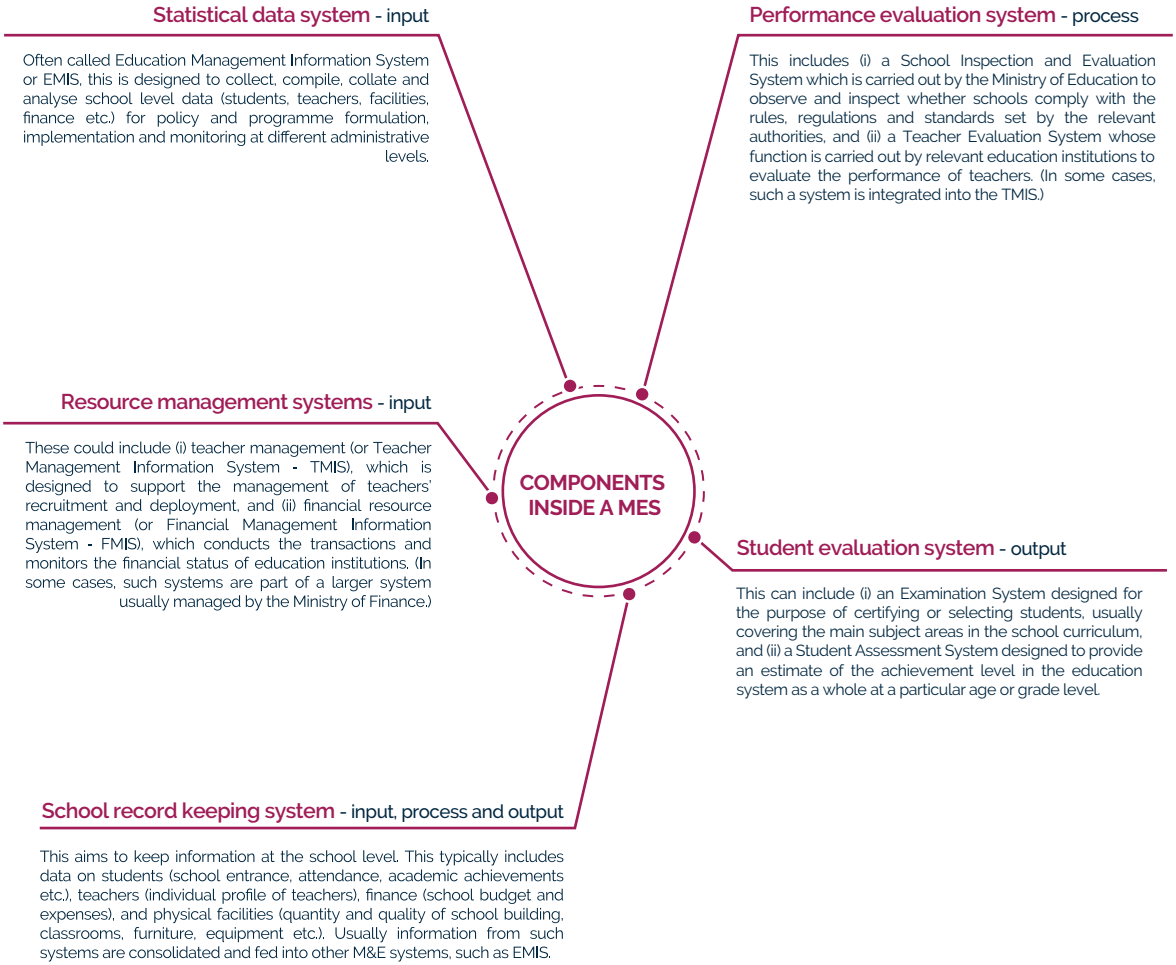


Figure 28. Components of Monitoring and Evaluation Systems (MES)

Source: adapted from UNESCO, 2016. Designing effective monitoring and evaluation of education systems for 2030: A global synthesis of policies and practices. Preliminary version. Available at http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/pdf/me-report.pdf

Communication Systems

Communication Systems (CS) are considered tools that allow and facilitate the connection between the different actors inside an education system (students, teachers, parents, institution manager, etc). This way is possible to construct a network between the parts in order to improve, assist and optimize the experience of teaching and learning. Usually, this system provides updated information, events, new ideas and impulse the creativity of the students through sharing with other students or professors, and some other features.

Likewise, on EdTech for CS is popular the use of channels of communication such as district and institution website, mobile apps, notifications and alerts, email, social media and video. Each of these channels has and provide a different type of information according to its complexity and the capacity of the channel itself (figure 29). For example, is not the same sort of contents when the actors interact through an institution platform than the use of websites like Twiducate (image), because on the first one usually the student and the teacher can share some work, contents and evaluation scores, while on Twiducate permit a more personal experience between them, constructing the courses online as well.

Type of Information	Website	Mobile App
Emergency alerts	✓	✓
Public relations	✓	
Event promotion	✓	✓
Special announcement	✓	✓
Important reminders	✓	✓
Forms / documents	✓	
Campaigns	✓	
PTO information	✓	

Figure 29. School communication channels vs type of information
Source: Williams, S. 2015. 6 Key School Communication Channels and How to Use Them. https://www.ca

Notification & Alerts	Email	Social Media	Video
✓	✓	✓	
		✓	✓
	✓	✓	✓
	✓	✓	✓
✓	✓	✓	
	✓		
	✓	✓	✓
	✓	✓	

mpussuite.com/blog/6-key-school-communication-channels-and-how-to-use-them

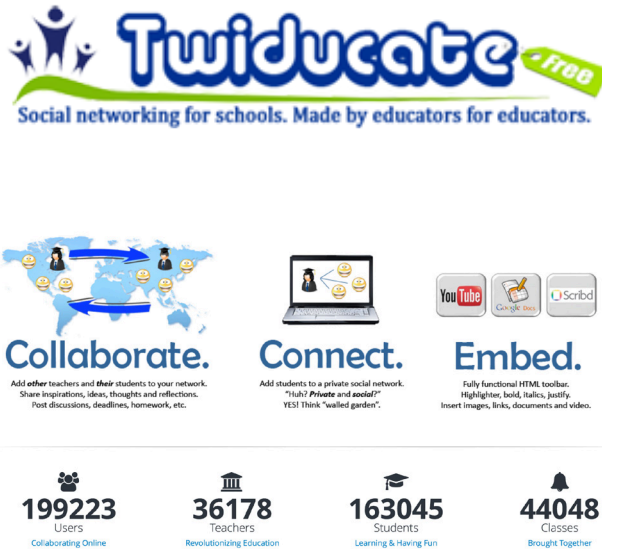


Image retrieved from https://www.livelingua.com/twiducate/

Artificial intelligence on education

AI technology has been explored and applied in a variety of industries to progress in term of data and information management, its collection and process to create more efficient systems inside machinery, services, products, and production processes.

From this perspective, the education industry is also immersed on those who are implementing the power of AI as a computer system looking to achieve benefits on the teaching and learning processes in order to improve the quality of the education systems. Particularly, AI can modify educational resources, providing supportive tools to educators, connecting students and teachers all over the world, getting better solutions to people with some special difficulties; all of these through the construction of intelligent platforms and the ability of mixing realities that enable the users to experience the things around them in ways that was not even thinkable before.

Consequently, a large variety of research and studies on this field has established some benefits of using AI technology on EdTech, however, it has not been clear what are the limits of the technology and even if is a powerful processor of information and a technology able to learn, it cannot be put at the same level as the human intelligence. For this reason, the inclusion of AI in education need to be accompanied by the right establishment of functions that it is capable of developing and the big difference between providing information and constructing knowledge. In other words, developers of AI on education need to clarify the role of the technology as a supportive tool not as a replacing element of teachers role in learning environments, because is them who necessarily need to be behind the technology in order to achieve valuable results on the process of learning of the students.

Therefore, the key element to keep in mind with the introduction of this new technology on education, is the challenge that the teachers must face and, as the technology might help with some of their work at the same is going to test and ask for an intensification of their role as tutors and as drivers for the construction of knowledge and critical thinking of students, based on the recognition of the environment and the elements that move around them, which can only be recognized under their own experiences as human beings through social interaction and personal analysis.

On the other hand, is not a secret that behind every industry there is a group of people trying to reach a profit or a monetary benefit from the development of this type of technology. Which means, the idea of AI can be sold to governments or institutions leaders as the solution for reducing the human capital (teachers). For this reason, and from the ethical point of view, developers need to recognize, design and share the right information about AI, because in the majority of the studies taken into account for this thesis, developers tend to focus on the features of the technology but forget about the most important element of the design of a product, the user requirements, profile, and its value on the project, in other words looking to obtain a human-centered approach. Hence, *"it is certainly true that we need to engage a more diverse population in acquiring the skills to design and develop the future of our artificial intelligence"*[40] (Luckin R, 2018).

From this context, professor Rosemary Luckin (2017) introduce two dimensions from where AI should be addressed from the education point of view (figure 30) and based on the following questions:

i. How can AI improve education and help us to address some of the big challenges we faced?

ii. How do we educate people about AI so that they can benefit from it?

This way, throughout this section it will be presented information related with the concept, characteristics, limits and significant examples of the application of AI technology on education in order to construct a scenario of what is AI, and where should it go to the future education.

Artificial Intelligence Concept

In order to understand the concept of AI it is necessary to identify firstly when it was born and a short overview of its evolution. The first time the term "Artificial Intelligence" was used and recognized by the science was in 1969 at the first International Joint Conference on Computer Science which took place in the capital city of Washington[41] (Alla A. et All. 2015). Since then, some authors started to explore and propose their theories around it, such as the concept of "Singularity" that refers to an artificial super-intelligence with a terrific power to process and self-improvement ability willing to change human civilization as it is been known

40 *Ibid 4*

41 *Alla A. et All. 2015. Knowledge in Artificial Intelligence Systems: Searching the Strategies for Application. Procedia - Social and Behavioral Sciences. Volume 166. Pages 589-594. ISSN 1877-0428. Available at https://doi.org/10.1016/j.sbspro.2014.12.578. (http://www.sciencedirect.com/science/article/pii/S1877042814067160) , (consulted 2/12/2018)*

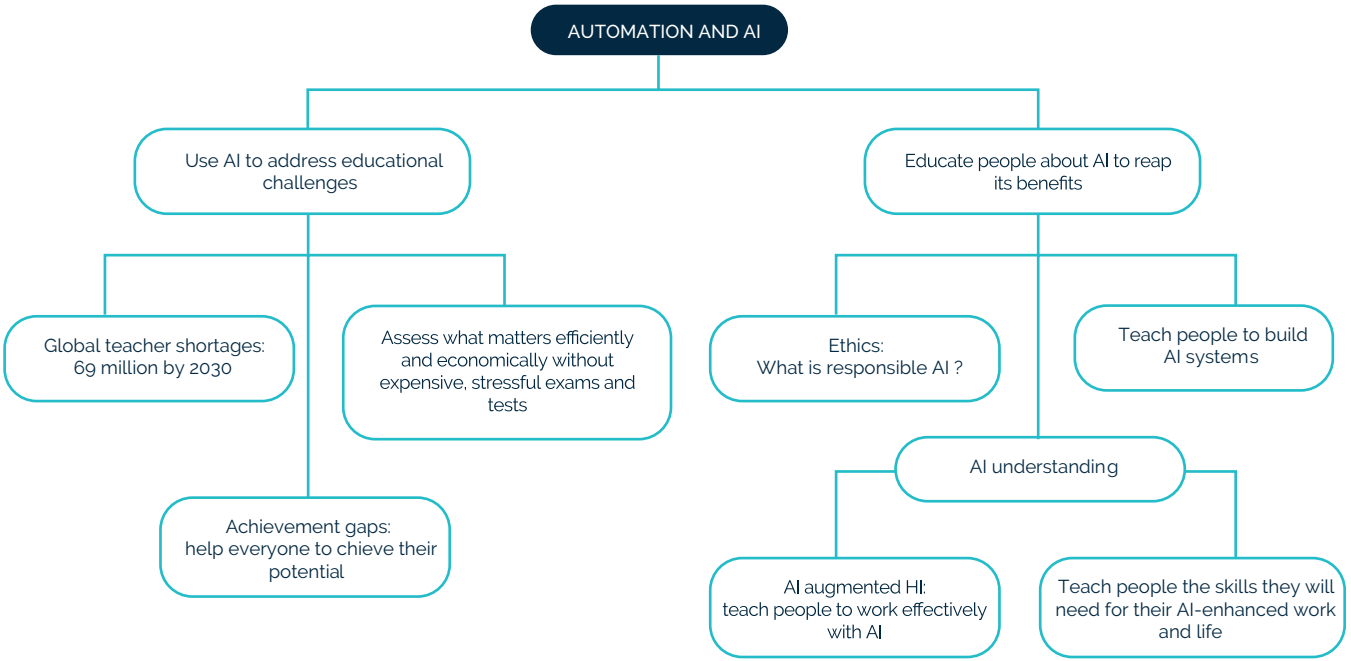


Figure 30. The AI and education knowledge tree with its two dimensions

Source: Luckin, R. 2017. The implications of artificial intelligence for teachers and schooling. In Loble, L., Creenaline, T. and Hayes, J.(eds) Future Frontiers: Education for an AI world. Carlton, Victoria: Melbourne University Press and New South Wales Department of Education, 109-26.

so far. As a matter of fact, some authors believe that *"this process would capture a person's entire personality, memory, skills, and history"*[42] (Ray Kurzweil, 2005). As a result, according to professor Luckin Rosemary (2018), AI gains power on the current century due to the access to a large amount of information, the power developed of computer processing and the big number of clouds either for raw and processed data that is available almost anywhere[43].

As mentioned before, there are a variety of authors who tend to construct the meaning of AI, but I found two interesting concepts that can complement each other in order to obtain a general view of the term.

42 *Ray Kurzweil, The Singularity is Near: When Humans Transcend Biology, New York, Penguin 2005, ISBN 978-0-14-303788-0.*

43 *Ibid 4.*

Then, AI can be recognized as:

> i. a computational method that attempts to mimic, in a very simplistic way, the human cognition capability so as to solve engineering problems that have defied solution using conventional computational techniques[44] (Flood, 2008)

That ...

> ii. interprets the expert knowledge as a combination of theoretical understanding of the problem and a set of heuristic rules to solve it – the rules, the effectiveness of which is evident in a particular domain.[45] (Alla et All. 2015)

44 *Flood, I., 2008. Towards the next generation of artificial neural networks for civil engineering. Advanced Engineering Informatics 22 (1), 4e14.*
45 *Ibid 41.*

In general and superficial terms, an AI system works based on the inputs it receives (data), a cyclic process of learning and improvement, and the selection of the most appropriate content to solve the problem requested (figure 31).

Some of the common inconveniences that AI still working on is the knowledge representation, that mainly refers to the language the system use looking to communicate as similar as possible to human responses; and on the other hand, the searching process that basically focuses on the rule plan construct to solve the problem. This is one of the reasons why there is not a generic path of AI, every system tend to specialize on a specific topic, as each has its own rules structure.

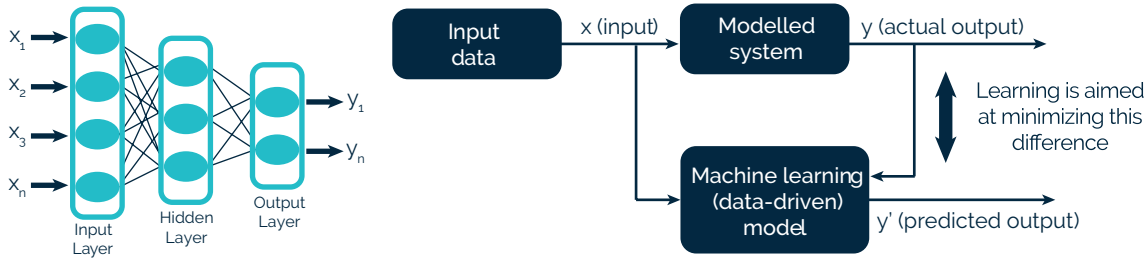


Figure 31. AI System general process structure

Source: Mohamed A. Shahin. 2016. State-of-the-art review of some artificial intelligence applications in pile foundations. Geoscience Frontiers. Volume 7, Issue 1. Pages 33-44. ISSN 1674-9871.. Available at https://doi.org/10.1016/j.gsf.2014.10.002. (http://www.sciencedirect.com/science/article/pii/S1674987114001327)

Artificial Intelligence vs Human Intelligence

For this reason, and in context with the thesis topic, it has been taken a reference on the professor and president of the International Society for Artificial Intelligence and Education, Rosemary Luckin, whose work is based on understanding the essential values of human intelligence above AI technologies purposes. In other words, her research is to put in evidence all the elements that characterize human intelligence capacity and where is the real implementation of AI in the education field.

Based on the contents of the section "Education Concepts", the author constructs her theory on what is called "Interwoven Intelligence", composed of 7 components that describe the way the human brain works. Due to this analysis of the skills and knowledge required for each of them is possible to recognize that AI systems are not at an equal level as human intelligence. Nevertheless, it is clear that this technology is and will continue transforming human civilizations, which only means it is highly requested to challenge the human intelligence potential in order to maintain a positive perspective of the benefits it can bring, avoiding to refer about AI in the same terms as human intelligence. Parallel, Luckin specify some of the elements that AI still missing to be compared and similarly treated as human intelligence (figure 32).

Therefore, either developers, designers, actors involved in the education system and especially users (teachers and students) need to recognize the potential of AI technologies but also have clear their limits in order to understand their role for its performance and the objectives of its implementation on teaching and learning environments. Consequently, the components that have to be included on AI applications are *"teaching people about how to work effectively with AI systems; giving people a voice in what AI should and should not be designed to do; and helping some people to build the next generation of AI systems"*[46] (Luckin , R. 2018).

46 *Ibid 4*

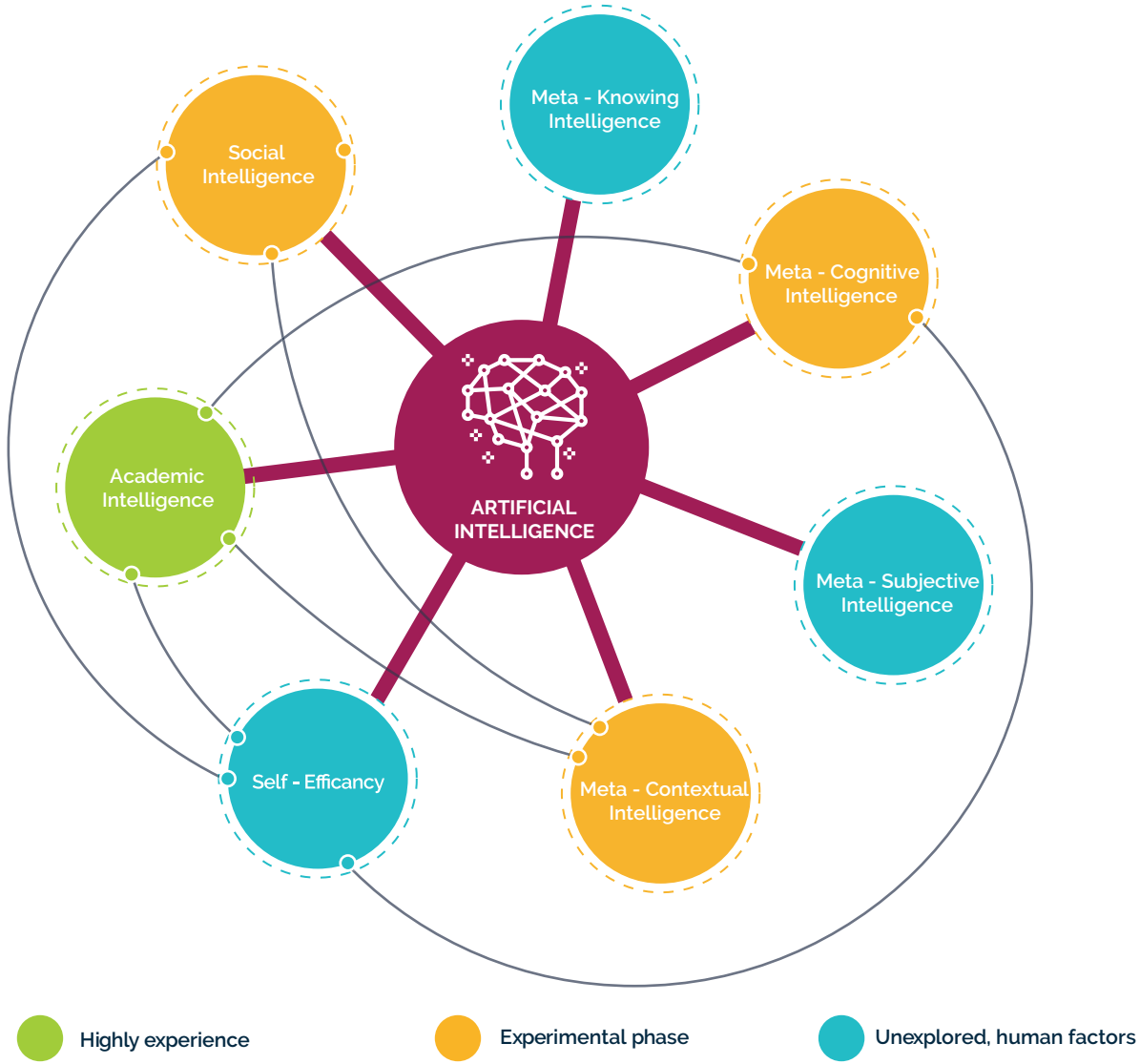


Figure 32. Artificial Intelligence Systems connection according to the theory of Human Interwoven Intelligence

Source: created based on Luckin Rosemary. 2018. Machine learning and human intelligence: the future of education for the 21st century. UCL Institute of Education Press, University College London.

Intelligent Tutoring Systems (ITS)

This is a term commonly known on the literature related to applications of AI systems on EdTech. Starting from a general point of view, an Intelligent Tutoring System (ITS) is an *"interdisciplinary field that investigates how to devise educational systems that provide instruction tailored to the needs of individual learners, as many good teachers do"*[47] (S.D. Schoksey. 2004) In other terms, ITS is a computing technological instrument which purpose is to provide an individualized learning experience to the student. During the years, ITS has been studying some relevant characteristics needed to increase the quality of the service, as the value of communication on user's interaction with the system, mostly through conversational dialogue technologies, or the denominated Chat-bots (influenced by Artificial Intelligence systems).

Usually, an ITS includes four main components that interact during its performance to achieve the desired result, their connection can be evidenced on the figures 33 and 34. Likewise on figure # is possible to observe the general structure of an ITS, which allow us to recognize the specific moment where the user is situated and the interactions of the elements when the input goes inside the system, processing the information and providing an output to the user as well.

47 *S.D. Schoksey. Intelligent tutoring systems: New challenges and directions. Master's Thesis. Worcester Polytechnic Institute., 2004*

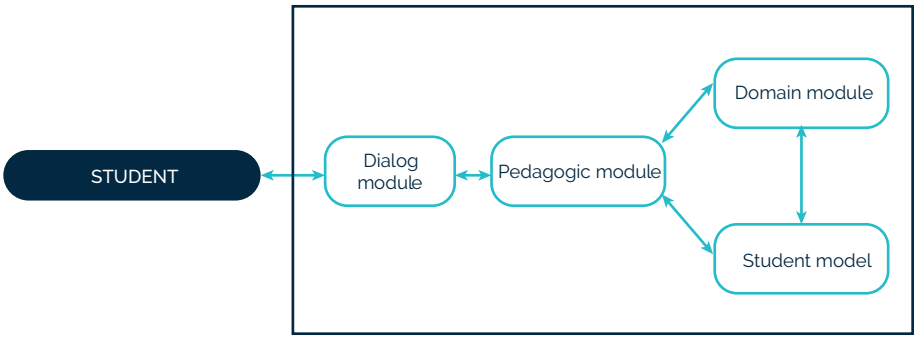


Figure 33. Main components of an Intelligent Tutoring System (ITS)

Source: H. Escudero ; R. Fuentes. 2010. Exchanging courses between different Intelligent Tutoring Systems: A generic course generation authoring tool. Knowledge-Based Systems 23 pp.864–874. ELSEVIER. Available at . https://www.journals.elsevier.com/knowledge-based-systems

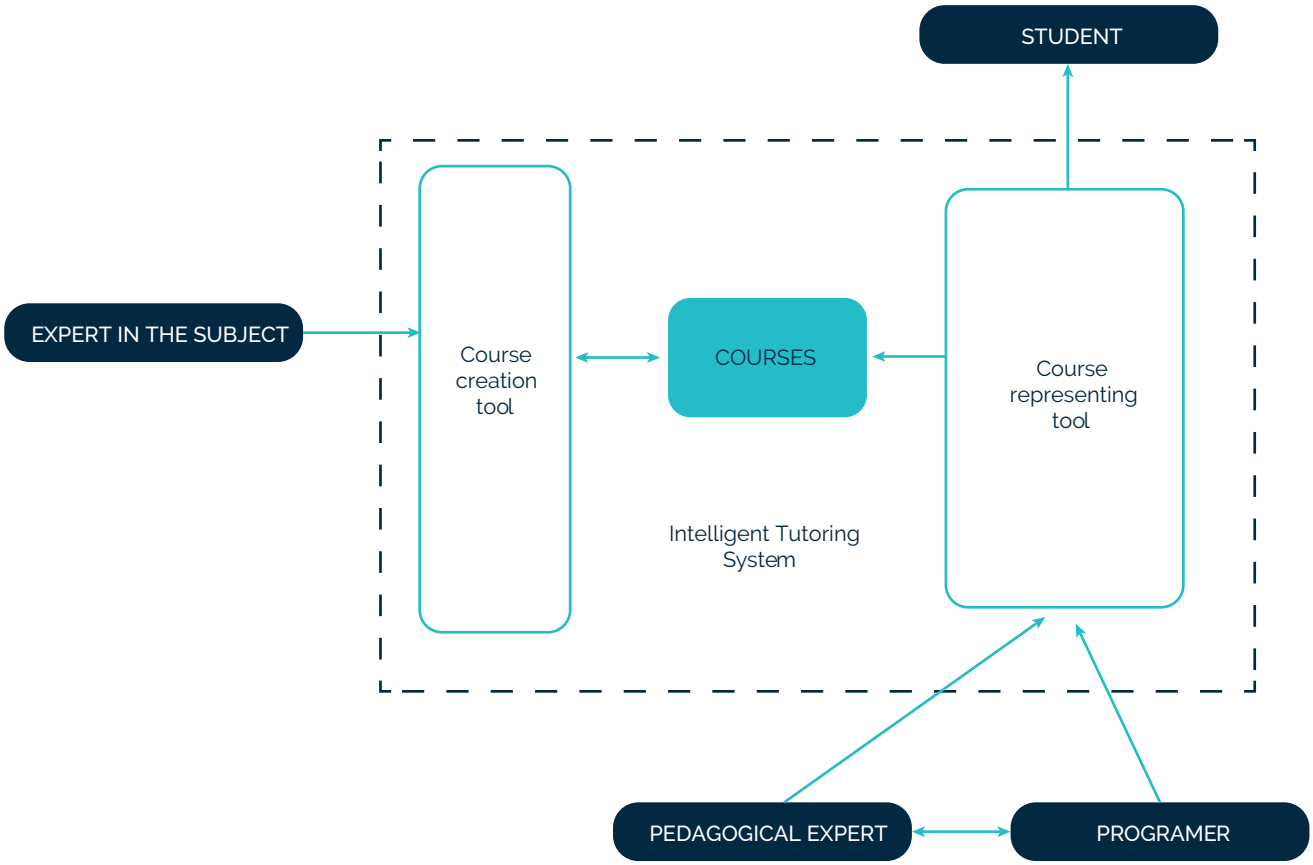


Figure 34. The general structure of the Intelligent Tutoring System (ITS)

Source: H. Escudero ; R. Fuentes. 2010. Exchanging courses between different Intelligent Tutoring Systems: A generic course generation authoring tool. Knowledge-Based Systems 23 pp.864–874. ELSEVIER. Available at . https://www.journals.elsevier.com/knowledge-based-systems

Content-Oriented Learning Systems

The term of Content-Oriented Learning Systems (COLA), borns on experimental research from a team of students, professors of Politecnico di Torino and Politecnico di Milano, besides the support of experts on AI technology from IBM Milan. This type of system was created to *"build learning conversations using modern AI approaches based on a good and well-organized body of content"*[48] (Akcora, E et All. 2018) and the guidelines of the project are the ones evidenced on the figure 35. The experiment was done with the contents of the course of 8th grade of school in mathematics.

48 *Akcora, E et All, 2018. CHECK: CHatbot in Education and Cultural Knowledge acquisition. Multidisciplinary project report. Alta Scuola Politecnica. Pp38- 47*

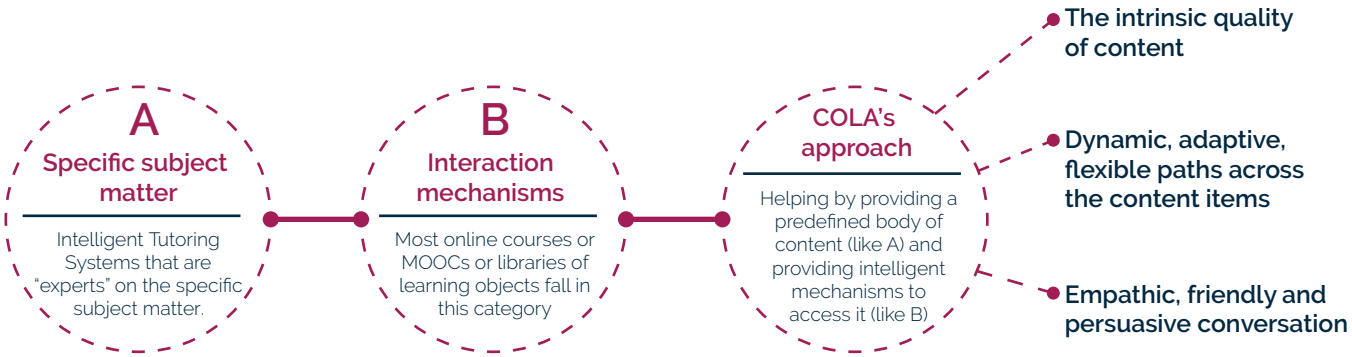


Figure 35. Main directions for an application supporting learning, COLA system.

Source: Akcora, E; Belli, A; Berardi, M; Casola, S; Di Blas, N; Falletta, S; Faraotti, A; Lodi, L; Nossa, D; Paolini, P; Renzi, F; and Vannella, F. 2018.Conversational support for education. In Artificial Intelligence in Education - 19th International Conference, AIED 2018, London, UK, June 27-30, 2018, Proceedings, Part II, pages 14–19, 2018. doi: 10.1007/978-3-319-93846-2_3. URL https://doi.org/10.1007/ 978-3-319-93846-2_3.

The architecture that structure the functional system is composed of different elements from the exterior (interface) and the intern system that allows the conversational experience with the user and the right response from it. (figure 36). However, during the process, there were some technical issues and limits from the technology that required the use of AI features to train the system to overcome those inconveniences and be ready to face the user interaction.

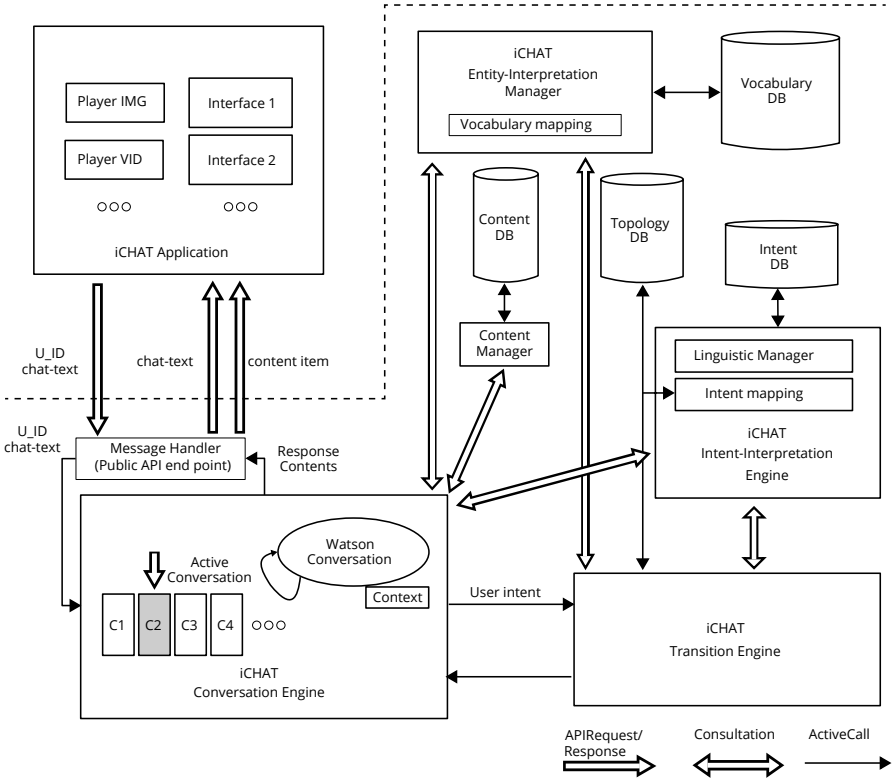


Figure 36. iCHAT's conversation manager architecture

Source: Akcora, E; Belli, A; Berardi, M; Casola, S; Di Blas, N; Falletta, S; Faraotti, A; Lodi, L; Nossa, D; Paolini, P; Renzi, F; and Vannella, F. 2018. CHECK: CHatbot in Education and Cultural Knowledge acquisition. Multidisciplinary project report. Alta Scuola Politecnica. Pp 37-39

From a different perspective, this system remains on a first stage in which there are a big amount of problems to solve, but what seems to be more critical on the methodology implemented is the reduce analysis of the user and his participation on the design process. Most of the failures and missing components founded on the system are related to the interaction of both users with the technology, as it is not clear and designed for the user but is entirely develop from an engineer to an engineer. In other words, is basically requesting the user to learn the complexity side of the technology, which probably is not going to happen because the tool should be constructed to facilitate the user work, not to complicate it even more (figure 37). In summary, even if the project did not have the chance to achieve a higher design of the interface part, the user is an element that needs to be part of the project from the begging, that way is easier to identify the real requirements for the system to be designed.

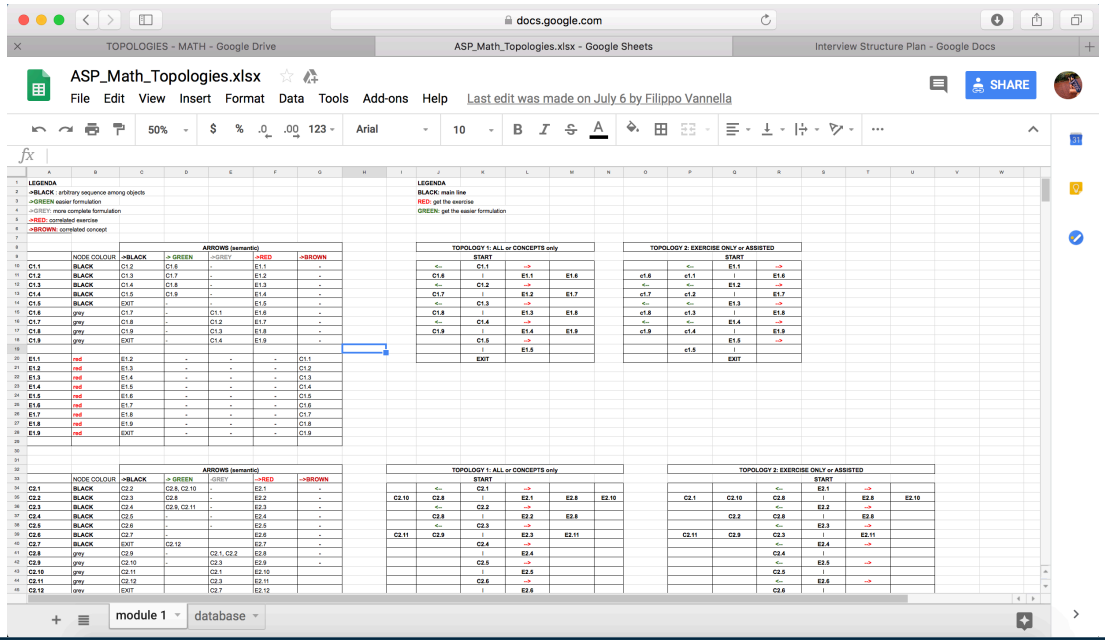
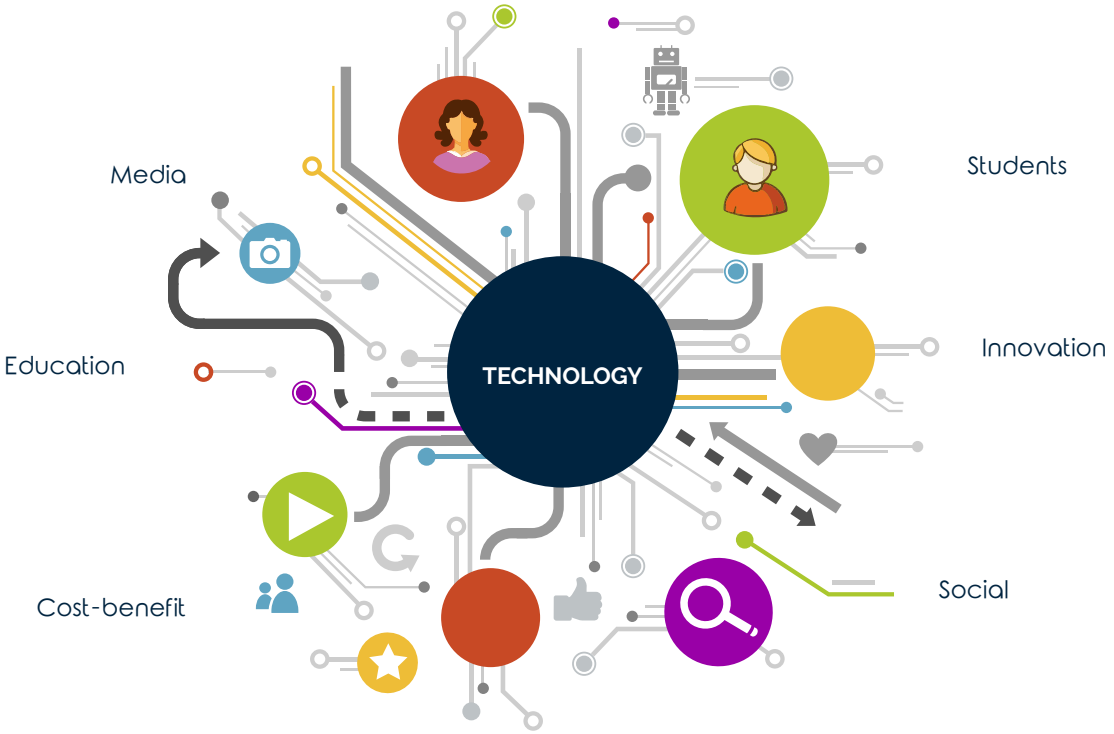


Figure 37. Interface of COLA system for teachers.

Source: Akcora, E; Belli, A; Berardi, M; Casola, S; Di Blas, N; Falletta, S; Faraotti, A; Lodi, L; Nossa, D; Paolini, P; Renzi, F; and Vannella, F. 2018. CHECK: CHatbot in Education and Cultural Knowledge acquisition. Multidisciplinary project report. Alta Scuola Politecnica.

Cases of Reference

Regarding all the information exposed about the education from different aspects, this thesis conducted the research on cases of reference which were able to give an idea of possible solution related to impulse employees motivation, technology support in education, and innovation boosters from an open perspective. In other words, in this section will be shown examples of projects and companies from the education industry but also from other industries that are working and developing services with similar purposes of this thesis project. In addition, some of these cases include the implementation of AI systems in order to evidence as well how iconic companies are introducing this technology to the market.



General cases of reference

Qmarkets

Noam Danon, the Founder & CEO
Rosh Haayin, Center District of Israel. 2006
https://www.qmarkets.net/company/about-qmarkets/

Qmarkets is an idea management platform that consists of software designed to assist companies or organizations to supervise and organize the innovative ideas of the members that work on it. This platform is based on the concept of "cooperative intelligence", which means that the system is able to collect the ideas and filter them smartly in order to obtain a coherent combination of future solutions and innovation inside the companies. In addition, the software provides also an analysis of those innovations from the point of view of different departments (marketing, production, financial) to identify its feasibility.

- ✓ Motivate and challenge the employees
- ✓ Open platform that connects various stakeholders.
- ✓ Smart management of the ideas (AI systems)
- ✓ Connect professionals from different backgrounds

- ✗ Does not provide incentives to the employees
- ✗ Is not a personalized experience

Qmarkets
Collective intelligence solutions

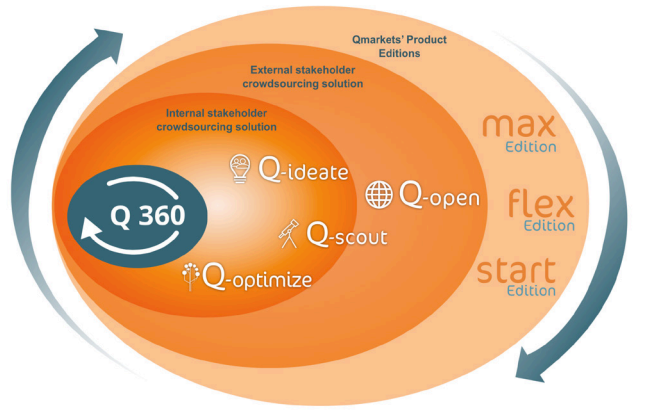


Image retrieved from https://www.capterra.com/p/83531/Ideation-2-0/

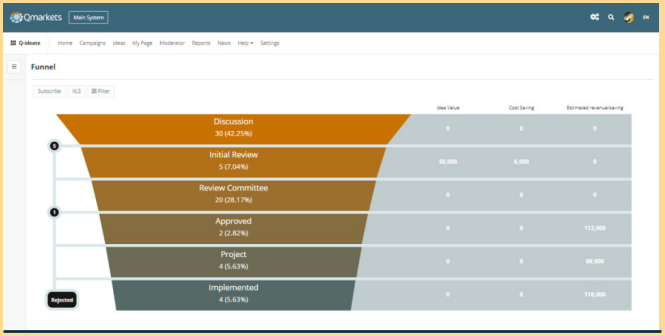


Image retrieved from https://www.capterra.com/p/83531/Ideation-2-0/

The knowledge arcade

Growth Engineering
Windsor, UK. 2004
https://www.growthengineering.co.uk/knowledge-arcade-learning-app/

The knowledge arcade is a mobile app that furnishes a challenging and dynamic learning environment for employees. Its purpose is to drive a real behavioral change in the workspace through a ludic tool (game-based interaction) that connect the people at work while is also a learning space. The app is composed of cutting-edge commitment technologies and learning methodologies that reinforce individuals hunger of knowledge. This innovative idea increases the intellectual capital inside the companies but especially maintain active and motivated their members.

- ✓ Motivate and challenge the employees
- ✓ Learning interaction for employees
- ✓ Game-based interaction
- ✓ Role game experience (superhero style)

- ✗ Is an app for cell phones
- ✗ Content connection with the office work
- ✗ Companies personalization

Image retrieved from https://www.growthengineering.co.uk/knowledge-arcade-learning-app/

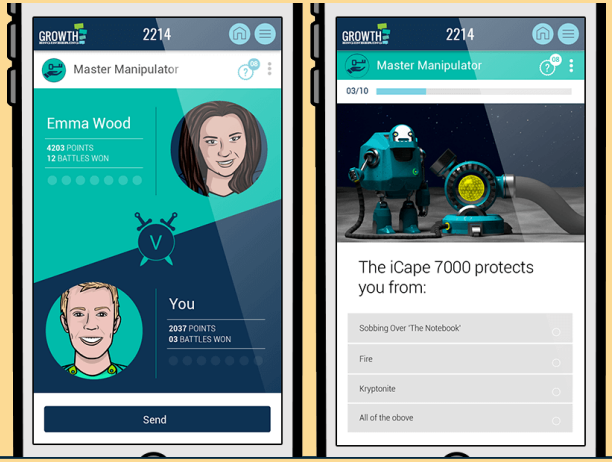


Image retrieved from https://www.growthengineering.co.uk/knowledge-arcade-learning-app/

Vantage Circle

Anjan Pathak and Partha Neog Founders
Delhi, Guwahati, India. 2011
https://www.vantagecircle.com/en/

Vantage circle is a cloud-hosted platform created to attract and retain key employees, keeping them motivated and real-time monitoring report of their work in order to maximize the productivity of the organization's workforce. Some of the features of the platform are shopping discounts to the employees, rewards, and recognition of their hard work transmitted on monetary or prices (travel, vacations), and health and wellness challenges (exercises suggestions).

- ✓ Advice methodology to motivate the employees
- ✓ Incentives from the company
- ✓ Real time data

- ✗ Is an app for cell phones
- ✗ Feedback also for the employees in terms of data
- ✗ There is not a professional gain, is missing an empowering methodology.

Image retrieved from https://www.vantagecircle.com/en/

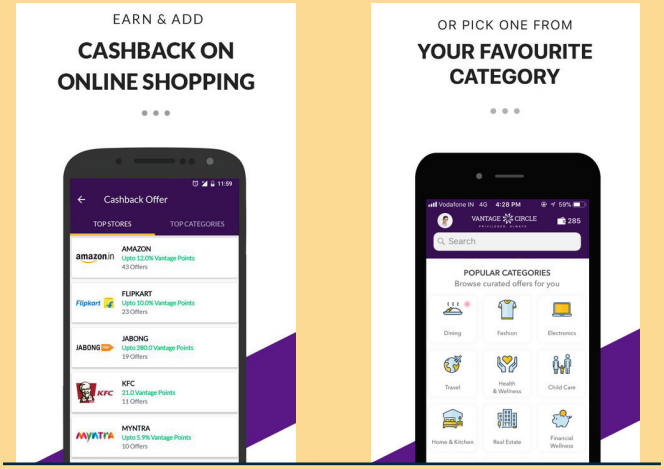


Image retrieved from https://appadvice.com/app/vantage-circle/869311123

Brain Wellness

Neocogita Company. Nicola De Pisapia, chief science officer & founder. Rovereto, Italy. 2012
http://www.neocogita.com/brain-wellness-platform/?lang=en#form-contatto

Brain Wellness is a platform composed of a series of mind training pathways to keep active and improve the collaborator's brain and validated on a neuroscientific basis. The main purpose of this system is to encourage a mental practice on employees and at the same time motivate them through exercises that at the same time release anxiety and some of the pressure present on working environments. Consequently, it provides cognitive training strategies, meditation breaks, and individual & group reports of the results obtained after the pathway. As a result, employees will optimize their efficiency at work and prepare them for decision-making processes inside the company.

- ✓ Improvement of intellectual skills
- ✓ The results can be anonymous
- ✓ Relaxing methods to release stress
- ✓ Neuroscientific strategies

- ✗ Is not a collective experience
- ✗ It does not have a strong incentive to keep using it

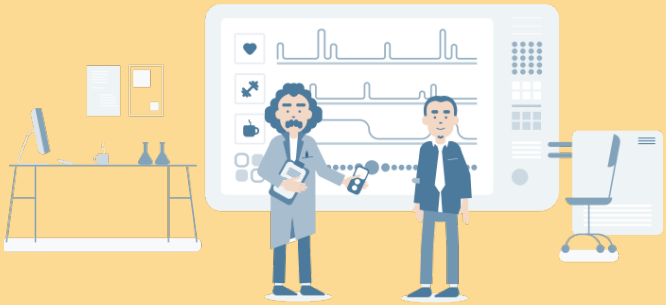


Image retrieved from http://www.neocogita.com/?lang=en

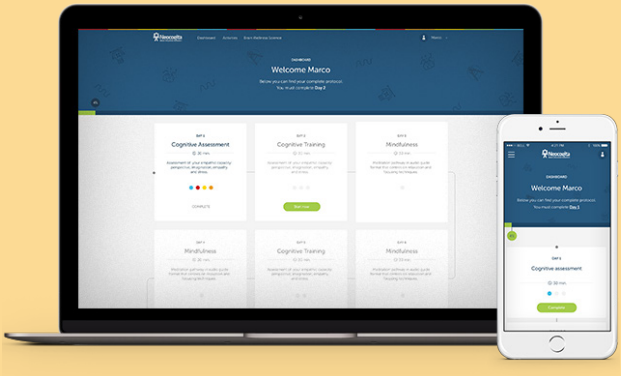


Image retrieved from http://www.neocogita.com/brain-wellness-platform/?lang=en

Cases of references on the education field

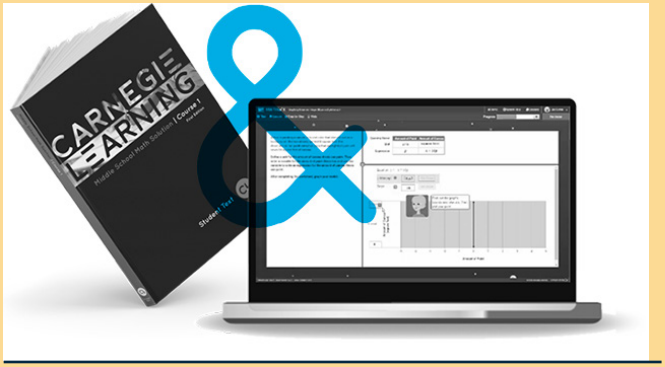
Carnegie Learning

Apollo Education Group
Pittsburgh, USA. 2015
https://www.carnegielearning.com/services/

Carnegie Learning is a company that offers a variety of services (workshops, professional advice) and products (textbooks, software) focus on the transformation of math classrooms, exploring and getting better solutions for teachers and students. They offer a complete program that combines both sides of their company. It has a plan of workshops to train teachers and allow them to connect with other experts in the field to improve their methodologies on the classroom. On the other hand, the software is equipped with personalized and constructive guidance (AI technology), a package of assignments and a cognitive designed interface that allows an easy and flexible experience of interaction.

- ✓ Human & technology interaction
- ✓ Services to improve the teachers' performance

- ✗ Does not include the value of the teacher to the software assistant's improvement
- ✗ Is missing a motivation strategy for the teachers



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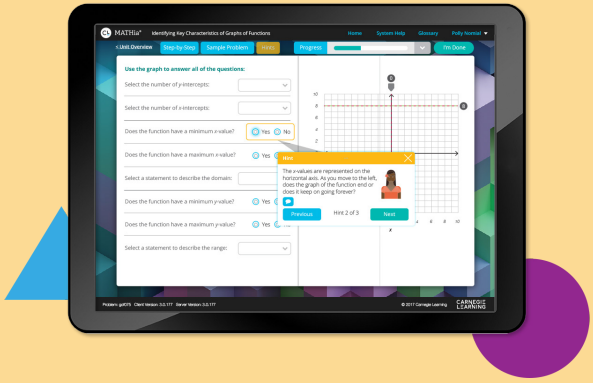


Image retrieved from https://www.carnegielearning.com/products/software-platform/mathia-learning-software/

InsertLearning

Matt Nupen and Karin Hogen
Minnesota, USA. 2014
https://insertlearning.com

InsertLearning is a platform designed to allow teachers the possibility of interacting with the students adding instructional content (questions, discussions, in-depth information) into any website through the use of a browser plug-in. It changes the way a traditional classroom works and empower teachers to challenge themselves and create new strategies to improve the critical thinking processes of their students. As it is connected with OpenStax and Google, the platform allows access to an accurate search engine that provides a high quality of information. This is an instrument created by teachers for teachers and students needs.

- A tool created by teachers for teachers
- Empower teachers role of critical thinking boosters
- Live interaction with the students
- Challenge teachers to amplify the contents of their lectures

- Teachers need to spend more time of research
- The number of students that can use it at the time

Image retrieved from https://hiltoncadettech.blogspot.com/2018/01/insert-learning-from-your-dreams-into.html

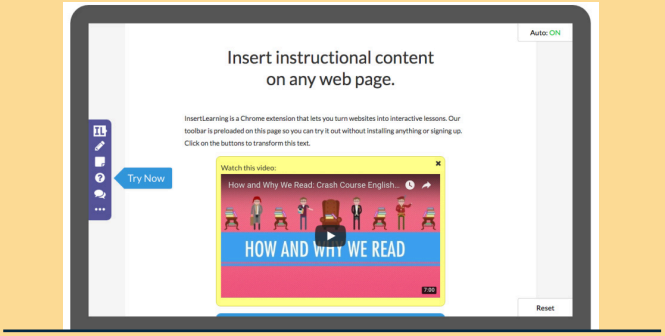


Image retrieved from https://stimeeducator.wordpress.com/2018/04/15/insertlearning-week-9/

Khan Academy

Salman Khan
Mountain View, USA. 2008
https://www.khanacademy.org

Khan Academy is a non-profit educational organization that provides a set of online contents to help students on their learning processes in different subjects of elementary school. The website includes a group of videos with lessons of diverse topics, practice exercises and specific material for educators. It is available in approximately 13 languages including English and Italian. In terms of interaction design, the webpage has an interface for teachers and another one for students, then the user experience designed for each one has its own functions and features based on their needs. It supports teachers lessons but also allows them to complement their courses' content.

- ✓ Founded from a personal teaching experience
- ✓ Open source
- ✓ Far-reaching countries and variety of languages
- ✓ Community and public stakeholders network
- ✓ It includes a teachers manual of instructions (set of videos)

- ✗ Does not impulse critical thinking exercises

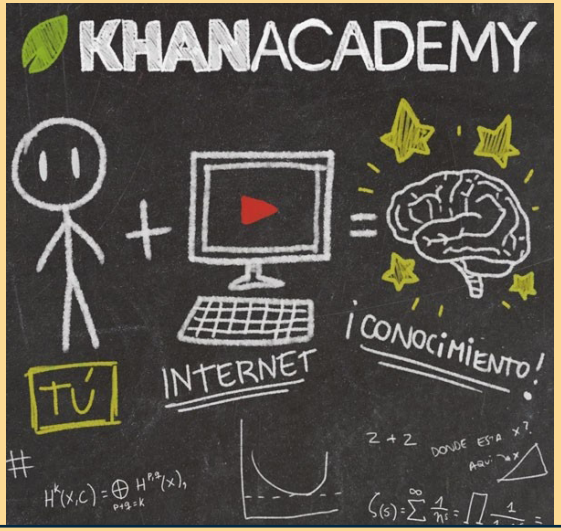


Image retrieved from https://www.eldefinido.cl/actualidad/mundo/310/Khan_Academy_Educacion_gratuita_y_de_calidad_en_tu_casa./

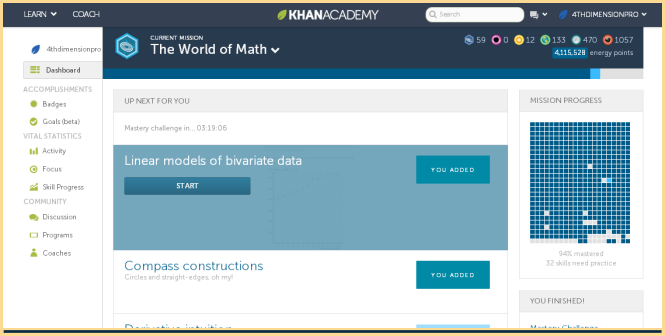


Image retrieved from http://khanacademy.wikia.com/wiki/Learning_Dashboard

Teacher Advisor with Watson

IBM International Foundation
USA. 2017
https://teacheradvisor.org/landing/

Teacher Advisor with Watson is a non-profit and open web-based instruction planning tool created by teachers for teachers. This advisor system includes Watson technology (AI system developed by the IBM) with the purpose of saving time for educators on the creation and structuring process of their courses based on vetted content. It is equipped with a series of videos of teaching advice, lesson plans and teaching strategies that educators can apply in their classrooms. It is one of the reduced numbers of ideas with an approach to improving teachers skills directly on their labor.

- ✓ Set of tools to improve teachers' skills as tutors
- ✓ Accurate verify contents by Watson system
- ✓ Open source
- ✓ Teachers network all over the world

- ✗ Linear and limited interactive features
- ✗ Limit critical thinking skills of teachers
- ✗ Non instructed information about AI of Watson

Image retrieved from https://teacheradvisor.org/landing/

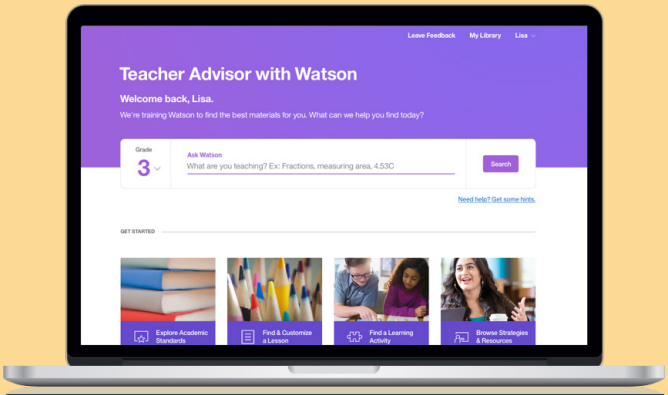


Image retrieved from https://teacheradvisor.org/landing/

SmartED

Netex founded by Carlos Ezquerro and Joserra Mosteiro
Madrid, Spain. 2013
https://www.netexlearning.com/en/smarted/

SmartED is a platform which purpose is to create digital classroom-oriented solutions to enhance and reinforce educators and learners on teaching and learning processes. It is capable of providing data-driven business decisions with AI features, templates and suggestions for planning strategies of the courses, access to wisely selected contents created by experts on educational innovation and an integrated cloud that contain and distribute effectively the information. Then, the main concepts behind SmartED idea are integrated authoring (customizing content), gamification (raise levels instead of pass exams), adaptivity (personalized teaching), learning analytics and real-time collaboration.

- ✓ Customizable
- ✓ Data-driven business decisions
- ✓ Gamification strategies

- ✗ Limit critical thinking methodologies
- ✗ Support but does not challenge teachers to improve their performance intellectually

Image retrieved from https://www.slideshare.net/NetexLearning/netex-smarted-catalogue-4q2017-en

Image retrieved from https://www.netexlearning.com/en/smarted/

Cognii

Dee Kanejiya, founder and CEO
Boston, USA. 2013
http://www.cognii.com

Cognii is a company that provides software of AI-based educational technologies. One of their main products is a Conversational Virtual Learning Assistant with the ability to tutor students and giving instant assessment according to every student path of learning. The ITS of the conversational feature is established by two main components: a Natural Language Processing algorithms that through machine learning processes improve the vocabulary getting closer to the way a real teacher communicates with their students; and cognitive computing that reach the appropriate level of content needed.

- ✓ Human conversational features

- ✗ Limit critical thinking skills of teachers
- ✗ Non instructed information about A
- ✗ Linear and limited interactive features
- ✗ Non innovative UI experience

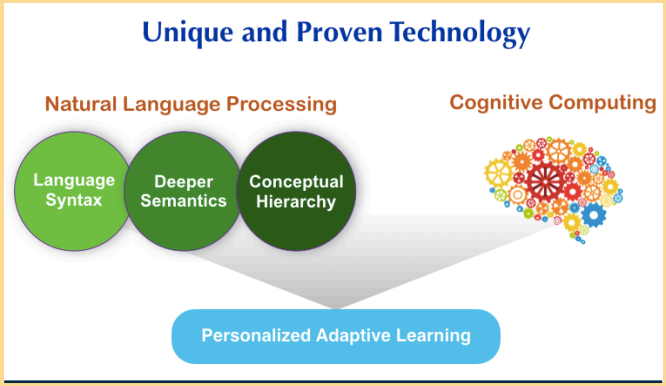


Image retrieved from http://www.cognii.com/technology

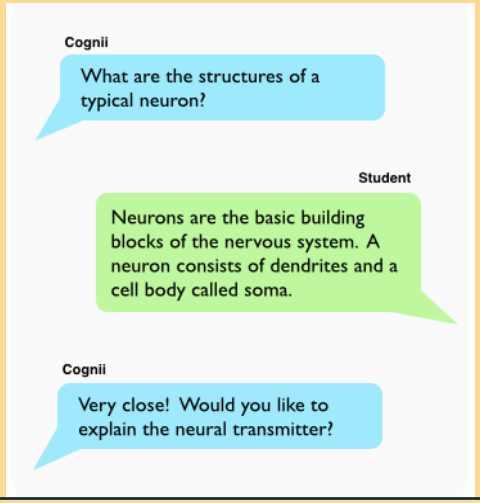


Image retrieved from http://www.cognii.com/technology

Photo by rawpixel on Unsplash

BACKGROUND INFORMATION

DESIGN APPROACH ON EDUCATION

In this section, there are some concepts around the discipline of Design that are relevant to the project in terms of ideology, methodologies implemented, and tools for solving complex problems. Nowadays, designers are being involved in projects from all kind of industries, due to their ability in analyzing the problem from various scenarios and a multi-disciplinary perspective. This way, the incorporation of design thinkers on education studies is fundamental, as they become the bridge that connects the technical, psychological, ethical, economic, and all other disciplines involved in the corresponding situation.

Therefore, in terms of innovation and in relation with the discussion of disruptive technologies impact on education systems, designers have the responsibility of creating connections between the actors and the tools but also mediating through an efficient communication that *"must ensure the spread of morally correct practices from which will emerge a correct behavior, conscious of the fact that spreading such a technology would lead to great results for all the community"*[49] (Valpreda, F et All. 2015.) (Figure 38).

49 *Valpreda, F; Novakovic, A; Regis, M. 2015. Re-futuring: Awareness and design process in hyper-technologic era. Strategic Design Research Journal, 8(1):15-20.*

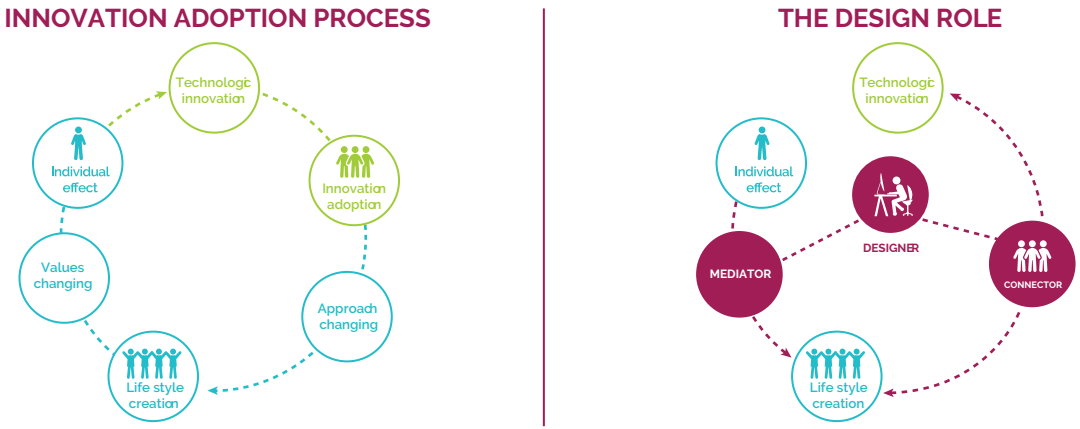


Figure 38. The process scenario and the role of the designer within the net of subjects involved.
Source: original image by Novakovic, A and Regis, M. Taken from Valpreda, F; et All, 2015. Re-futuring: Awareness and design process in hyper-technologic era. Strategic Design Research Journal, 8(1):15-20.

Design concepts applied

Systemic Design

Systemic Design is an example of applied strategies of what is cataloged as Systemic Thinking, *"a set of synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviors, and devising modifications to them in order to produce desired effects"*[50] (Ross D. et All 2015).. This means is a methodological style of analyzing problems with high levels of complexity, and as the approach of the thesis is to understand education systems in a big part of its structure, Systemic Thinking guides the designer to observe the situation from a broader scenario to a detailed study of each piece inside.

Until this point, the concept remains on science terminology, however when the term is transferred to the design perspective *"the aim of the systemic design is to map, propose and reconfigure such complex systems through a human-centered design approach. It is also important to notice that systemic design is not a discipline, as opposed to industrial or graphic design, but a design orientation that considers the use of different disciplines as needed."*[51] (D'Urzo, M et All, 2017.)

Therefore, to orientate the project from this theory is necessary to considerate three key elements that involve the analysis of a systemic design project: the purposes inside the system, its components, and the interconnections and interactions between them. As mentioned before, all these information collected need to be organized, categorized and mapped, that way the process of analysis will be more flexible and efficient in terms of understanding the main elements and problems present on the system. Consequently, the outcome will be a dynamic and well-integrated system that through the correct connections in between, acquires cohesion and an autopoietic ability to auto-generate according to the context variability.

50 Ross D. et All. 2015. A Definition of Systems Thinking: A Systems Approach. Procedia Computer Science. Volume 44. Pages 669-678. ISSN 1877-0509. Available at https://doi.org/10.1016/j.procs.2015.03.050. https://ac.els-cdn.com/S1877050915002860/1-s2.0-S1877050915002860-main.pdf?_tid=e0264227-a397-47f0-a994-76d4b8d9d68a&acdnat=1548864944_73f6afb98c04e13cfd2f90c29befb141 , (consulted 12/12/2018).

51 D'Urzo, M et All, 2017. Systemic design and social marginalization: mapping and assessment of projects for the empowerment of people experiencing social exclusion. Relating Systems Thinking and Design 2017 working paper. Available at www.systemic-design.net , (consulted 12/12/2018) .

On figure 39 is illustrated the process model of Systemic Design and its principles.

This way, the Systemic Design approach was enforced to understand, analyze and identify all the elements that surround the education system scenario of the thesis, permitting to recognize the connections between them, the problems inside and possible solutions to be explored. In conclusion, it was taken as the methodological principles for the research and problem-solving process and it will be evidenced on some of the cases of reference presented on the following pages, the successful results of its inclusion on the education field and how is possible to obtain relevant impact on society.

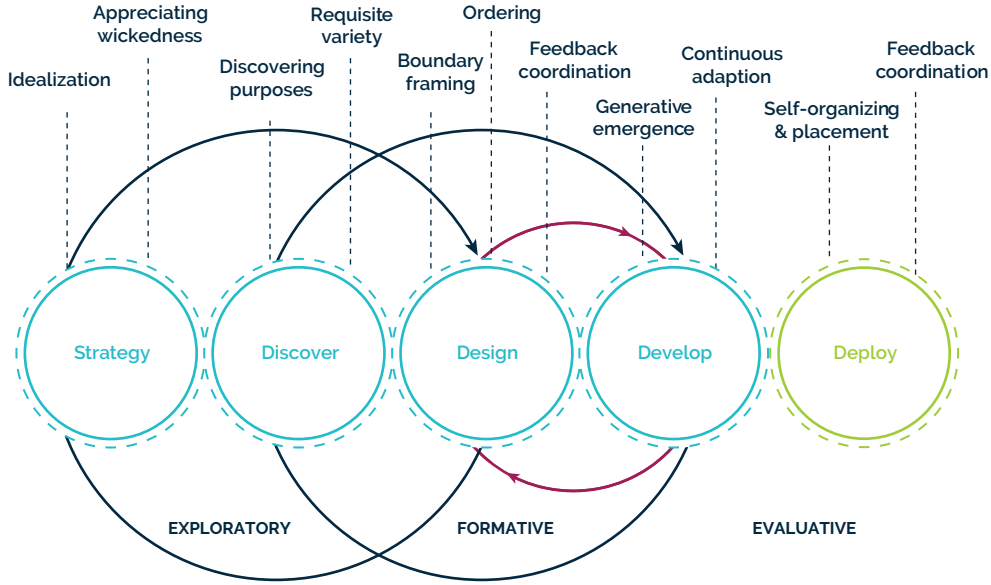


Figure 39. Process Model for Systemic Design Principles

Source: Adapted from Evenson, S; Dubberly, H. 2010. Designing for service : creating an experience advantage. Available at https://www.researchgate.net/publication/280921326_Systemic_Design_Principles_for_Complex_Social_Systems

Design Thinking

Design Thinking is a methodological problem-solving instrument used by designers on projects where the problem is exposed through research structured on human-centric characteristics. More specifically, design thinking "incorporates analytical, synthetic, divergent and convergent thinking to create a wide number of potential solutions and then narrow these down to a "best fit" solution"[52] (Interaction Design Foundation, 2017). The process followed by this strategy of design is based on 5 phases: empathize, define, ideate, prototype, and test (figure 40). Nevertheless, this is not a linear process, which means that according to the designer procedure and frequently related to the user requirements, the path can be modified and easily adapted to any project. In this context, the approach of this thesis is mainly focused on the three first steps of the design thinking process, as its purpose is to estimate a problematic based on a user research and consequently reflected on a designed strategy plan that does not achieve a concrete prototype but remains at the base-state for an experimental procedure in future work.

The first step, Empathize, regards to a group of methods implemented to distinguish the problem through the user's eyes. Then, is typically to apply tools as observation of the activity that is being studied, surveys and interview with the users which later will become the key to a participating design connecting designer abilities with the direct intervention of the final customer.

The second phase is the Definition of the scenario, in other words, is the interpretation and integration of the information obtained on the previous step and can be reduced on an Empathy Mapping (contains user thoughts, actions, feelings and opinions).

Finally, the third and last step materialize on this project is the Ideation where is developed the generation of possible solutions or scenarios able to change the current problems.

52 Interaction Design Foundation. 2017. Design Thinking, Essential Problem Solving 101- It's More Than Scientific. Article. Available at https://www.interaction-design.org/literature/article/design-thinking-essential-problem-solving-101-it-s-more-than-scientific , (consulted 11/27/2018).

From the project aspect, the methodology can be also applied to processes inside education systems, from leaders to directly to the methods used by teachers to study and impulse their students to learn. As a matter of fact, there are already projects on the education field, taking advantage of the way of thinking of designers in order to open teachers and managers mind to new and innovative solutions to overcome the problematics around teaching and learning environments.

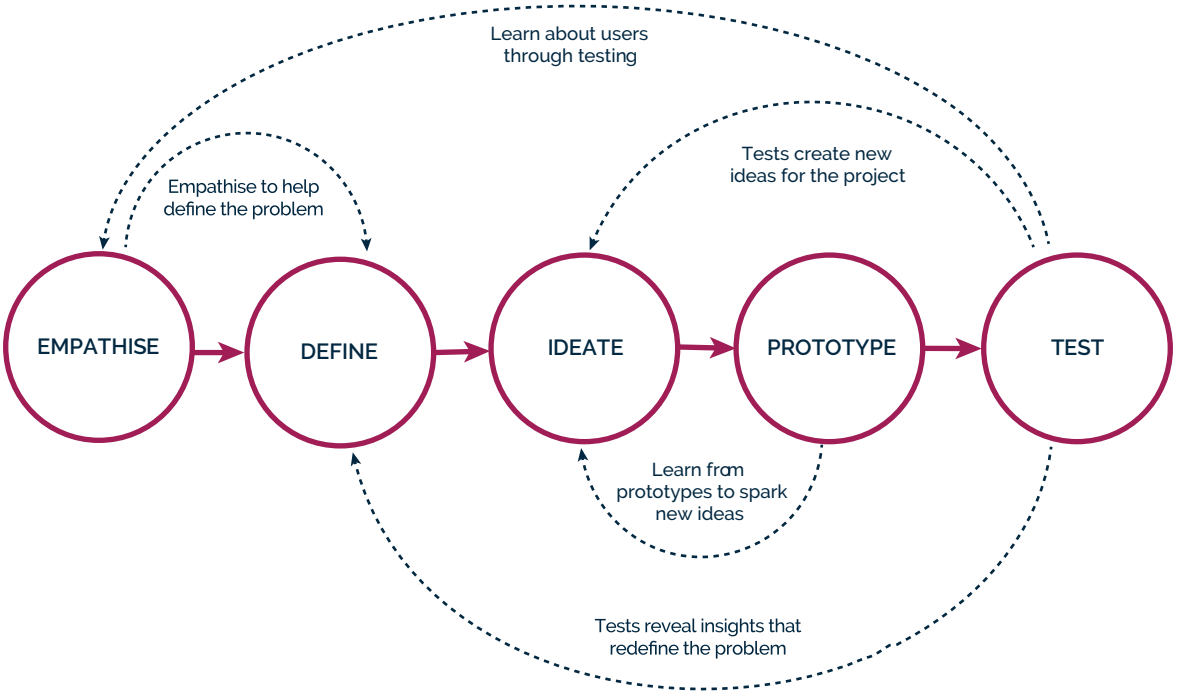


Figure 40. Design Thinking: a non-linear process.

Source: Author/Copyright holder: Teo Yu Siang and Interaction Design Foundation. Copyright terms and licence: CC BY-NC-SA 3. Reached on Interaction Design Foundation. 2017. Design Thinking, Essential Problem Solving 101- It's More Than Scientific. Article. https://www.interaction-design.org/literature/article/design-thinking-essential-problem-solving-101-it-s-more-than-scientific

UX Design

According to the Interaction Design Foundation (IDF), User Experience Design (UX Design) is *"the process of creating products that provide meaningful and relevant experiences to users; it involves the design of the entire process of acquiring and integrating the product, including aspects of branding, design, usability, and function."*[53] (IDF).

The concept was taken into consideration to the project, thereby enabling the adequate involvement of the user at the center of the design process of future supporting tools on education. Hence, during the research phase and the conceptual design process were implemented some of the techniques defended by UX methodologies, such as user research (surveys, interviews), personas characterization of the user, ecosystem map (visualization of the scenario), brainstorming, and card sorting strategies.

Technology is an aspect that is highly taken in reference on UX Design, a cause of the constant increment of its application on every industry, either as a service or as a product. It is characterized by a process of adoption from the customers until it becomes part of their daily life. Then Donald Norman argues that:

> *"Technologies migrate as they mature. In early childhood, their very existence is a marvel, even as people wonder what can be made of it. In early adolescence, they become more and more able to perform useful functions for us, and for a while, they are judged primarily on their ability to do more and more, better and better. Finally, in maturity, it is the quality of the experience provided by these technologies that matter [...] once the technology becomes mature, it recedes into the background, supportive of the total experience it provides"*[54] (Soegaard, 2013)

Nevertheless, UX Design has an approach that should be exploited, not only from the industrial point of view, but also from the angle of complex organizations that are able to connect different subsystems, willing to generate a local, or even a global positive impact from socio-cultural and environmental perspectives.

53 *Interaction Design Foundation. User Experience (UX) Design. Available at https://www.interaction-design.org/literature/topics/ux-design , (consulted 11/27/2018).*

54 *Mads S et All ,2013. The Encyclopedia of Human-Computer Interaction, 2nd Ed. User experience and experience design. By Marc Hassenzahl. The Interaction Design Foundation. Available at https://public-media.interaction-design.org/images/books/hci/hci.pdf , (consulted 11/27/2018).*

Contextual Design.

An important strategy applied on UX Design is the called "Contextual Design", which refers to *"a structured, well-defined user-centered design process that provides methods to collect data about users in the field, interpret and consolidate that data in a structured way, use the data to create and prototype product and service concepts, and iteratively test and refine those concepts with users"*[55] (Holtzblatt, 2013). This instrument, point out the elements a designer has the connect coherently in respect with the behavioral paths reveal by the context and its parts interaction (figure 42).

55 *Soegaard Mads and Rikke Friis Dam. 2013. The Encyclopedia of Human-Computer Interaction, 2nd Ed. Contextual Design. By Karen Holtzblatt and Hugh R. Beyer. The Interaction Design Foundation. Available at https://public-media.interaction-design.org/images/books/hci/hci.pdf , (consulted 11/27/2018).*

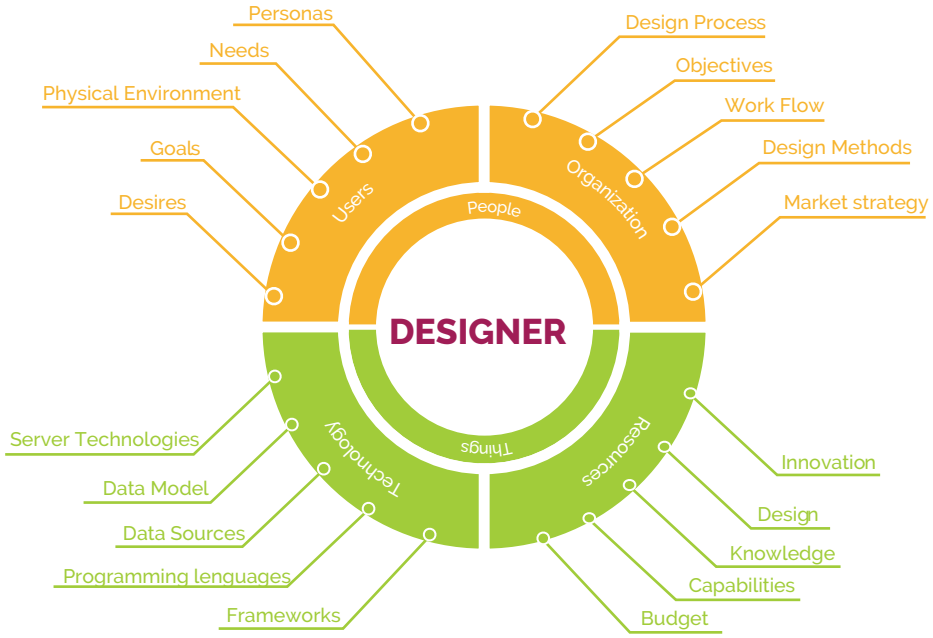


Figure 41 . Design Context: The four legs of interaction design.
Source: Michael Cummings. Creative Commons - Attribution - Noncommercial 3.0 United States. Available at http://uxdesign.com/ux-defined

Cases of references

The Teachers Guild

Plussed at Riverdale Country School, and incubated by IDEO's Design for Learning Studio.
New York City, USA. 2016
https://www.teachersguild.org

The Teachers Guild is a project that connects teachers and impulses them to become the creative leaders that prepare the problem solvers of the future. The idea is the development of various projects in schools around the world, where teachers receive advice on applying Design Thinking methodologies to evaluate and improve the methods of learning usually implemented. The aim is to prepare teachers for the challenge of finding uniqueness on the coming education strategies.

- ✓ Teachers motivation approach
- ✓ Innovative methodology
- ✓ Multi-faced strategy
- ✓ Design Thinking inclusion
- ✓ Open source and updated data reports

- ✗ Requires personal assistance (designers)
- ✗ Non inclusion of technology for creative creation
- ✗ Missing an interactive strategy

Teachers Guild Fellows kicked off the year together, launching a year long design journey together. Image retrieved from https://www.integration-design-consortium.org/teachers-guild/

A teacher participating in the Creative Leadership Institute at Gwinnett County Public Schools shoots a confetti cannon. Image retrieved from https://www.integration-design-consortium.org/teachers-guild/

Design Thinking for Educators

Plussed at Riverdale Country School, and incubated by IDEO's Design for Learning Studio.
New York City, USA. 2013
https://designthinkingforeducators.com

IDEO

Design Thinking for Educators consists of a toolkit specially designed for K-12 education teachers with the aim of helping them to create solutions for the everyday challenge present in a classroom. The methodology implemented is based on IDEO's design process and methods for Design Thinking solutions but adapted and modified to teach and motivate educators to improve their practices. This set is equipped with an open source guide and a workbook to apply the design methods included.

Image retrieved from https://usergeneratededucation.wordpress.com/2013/03/11/hacking-the-classroom-beyond-design-thinking/

Image retrieved from https://www.ideo.com/post/design-thinking-for-educators

- ✓ Teachers motivation approach
- ✓ Design Thinking inclusion
- ✓ Open source

- ✗ Non inclusion of technology for creative creation
- ✗ Missing an interactive strategy
- ✗ Limit to an on-line book
- ✗ Communication strategy

Social Learning Environment in China

Greg Perez, creator and Design Director IDEO Tokyo
Wall Street English, China. 2016
https://cn.ideo.com/en/case-study/wall-street-english

IDEO

Social Learning Environment is a design project developed to Wall Street English. The design team had the challenge to observe and create spaces of learning that engage students and create the right connections with their teachers. The idea was to optimize the experience of learning through more interactive areas, that generate better relations between the users. In addition, the IDEO team developed digital instruments designed with the students and teacher participation, offering solutions based on their experiences, using Bluetooth beacons and app prototypes.

Image retrieved from https://cn.ideo.com/en/case-study/wall-street-english

- ✓ Digital applications
- ✓ Social interactions methods
- ✓ Learning spaces design

- ✗ Low motivation strategy for teachers
- ✗ Teachers are not visualize as learners

Image retrieved from http://exceptionalalien.com/the-creative-magic-of-japan-with-california-native-michael-peng/

TD4Ed

Business Innovation Factory
USA. 2014
http://www.emmabeede.com/td4ed/

Teachers Design for Education (TD4Ed) is a free online platform that teaches Design Thinking skills to educators, is a teacher-centered approach to innovation on education. It contains multimedia content that allows users to work together and connect their experiences and ideas to generate, co-create and innovate the methods used in learning environments. Consequently, through this educational design process teachers will be able to impulse themselves and their students to demonstrate and train curiosity, creativity, collaboration, and confidence during the learning road.

- ✓ Open source
- ✓ Online platform create a network
- ✓ Guided and experience-based solutions
- ✓ Teachers motivation approach
- ✓ Design Thinking inclusion

- ✗ Interactive strategies to open teachers mind
- ✗ Co-creation with students
- ✗ Non inclusion of university educators

Image retrieved from https://www.tumblr.com/privacy/consent?redirect=http%3A%2F%2Fredappledigest.tumblr.com%2F

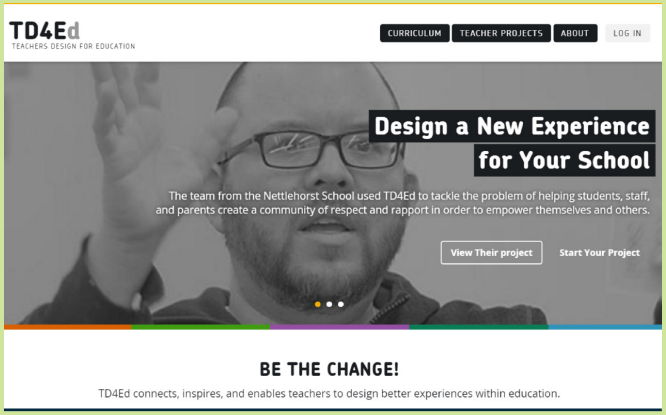


Image retrieved from https://designawards.core77.com/Design-Education-Initiative/33961/Teachers-Design-for-Education

Photo by rawpixel on Unsplash

USER RESEARCH

On this segment of the thesis, is presented the background information related to the user professional responsibilities, the tasks they are requested to solve, and the usual strategies proposed by experts on pedagogy to achieve them. Likewise, it was planned and implemented a user research, directly involving educators from the Politecnico di Torino and Politecnico di Milano into the study, based on observation, their personal experiences, and opinion on the topic through a survey.

The aim of executing this combined methodology of research was to analyze and obtain design solutions teacher-centered, argued on the creation of a contextual scenario seen from the users perspective.

USER NEEDS

Design concept

USER REQUIREMENTS

Components of the project

USER MOTIVATION

Purposes of the project

TEACHERS ROLE

Nowadays, teachers roles have been extended to areas and tasks nearer to human aspects, which means that they are not only transmitters of knowledge but at the same time counselors of learners that expect to become promising individuals in the society. Hence, across this chapter, it will be provided information related to the relevance of teachers appearance on education, how do they currently respond to the several tasks they are being requested? And finally why is it important to invest, at the same level as it happens with students, on strategies that support and facilitate their job?

In this respect, I would like to start by defining the two type of roles that teachers generally apply on their learning environments, making reference to the methodologies of teaching and learning processes already explained at the beginning of the chapter. According to A.H. SEQUEIRA (2012) from the National Institute of Technology Karnakata (India) , the first one is denominated as the "Traditional Role", which mainly refers to teacher's centered processes. It means teachers decide, design and organize the contents that the student has to learn, memorize and demonstrate its acquirement on the evaluation process (exams). As a consequence, the author stated that this model can be well pictured as the scenario of students sitting in rows in front of a teacher, who is providing information to them by a speech and with the aid of a blackboard; the students might be listening passively or hopefully taking some notes. However, with the pass of time and new features identified on this field, this role is no longer considered as assertive for current conditions of education.

In contrast, the second category of teacher's role described by SEQUEIRA is primarily focused on the student (student-centered) and is called the "Modern Role" of teachers. This kind of role is based on making teachers build knowledge and skills on students starting from their own previous experiences, in this way, educators become counselors throughout the student's learning paths. However, it does not imply that teachers do not need to design or structure a learning strategy on their courses. Actually, their aim is to involve the key points where the student needs to reach, provide the essential information, and encourage them to construct and improve their learning route.

Taking into account that several authors agree on three learning domains for the human being (psycho-motor, cognitive and affective) , it implies then the uncountable approaches of learning depending on the individual conditions. Furthermore, SEQUEIRA highlights the importance of recognizing that given the present context, there has been a substantial change from the Traditional to the Modern role. *"The learning increases when the teacher builds on the previous experience of the student. However, individual's learning differs and each individual learns at his or her own pace [...] Thus, effective learning is to a great extent based on experiences. Direct experiences are student centered and participation in problem solving. While in indirect experience, the contents are carefully designed and organized by teacher."*[56] (SEQUEIRA, 2012).

Based on those findings, it would be possible to state that the teacher must balance under his work the multiple levels of learning for his students given their conditions as individuals, looking forward to achieve the objective of passing knowledge but keeping the audience at the same level considering each one's "speed"to advance collectively as a group as well.

In that way, it is supported on the World Development Report 2018: Learning to Realize Education's Promise (World Bank, 2018) that in order to help teachers teaching to the proper level of their students, leaving no learners behind is an absolute key principle. Moreover, it is indicated that this technique has been successful in several formats throughout a wide range of scenarios: *"whether by using community teachers to provide remedial lessons to the lowest performers, reorganizing classes by ability, or using technology to adapt lessons. In many cases, it does not require a significantly greater teacher effort, but rather relies on restructuring classes or providing remedial lessons for the lowest performers"*[57] (World Bank, 2018).

As a result, it stresses the relevance imparted by the report on adapting teacher's strategy of approach by grouping students by ability, which may allow the interlocutor to target teaching more effectively to the different levels of students in their classes.

56 Sequeira, A.H. 2012. Introduction to concepts of teaching and learning. National Institute of Technology Karnataka, Surathkal, India. Available at: https://www.researchgate.net/publication/272620585_INTRODUCTION_TO_CONCEPTS_OF_TEACHING_AND_LEARNING, (consulted 10/12/2018).

57 World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. doi:10.1596/978-1-4648-1096-1. License: Creative Commons Attribution CC BY 3.0 IGO . Available at http://www.worldbank.org/en/publication/wdr2018 , (consulted 10/01/2019).

Types of career structure and progression

Until this point, there has been a focus on the teaching methodologies, knowledge sharing techniques and the impact on students. For that reason, is also important to review some specific criteria that belong specifically to teachers as professionals, which has direct relation with the quality level delivered at the end to their students.

First of all, based on the European educational context it becomes relevant for this analysis to review the career structure for teachers, and their progression on it, which constitutes a motivational fact for teachers to improve their skills and advance on their professional path.

In that way, considering the scenario described, the Eurydice Report: Teaching Careers in Europe (2018) defines career structure as a recognized advance or progression path in a job/ profession. Moreover, the authors argue that depending on the education system per country in Europe, there is possible to refer to different Career structures with distinct levels, as follows:

i. In Flat Career structures, referring to those with only one level, *"a salary scale may be in use but it usually relates to years spent in service and, possibly, performance. A flat career structure may allow for a teacher to widen their experience or take on additional tasks or responsibilities"*[58].

ii. On the other hand, in multi-level career structures, the Eurydice Report 2018 states the levels are defined based on responsibilities as well as a set of competences required. That implies the escalation closely linked to increasing complexity and greater responsibility on each step. In that way, *"a salary scale may be in use but it usually relates to years spent in service and, possibly, performance"*[59].

However, each country might apply several adaptations to local legislation that would represent a slight variation between countries. In all cases, it is imperative to understand the roles and responsibilities that teachers are assuming nowadays in order to comprehend the behavioral trend existent , specially in Europe as the main focus for this analysis.

58 *European Commission/EACEA/Eurydice, 2018. Teaching Careers in Europe: Access, Progression and Support. Eurydice Report. Luxembourg: Publications Office of the European Union. Available at http://eurydice.indire.it/wp-content/uploads/2018/02/Teaching-Careers-in-Europe.pdf . (Consulted on 10/01/2019).*

59 *Ibid*

Teachers accountability and responsibilities

Even though the teaching will remain as primary role, teachers also acquire different roles and responsibilities, depending not only on their statement through the career structure previously reviewed, but also the part of the educational path where they are performing their labor (primary , secondary education, etc) . Definitely , for the purposes of this document, there will be considered sample cases related to the education systems in Europe.

According to the results conducted on the Eurydice Report :Teaching Careers in Europe (2018) presented on the figure 43, it has been identified that in three quarters of the education systems teachers might have pedagogical and methodological roles outside the classroom.

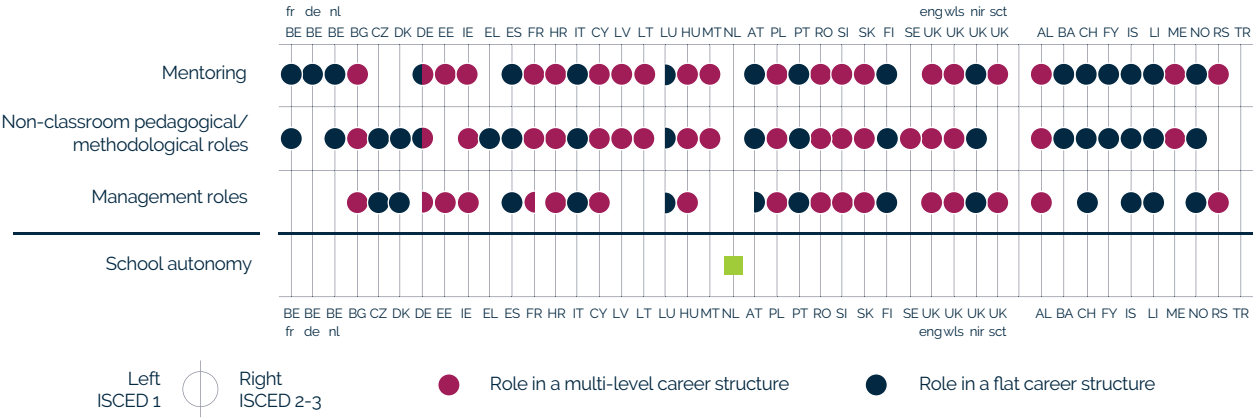


Figure 42 : Roles and Responsibilities available to teachers, primary and general secondary education systems in Europe (2016/17)

Source: Eurydice, 2018. Teaching Careers in Europe.

As a consequence, there have been discovered and defined a variety of additional roles assumed such as:

i. Subjects/ curricula: Related to roles such as head of projects, program coordinator, head of studies, school advisor or coordinator of working groups, among others.
ii. Pupil support: learning coaches, special education coordinator, guidance officer.
iii. School life: class tutor, home/school liaison coordinator;
iv. ITE/CPD: CPD coordinator, teacher trainer;
v. Evaluation: Referring to examination coordinator or inspector for other schools.[60]

Definitely, it is possible to appreciate the multidimensional performance of teachers on their labor, which allows them to advance on their own career path as professionals but also defines all the focal points that have to be approached to them succeed overall on their main objective as knowledge imparters.

Furthermore, the distribution or acceptance of the roles identified are directly related with the type of career structure to which each teacher is subject. Taking into consideration a closer view on the European system as reference point, the report states that *"in several of the education systems with a flat career structure, some of the additional responsibilities may carry a specific financial incentive. This is, for instance, the case in the German-speaking Community of Belgium, the Czech Republic, Spain, Italy, Latvia, Austria, the United Kingdom (Northern Ireland), Bosnia and Herzegovina, Iceland and Norway"*[61] .

60 *Ibid*

61 *Ibid*

Image retrieved from http://gem-report-2017.unesco.org/en/chapter/accountability-in-education-social-media-resources/

TEACHERS AS LEARNERS

Throughout the history of mankind, there have been enormous changes on the way of thinking, observing and acting of human beings, generating paradigms of interaction between the people involved, the resources around and the environment. This phenomenon has affected entire societies over the years, and especially during the last centuries, the impact of technologies has been significantly involved since it has become a "way of living" due to its presence on most daily activities.

Therefore, all this changes and advances from the science and technological angles are challenging educators way of work and is becoming teachers concern since their belief is that the future role of technological instruments is entirely replacing them. Surprisingly, this idea has not arrived only due to the information exposed to the customers but mainly due to the deficient communication strategies provided by the designers or developers of those new tools. In other words, teachers are unable of understanding the limits and benefits of the technology and consequently is not sufficiently evident the elements they need to focus as transmitters of knowledge and builders of critical thinkers and problem solvers.

In this respect, is necessary to recognize educators as continuous learners. Parallel to the concepts explained before on the section "Education Concepts", teaching and learning processes are extremely connected between them, because they feed each other's improvement, for this reason, they need to be continuously updated. In general terms, the world is constantly moving and being modified according to the circumstances, but science has also demonstrated that part of the life cycle is to adapt and generate solutions to overcome the difficulties (autopoiesis). From this perspective, an important goal for education systems is to keep teachers motivated and recognize their importance on learning paths, but mainly providing the correct incentives and supporting strategies to reinforce their potential.

KNOWLEDGE BUILDERS

As referenced on the last pages, part of teachers liabilities is the structure and construction of the course which includes the definition of the course goals, general syllabus (objectives, methodology, evaluation system, contents of the course), the topics to be explained, the supportive information and references that argued them, the assignments, a schedule with all the activities incorporated, and the tools required for the methodology chosen.

All this body content of a course is based on the decisions the educator takes according to the argument to be discussed and his/her knowledge on it. Then, it means that in order to provide well-aimed knowledge to the students is necessary for teachers to focus on three aspects:

i. Keep their content updated and reinforce constantly the arguments around;

ii. Provide the right sources and strategies to transmit knowledge and;

iii. Include critical thinking methods to boost students curiosity on the topic.

The third element mentioned will not just support the strongest value of education on society but also allows an intrinsic development of the processes inside. Hence, teachers are essential components of the systems that from every perspective need to be recognized, for this reason, this thesis project is concentrated on reminding them the importance of their work through the design of wise supportive tools.

User Research Plan

Purpose

The purpose of this study was to find out how the target group (teachers) construct the body contents of their courses and which methodologies, tools or technologies help them on this task. Consequently, was necessary to observe when, where and how does this activity take place. It was needed to get an understanding of this to know what new features would be most relevant and helpful for the target group.

Method

It was structured an on-line survey supervised by Luca Davico, a sociologist professor of Politecnico di Torino with experience on the construction of user research plans. The questionnaire was answered by 83 professors from different departments of high education institutions, with the goal of collecting relevant information regarding the process and usually methodologies implemented to the activity studied. Likewise, the survey was planned to recognize teachers expertise and motivation to use technology as a supporting tool and identify some important requirements they are expecting from those instruments.

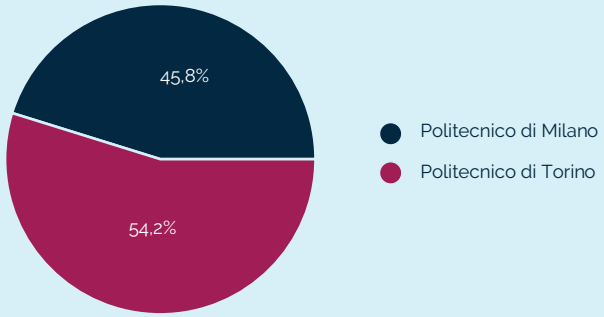
Participants

Participants were professors aged 40 to 80, who are involved on modern teaching environments which means have at least a basic experience with the use of technologies (eg. computers, cell phones, tablets, etc) for their daily work activities. The participants were recruited from the local area through the available network of professors inside the Politecnico di Torino and Politecnico di Milano.

Results

Universities involved in the research

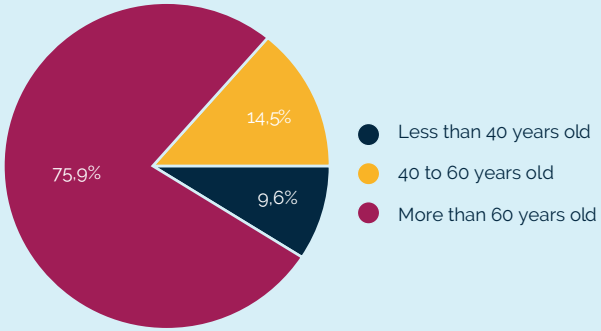
83 responses



The survey was driven to obtain a balanced group of participants from both universities.

What is your age range?

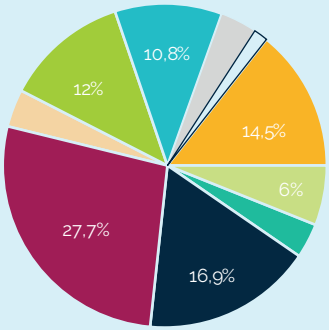
83 responses



The majority of the audience reached was between 40 to 60 years old.

What is the department you work with?

83 responses

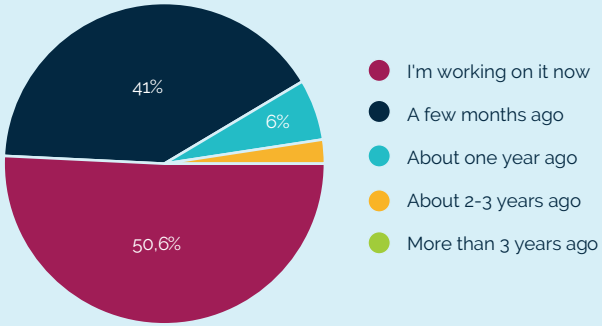


- DAD - Dipartimento di Architettura e Design - PoliTo
- DISAT - Dipartimento Scienza Applicata e Tecnologia - PoliTo
- DENERG - Dipartimento Energia - PoliTo
- DET - Dipartimento di Elettronica e Telecomunicazioni - PoliTo
- Dipartimento di Ingegneria Gestionale (DIG) - PoliMi
- Dipartimento di Ingegneria Civile e Ambientale (DICA) - PoliMi
- Dipartimento di Energia (DENG) - PoliMi
- Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB) - PoliMi
- Dipartimento di Design (Design) - PoliMi
- Dipartimento di Architettura, Ingegneria delle Costruzioni e Ambiente Costruito (DABC) - PoliMi

Approximately 60 % of the professors were from disciplines involve with technology experience.

When was the last time you built or modified the contents of your courses?

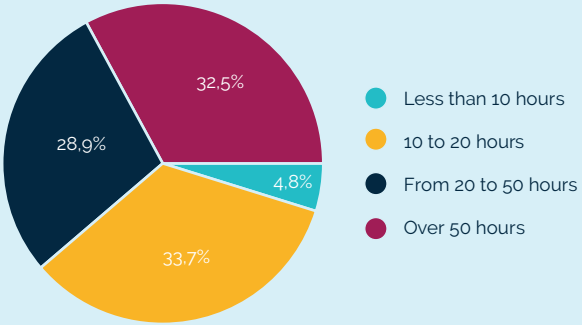
83 responses



Half of the professors are working recently on their courses contents and the other half have done it during the last year.

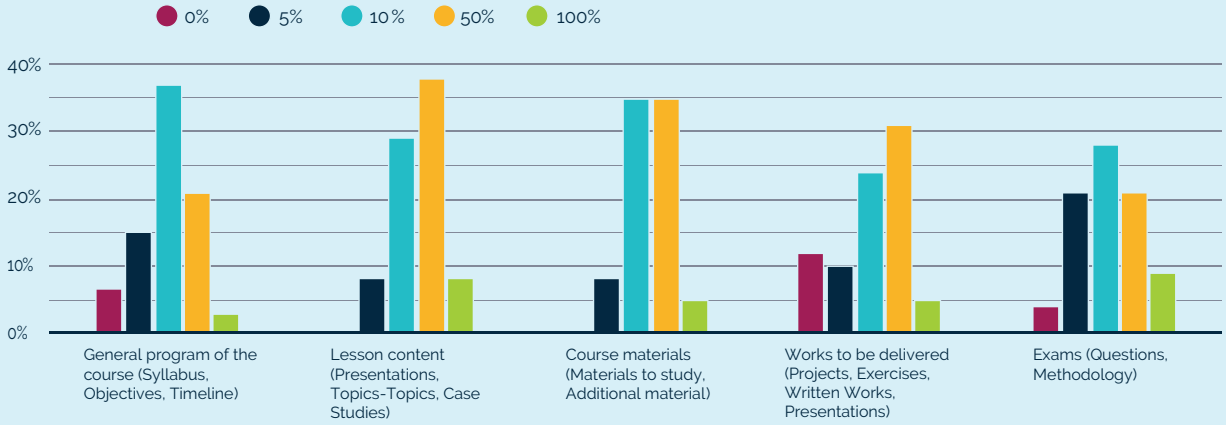
In the last year, how many hours of work do you spend on building, organizing or modifying course content ?

83 responses



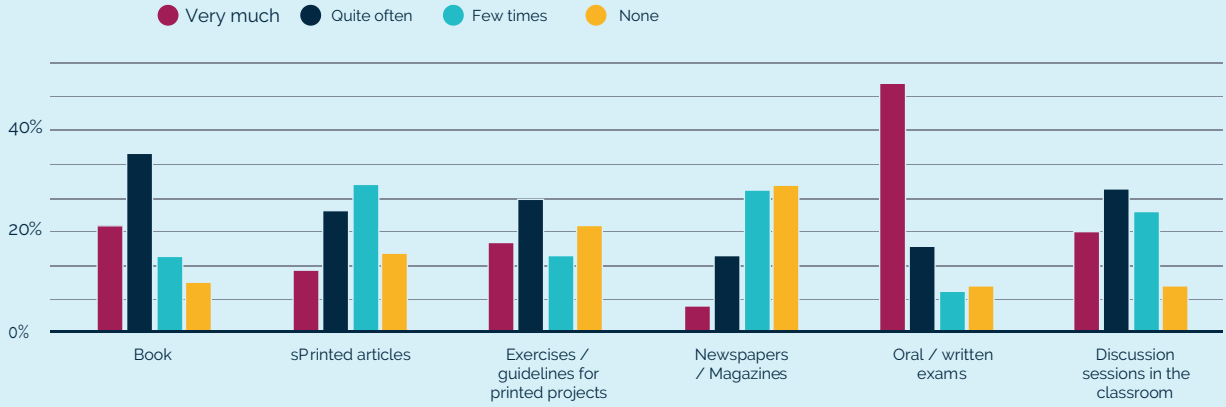
The difference of percentages is not significant between the options, which means that they usually invest from 10 to 50 hours.

In the last 5 years, how far have you made changes to the following aspects of your courses ?



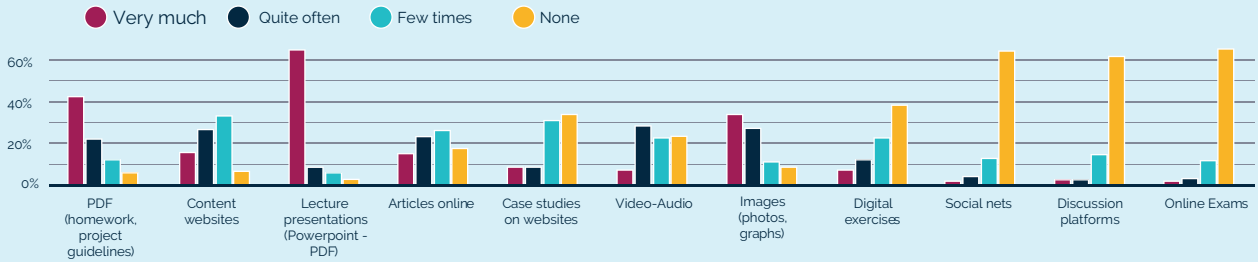
They usually modify the lesson content and the course material. And there is a low percentage of changes on the exams and eventually the general program of the course. The work to be deliver is between the media of the results.

What kind of PHYSICAL content / tools do you use most for your courses ?



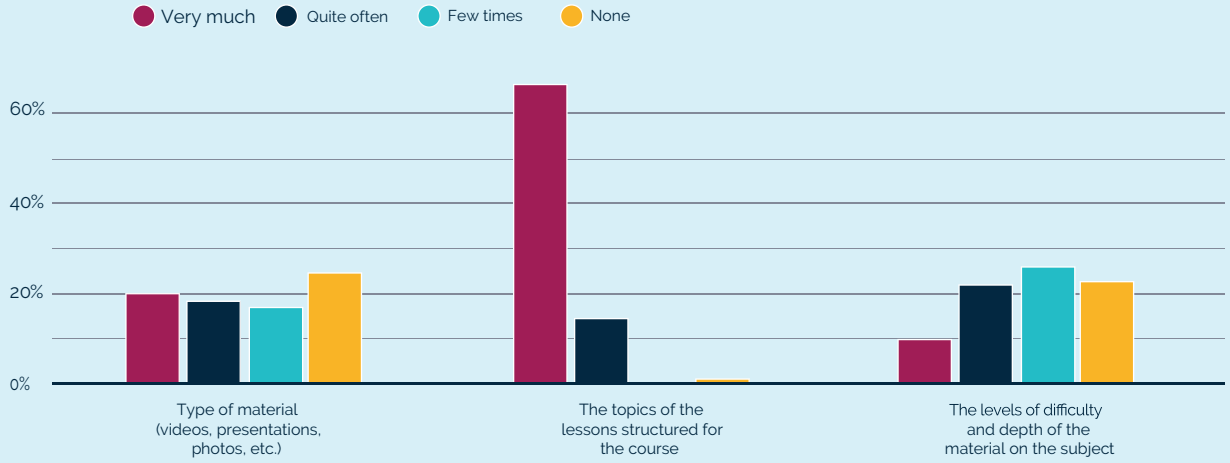
The method most frequently use in physical sense are the exams. From 20% to 35% of them use books and discussion sessions strategies.

What kind of DIGITAL content / tools do you use most for your courses?



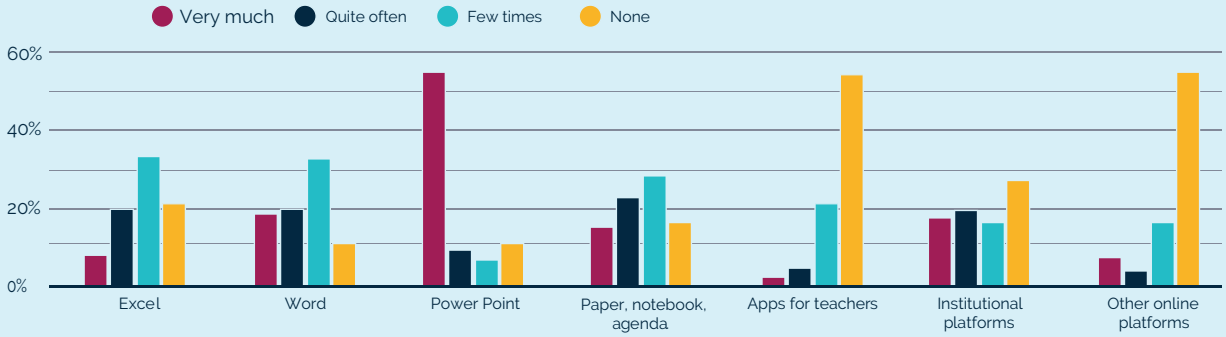
More of 60% of the professors use digital lecture presentations and 40% for project works or assignments. But a high percentage of them never use social networks, discussion platforms or virtual exams.

Do you organize your course materials according to the following factors?



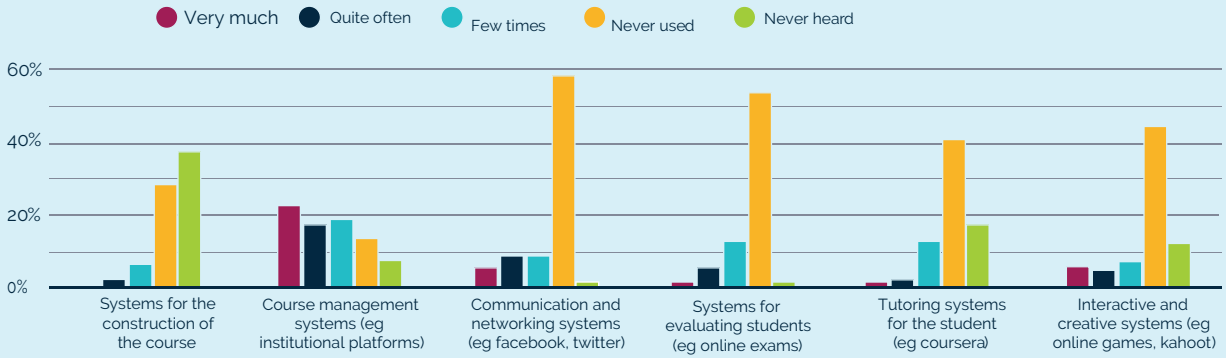
A high percentage of educators organize their material contents according to the topics of the lessons and a reduce number of them times related to the levels of difficulty.

What tools do you normally use for building your course structure?



Most of the teachers normally use power point, which means they have more familiarity with Microsoft language. However, a large part of them have never used apps for teachers or on-line platforms different than the one provided by the institution.

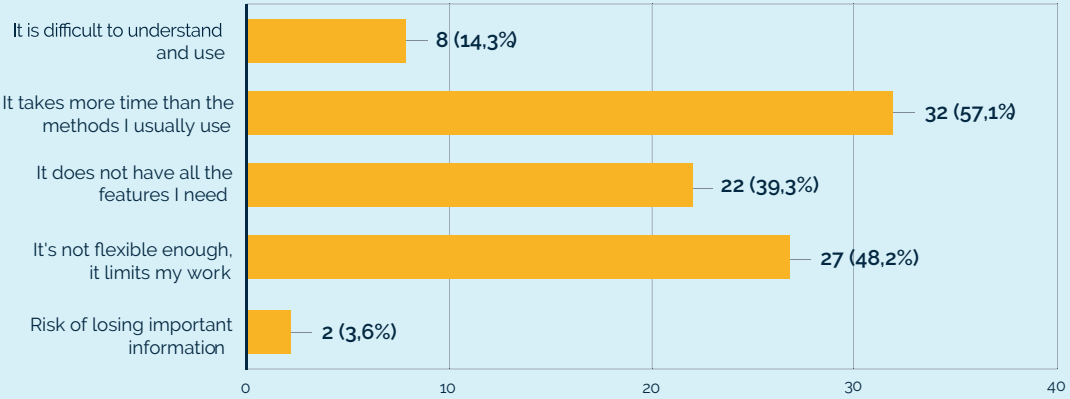
Have you ever used these support technologies to improve your performance as a teacher?



The majority of the participant have never used most of the systems mentioned. The system with a low but likewise significant recognition from the professors is the management systems. Besides a big part of them recognize have never heard about systems of construction of a course.

What are your problems with using the support technologies mentioned?

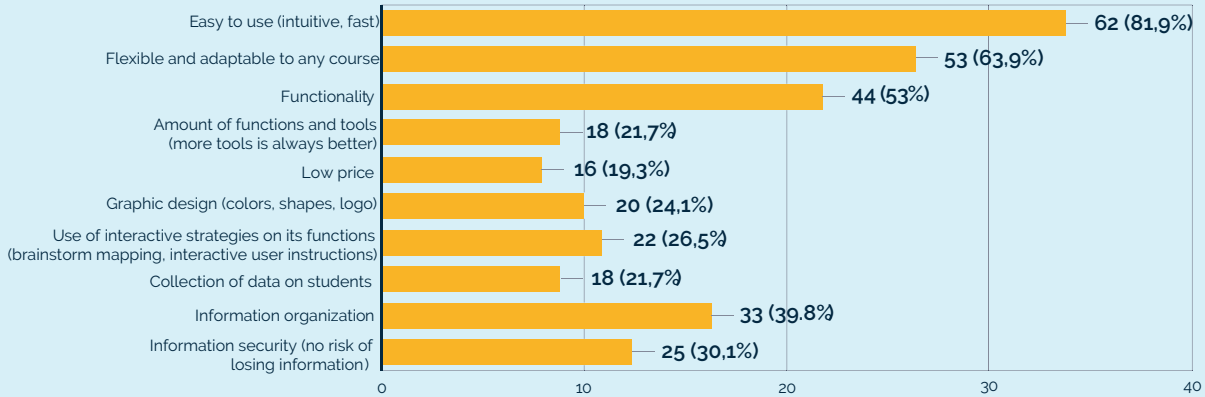
56 responses



Almost a 60% of the teachers affirm that new technologies take more time than normal methods and almost half of them agree that it limits their work and is has not all the features they need.

Which of these features are most important to you on support technologies that you use or would like to use?

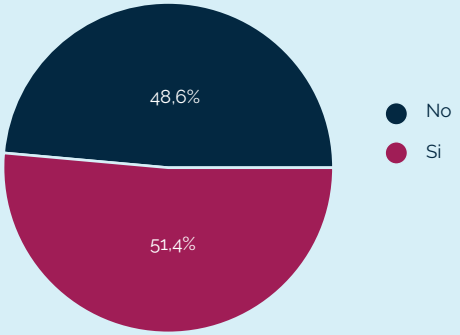
83 responses



Consequently, 82% of them will to have intuitive tools, flexible and adaptable to their needs. Likewise, they expect to have functional tools that specially permit to organize the information of their courses.

Does the institution you work in provide these kinds of resources or support technologies to make your tasks more effective?

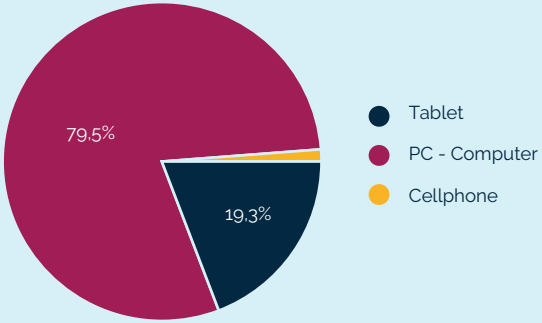
74 responses



The opinion is divided parallel, then half of them affirm the institution provide these tools while the other half imply the opposite.

Which device would you prefer to use for this type of platform?

83 responses



The highest percentage of the participants prefer to have access to these tools on a computer.

Conclusions

According to the survey most of the professors spend a significant period of time modifying the contents of their courses, which open the possibility of optimizing those times and provide the right sources to manage them.

It is relevant the fact that they are often used to the language of Microsoft and Latex interfaces that let us take this system as a reference of design, as it will be supporting with new technologies but based on the communication style of the current tools.

Most of the teachers found new tools non-well integrated systems, that limit their work and leading them to abandon their implementation. Actually is evident the use of different resources for short periods of time and eventually losing interest on them, until the point they do not recognize any of the new available tools.

The key requirements to keep in mind to the design of EdTech for teachers is include flexible, adaptable, intuitive and coherent functions based on teachers needs, expertise and their task procedure.

CHAPTER II
PROJECT APPROACH

Photo by New Data Servic… …splash

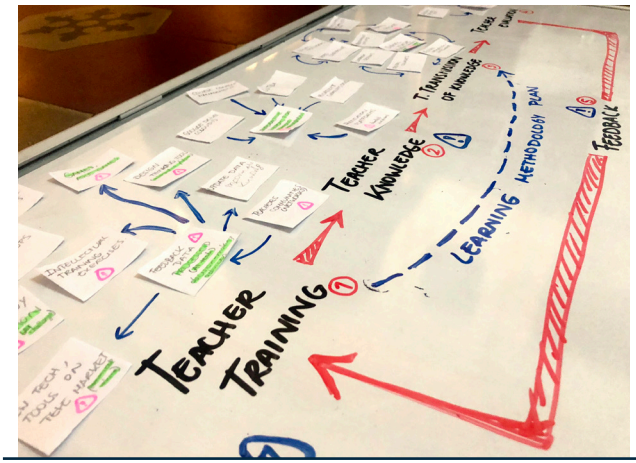
PROJECT SCENARIO

This chapter is structured by the results obtained during the analysis of all the information presented in the previous chapter. Therefore, to construct a coherent path of reasoning it was divided into four main phases, that explain and connect the conclusions extracted by every discipline and reproduce in different visual forms according to the elements that were necessary to put in evidence.

The first analysis presented is the problem scenario, where was implemented the strategy of problem-solution cards, as a brainstorming of all the problematics founded around the education systems. This process permits to identify the connections between them creating paths of problems and solutions from the most complex issues to the more specific ones, leading to obtaining a network of problems that involve the different actors inside the system.

The second scheme is focused on the results and analysis obtain through the user research and how it is connected to the processes inside learning environments and the current inclusion of technology as new methods of teaching and learning. The next step was to settle the activity path followed by the teachers on their main role as boosters of knowledge and tutors of the future critical thinkers. Then, it was parallel organized a brainstorm of the methods implemented to achieve each of these steps (image) and as a result was possible to identify the categories of technologies that were analyzed on the next and last graphic, the analysis of technology.

The aim of this methodology of reasoning and processing the information collected was to select the relevant points and understand the connections evidenced by the system. However, this strategy was consequently showing the missing connections, problems and possible points of intervention to strengthen the system itself.



Brainstorm methodology to analyze the teaching process and the methods included.

PROBLEM ANALYSIS

This phase of analysis was organized based on all the background information presented in the previous chapters. The methodology implemented to organize and categorize all the information was the construction of a problem map, where was possible to connect a network of problems and solutions in order to create possible paths able to untie the difficulties presented on the education systems.

As it was mentioned before, the quality of an education system depends on a group of elements working together and with a common objective to achieve. The approach of the project took a reference on some of the information as a contextual scenario of all the possible causes around education systems difficulties. However, to identify and construct the scenario that is closer to the problem faced on this project, the analysis was divided on two relevant problematics that are affecting the introduction of the new paradigm of learning and teaching proposed by the inclusion of technology on this industry. Those main problematics are the alignment of the stakeholders inside the system and the teachers' performance which involves a group of actors with higher levels of responsibility to overcome them (figure 43).

Then, on each of these problematics were organized a list of possible causes and through a brainstorming process, the idea was also to include the feasible solutions with their corresponding issues (figure 44 and 45). In other words, the idea was to connect all the arguments and perspectives of the research to determine a context scenario.

Consequently, this technique leads to the categorization and recognition of the role that each stakeholder represent inside the system, in order to obtain sustainable and significant connections between them. This way, the method known as "Personas" was implemented and demonstrate some of the characteristics, expectations, and role where it should be involved.

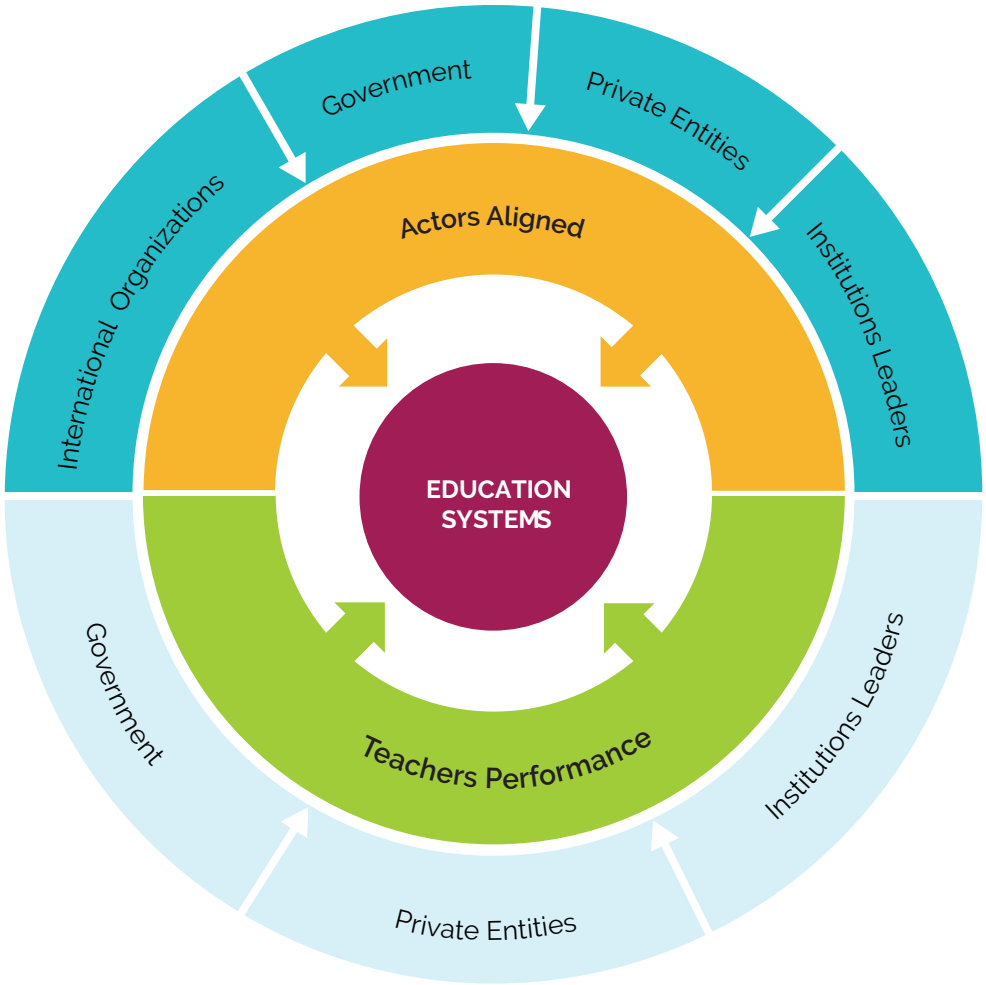


Figure 43. Main problematics of the system for the project approach

Source: graphic style based on World Bank. 2018. World Development Report 2018: Learning to Realize Education's Promise. Washington, DC: World Bank. http://www.worldbank.org/en/publication/wdr2018

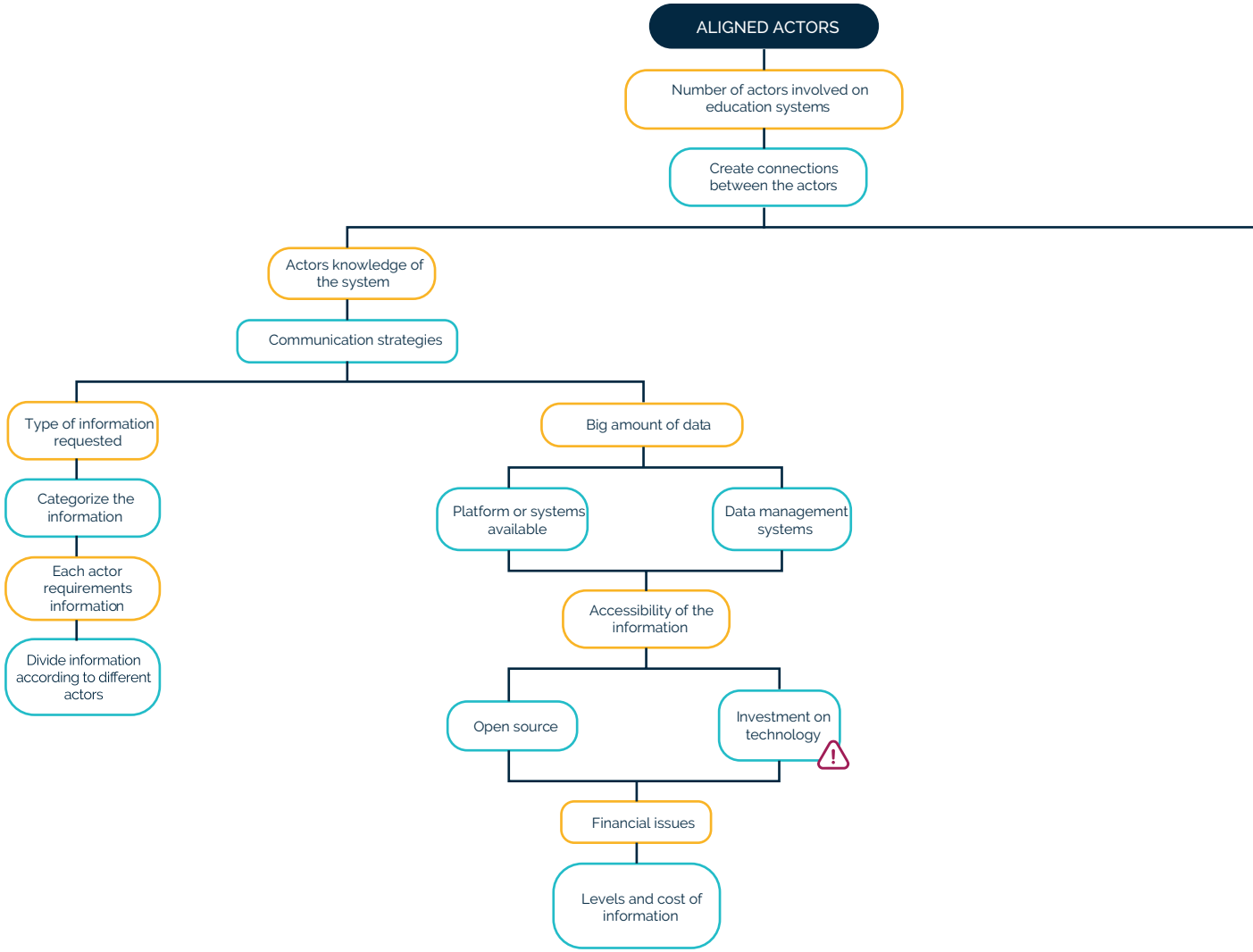
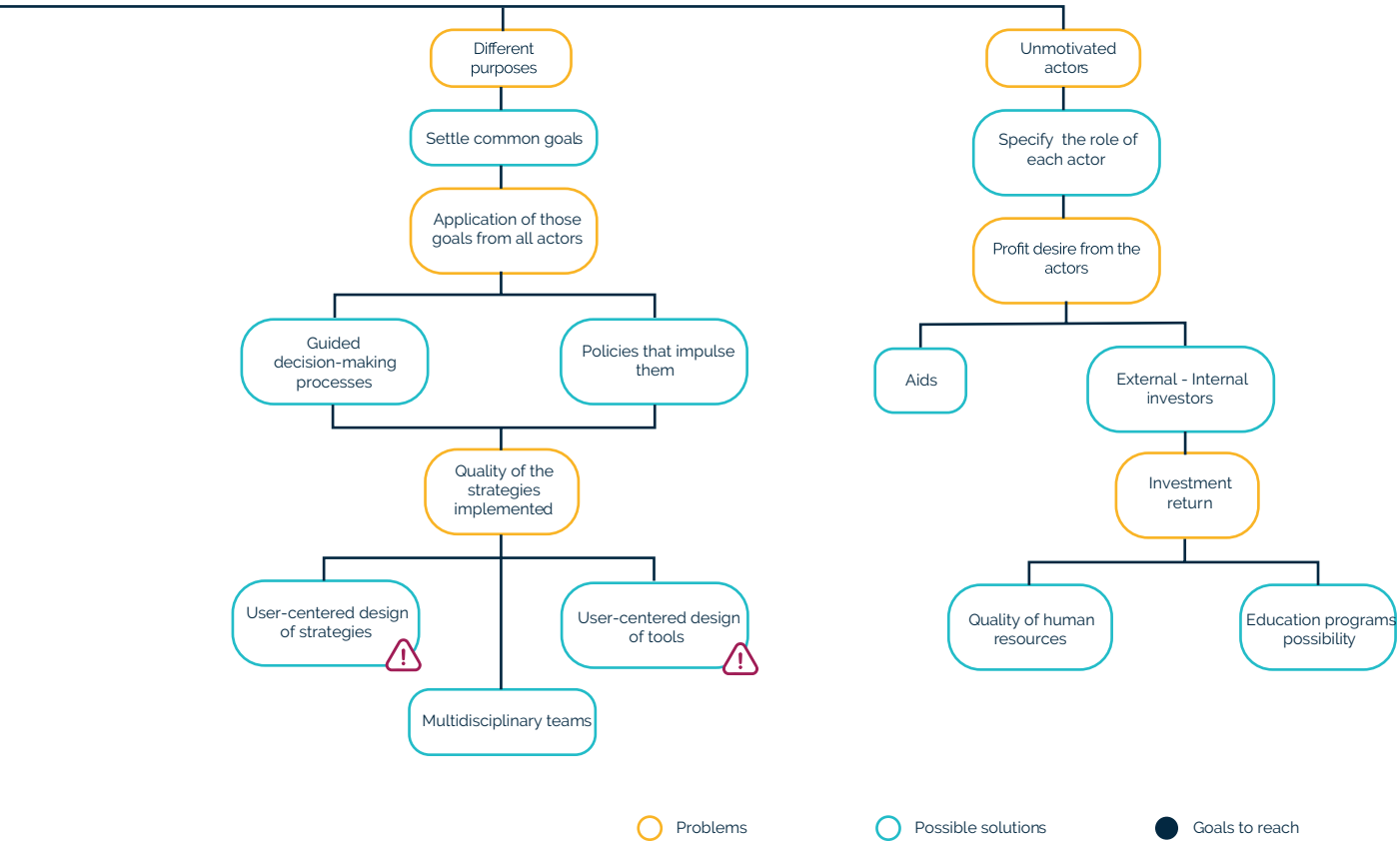


Figure 44. Aligned actors of education systems: problem network


Different purposes
Settle common goals
Application of those goals from all actors
Guided decision-making processes
Policies that impulse them
Quality of the strategies implemented
User-centered design of strategies
User-centered design of tools
Multidisciplinary teams
Unmotivated actors
Specify the role of each actor
Profit desire from the actors
Aids
External - Internal investors
Investment return
Quality of human resources
Education programs possibility
Problems
Possible solutions
Goals to reach

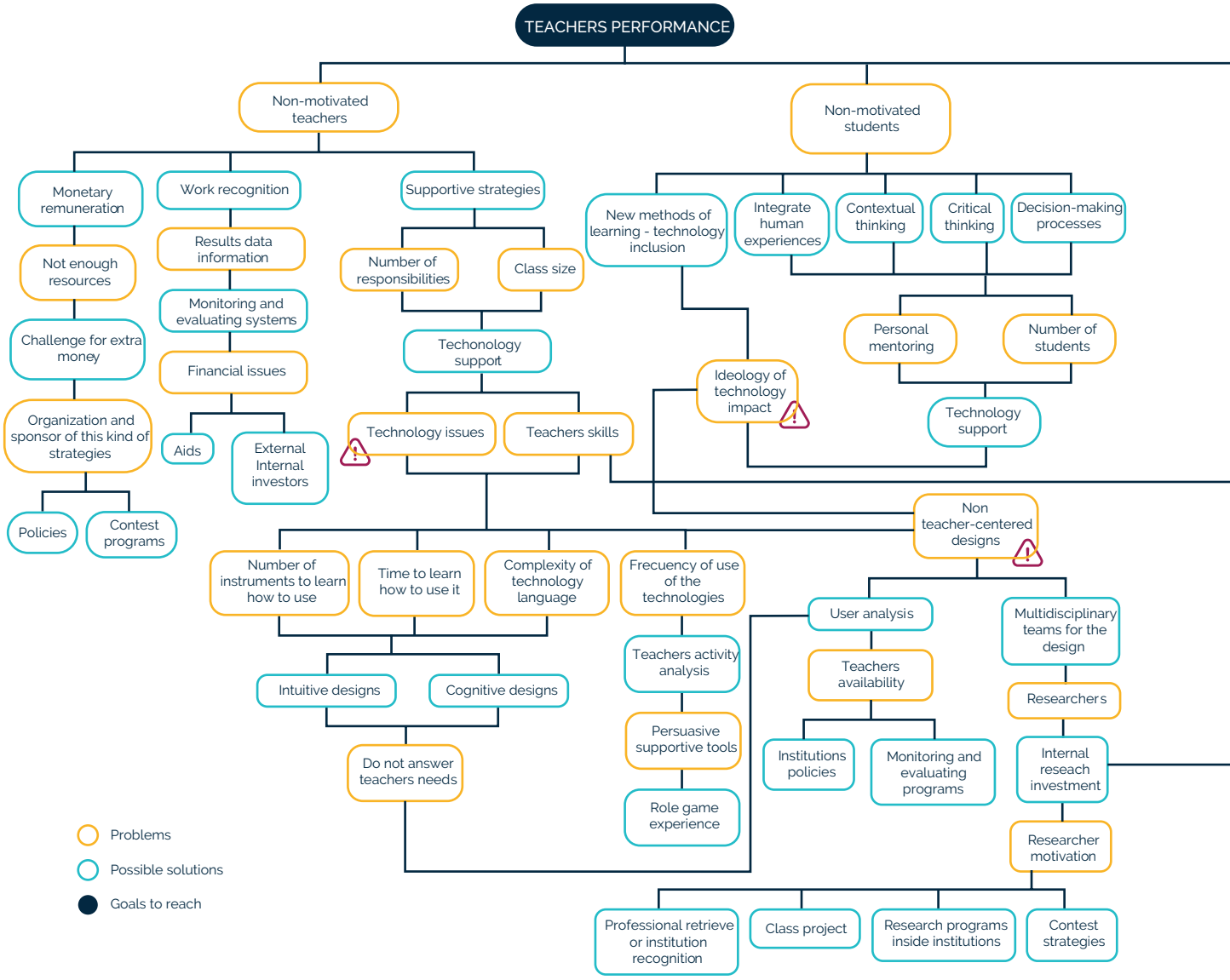
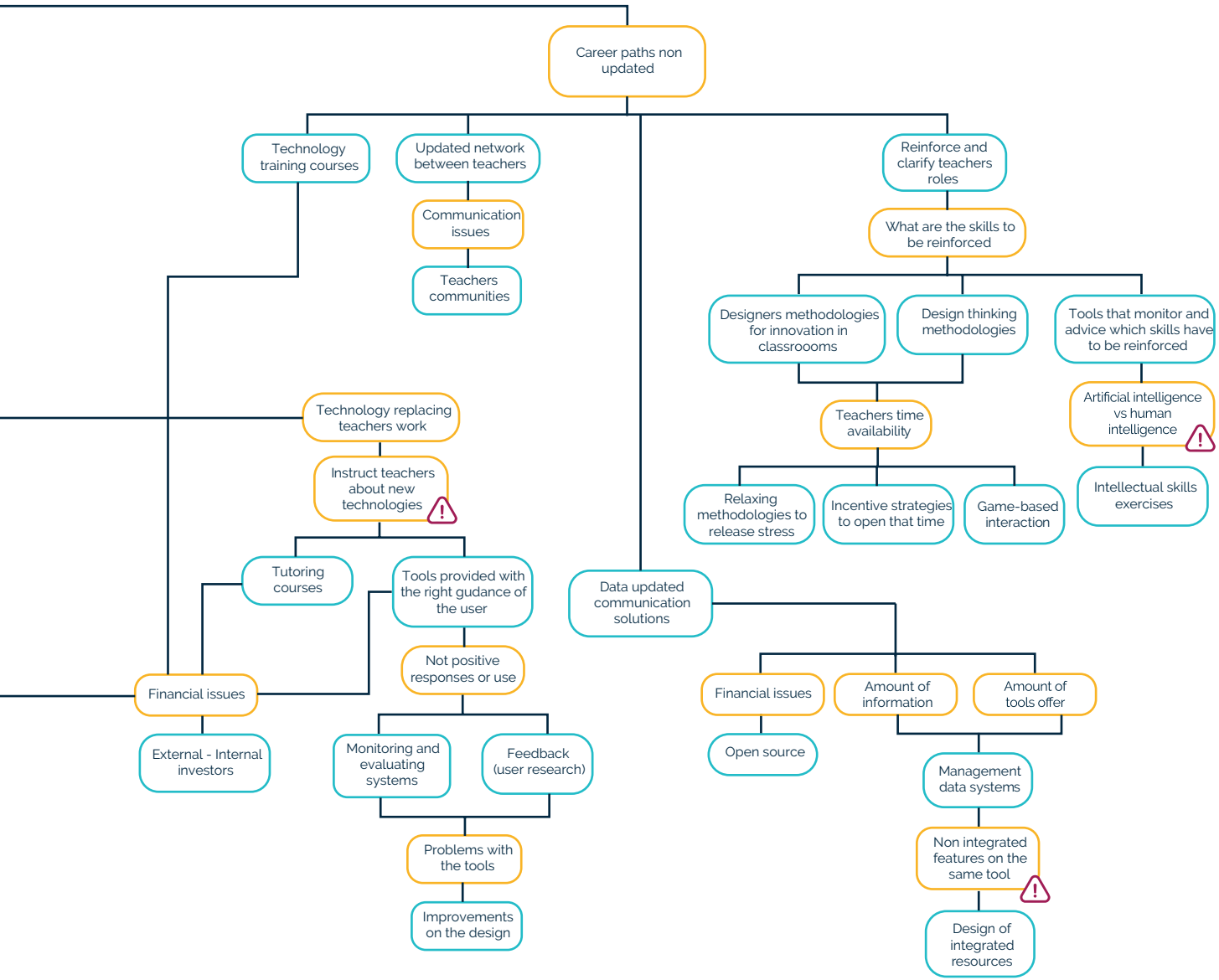


Figure 45. Teachers performance: problem network


Career paths non updated
Technology training courses
Updated network between teachers
Communication issues
Teachers communities
Reinforce and clarify teachers roles
What are the skills to be reinforced
Designers methodologies for innovation in classroooms
Design thinking methodologies
Tools that monitor and advice which skills have to be reinforced
Artificial intelligence vs human intelligence
Intellectual skills exercises
Teachers time availability
Relaxing methodologies to release stress
Incentive strategies to open that time
Game-based interaction
Technology replacing teachers work
Instruct teachers about new technologies
Tutoring courses
Tools provided with the right gudance of the user
Not positive responses or use
Financial issues
External - Internal investors
Monitoring and evaluating systems
Feedback (user research)
Problems with the tools
Improvements on the design
Data updated communication solutions
Financial issues
Amount of information
Amount of tools offer
Open source
Management data systems
Non integrated features on the same tool
Design of integrated resources

Personas Tool: stakeholders analysis

PRIVATE ENTITIES

The industrial developers of the system

Description: They are all the companies, private organizations that invest and produce the instruments for the education environments.

Goals:

Profit from the business

Reach more clients and keep current clients loyalty

Increase the market, overcome competitors

Role:
Provide the right resources needed on the education industry.

Capital Required

INTERNATIONAL ORGANIZATIONS

The drivers of the world's future

Description: They are the entities that study, collect, analyze and report the data around the world. Consist on multidisciplinary teams of work looking for the improvement of the system.

Goals:

Analyze global situations and problematics

Connect different institutions around the world

Collect and suggest solutions to global issues.

Role:
Collect and transmit all the information and analysis reached and impulse the solutions proposed.

Capital Required

INSTITUTIONS LEADERS

The decision makers of the future education

Description: They evaluate, study, manage and decide the education plan to be implemented, the resources and the strategies to keep the actors around satisfy and able to reach education goals.

Goals:

Provide a high quality of education to students

Manage efficiently the institution resources

Improve and innovate the process of learning

Role:
Take relevant decisions about education strategies and consequently invest on the on the right tools and human capital who hold the institution goals.

Capital Required

GOVERNMENT

The boosters of education systems

Description: This is the organization that structure the education system features and is the main actor to manage and improve the results of each country education.

Goals:

Optimize and provide coherent education plans

Provide education facilities to citizens

Improve the standards of human capabilities.

Role:
Support and implement policies, provide resources, invest on technology, innovation and motivate the actors involved to improve their performance.

Capital Required

STUDENTS

The key component for improvement

Description: They are the main goal of the strategies implemented on education systems, their result in terms of knowledge and skills for individuals prepare to manage life challenges.

Goals:

Learn, amplify, and improve their skills

Apply the knowledge in life experiences

Become prepared individuals to the world

Role:
Challenge and actively provide feedback to the education system and the actors around.

Capital Required

TEACHERS

The guide through the learning road

Description: They are the builders of knowledge and the developers of the education system purposes. They motivation is essential to optimize their work and the improvement of the system.

Goals:

Prepare students to face real life situations.

Guide students path of learning.

Support and motivate students to improve.

Role:
Provide the right knowledge and methods of learning that engage students to keep learning and support students along the road.

Capital Required

USER ANALYSIS

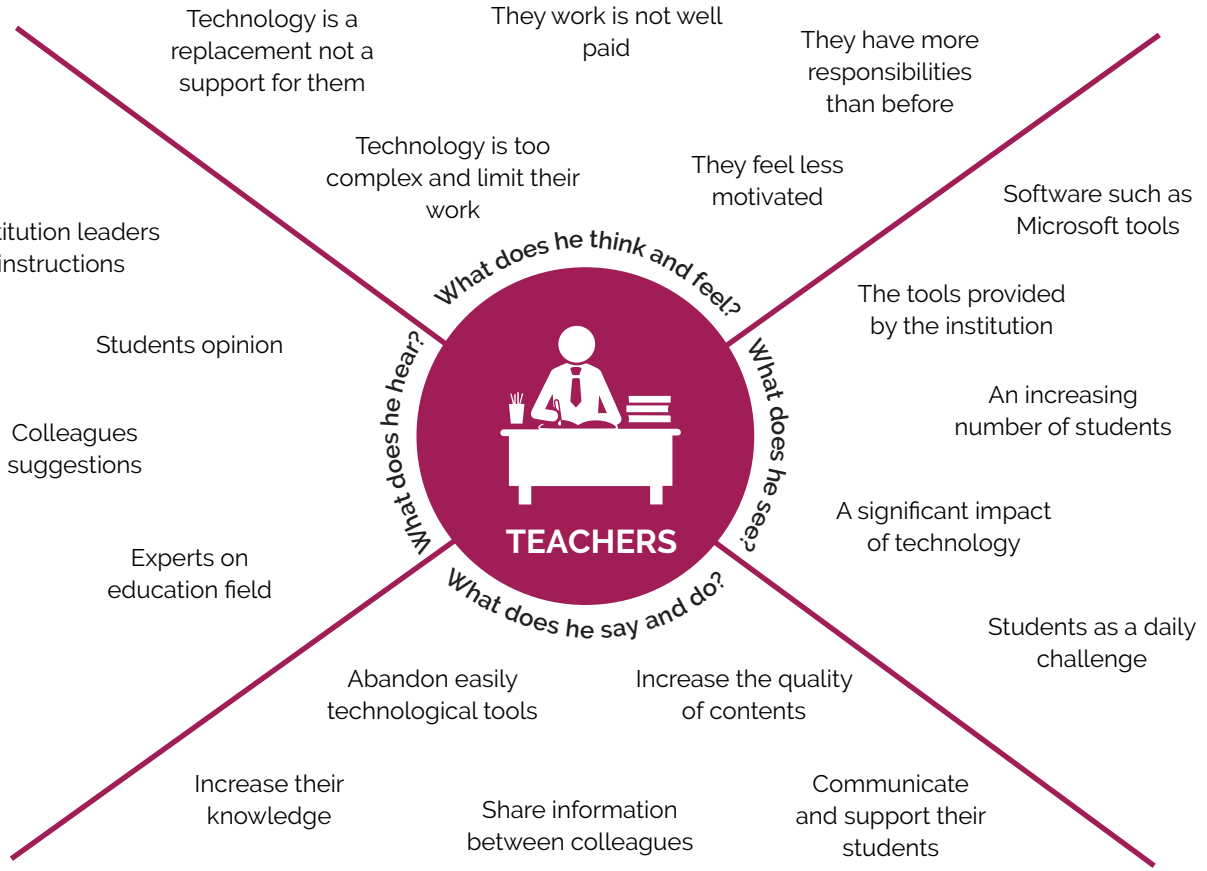
The conclusions achieved from the user research are mainly based on three sources: the theoretical information and studies related to the topic, the results of the data collected through the survey, and the observation obtained during the experimental project with the ASP program.

The first one, state the responsibilities of teachers in the learning environments, leading the project to keep special attention on educators as tutors that impulse the students to be critical thinkers and motivate them to go even farther than the information presented on the classroom. Consequently, is mainly required to stop marking teachers as the issuers of knowledge and evaluators, rather than optimize their interaction with the students and the methods to share and challenge the students to apply that knowledge in the real world in order to understand the potential of education outcomes and its impact on the society.

The second perspective provides an overview of the process followed by professors of universities in Italy on the construction of their courses and the body contents that support their main argument. The results manifested the frequency (in terms of time) of this process, the methods mostly implemented on their methodologies of teaching, the knowledge and expertise with new technologies, as their opinion related to the difficulties founded, their requirements, and expectations from those tools.

Finally, the direct interaction with educators confirms their opinion especially with the inclusion of AI-based EdTech methods to their learning methodologies. This specific discussion permits them to share their fears, and doubts about the supportive features of those technologies which lead the analysis to remark the form in which AI is being introduced and the limits around its potential, based on the communication strategies of the tools to the user.

As a result, each of these elements allows to identify and characterize the user from different aspects, making possible to accomplish an Empathy Map (in the following page) that provides an integrated description of the user requirements, desires, and characteristics that should be included on the design concept of future supportive tools for teachers.



Pain

Fail on the strategies of teaching

Their technological skills

Lose their job

Being replace by technology

Gain

Improve their methods or teaching

Motivated a prepared students

Supportive and integrated technologies

Facilitate and reduce the amount of work

ACTIVITY ANALYSIS

On this section was organized the steps of teaching process according to the previous analysis, combining the role of the teacher on the classroom but also the phase of improvement of their performance, then the educator that become also a learner.

From this viewpoint, the process was divided into five phases (figure 46): teacher training, teacher knowledge, teacher transmission of knowledge, teacher evaluation and feedback.

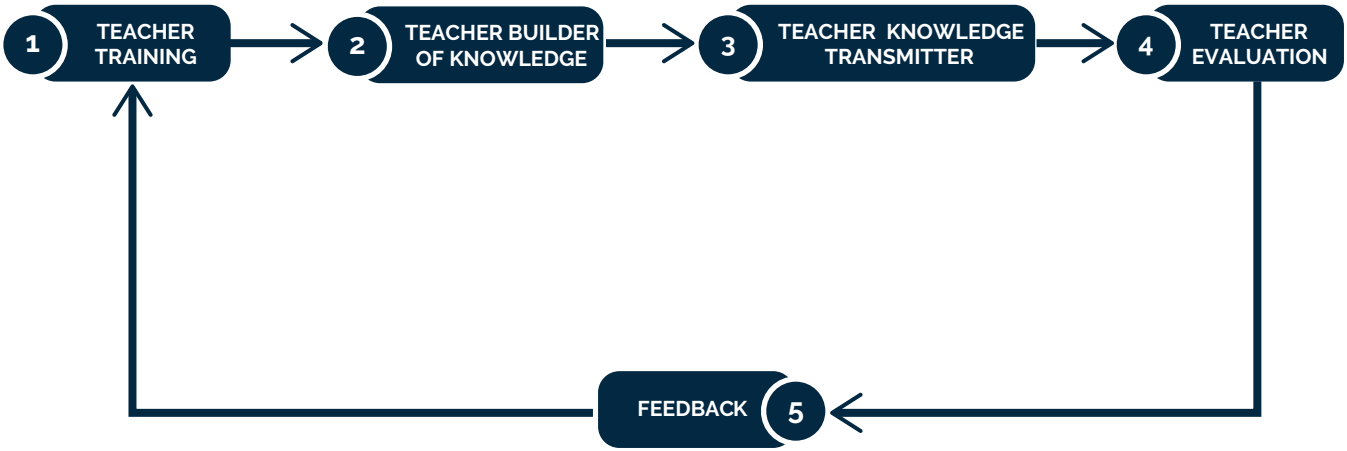
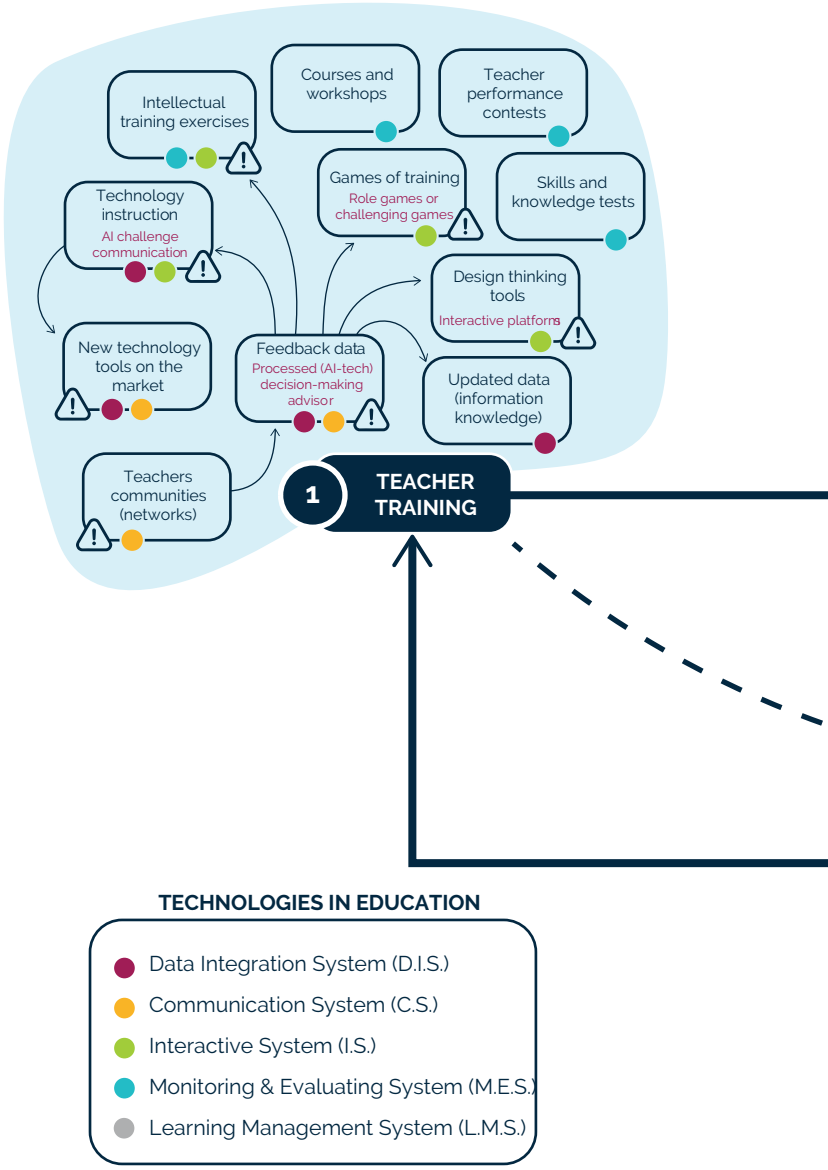


Figure 46. Teachers activity of teaching and learning: general framework

After understanding the points through which the educator must go, it was necessary to list a group of methods implemented on the education field and those from other areas that might have a potential to be included in this context as well.

The purpose was to categorize the tools that the users mentioned they are familiar with, in order to identify new solutions or missing connections between those methods. Likewise, this strategy illustrates the direct connection that should exist between the various methods implemented on each step of the process in order to provide integrated solutions and not single tools with different communication languages, which was one of the issues found by the user (figure 47).

Finally, it was possible to classify the methods into five types of technological systems that were consequently useful for the next phase of analysis related to technology implementation.



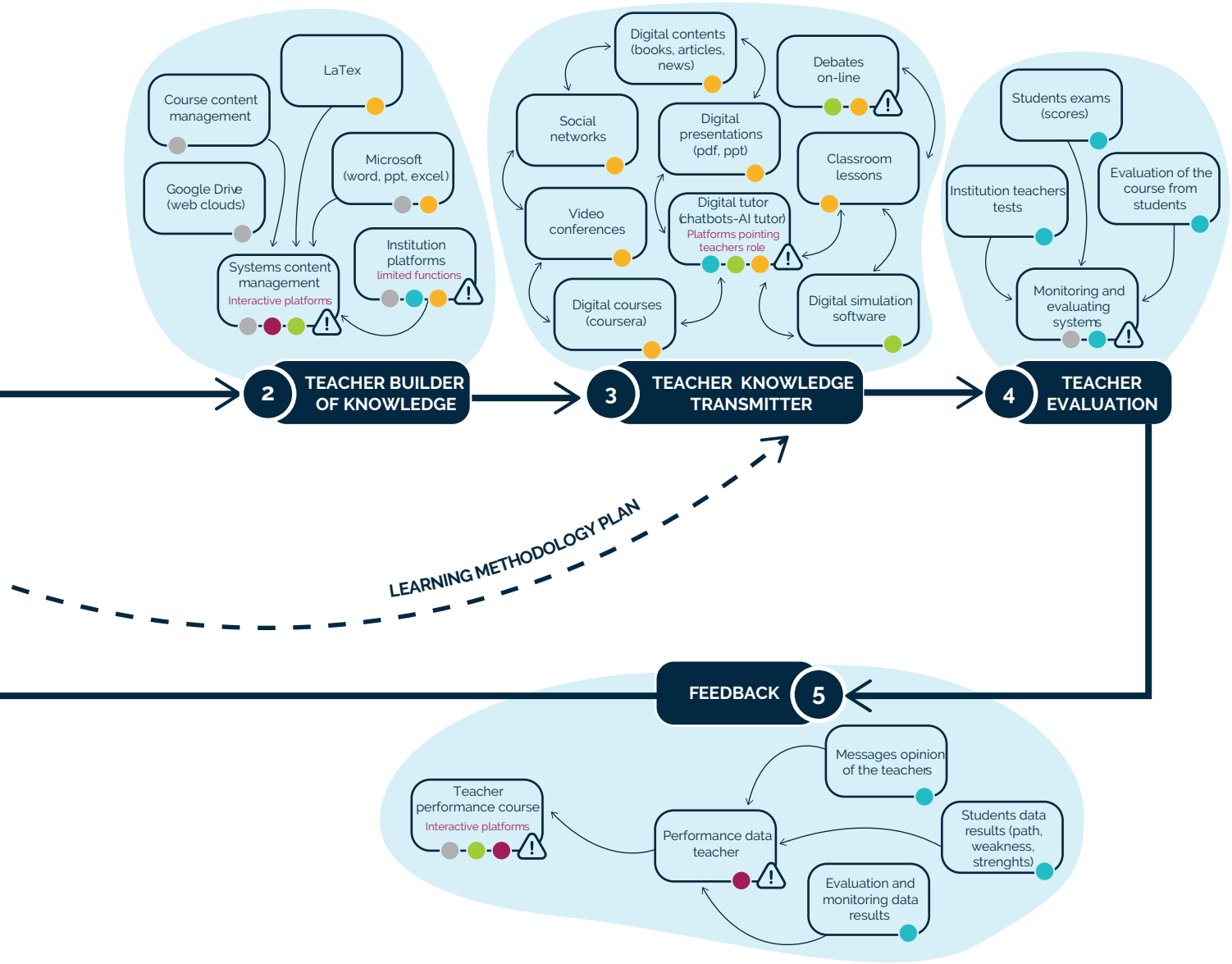
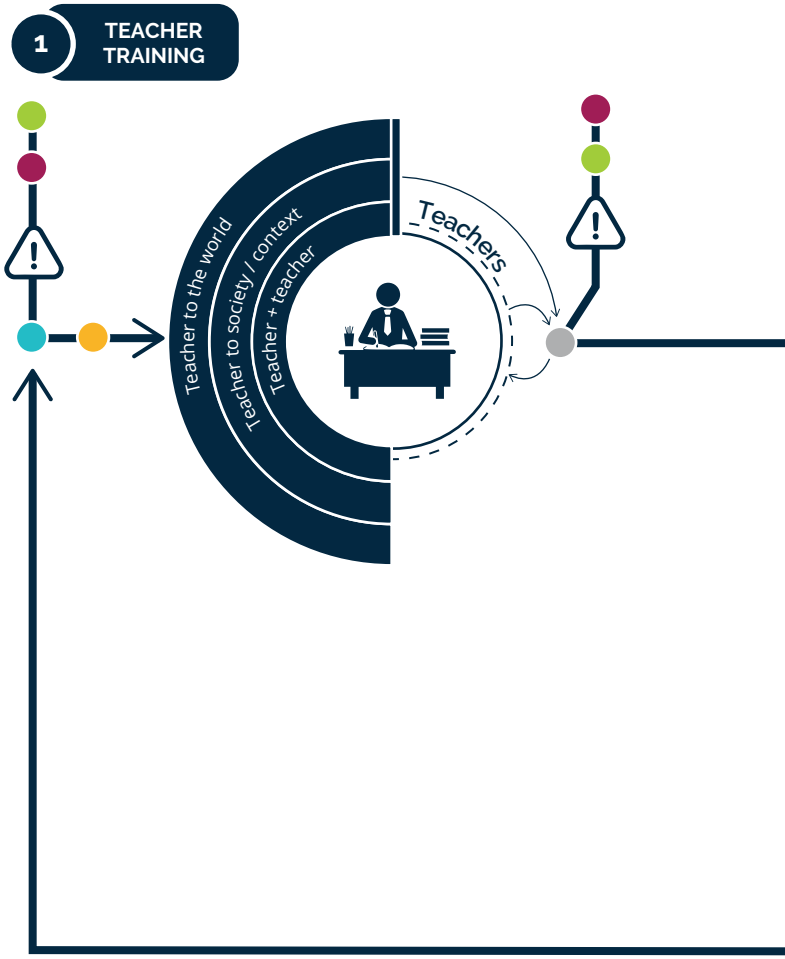


Figure 47. Teachers activity of teaching and learning: methods, systems categories and connections.

TECHNOLOGY ANALYSIS

This last step of analysis has the aim to locate on the current scenario each of the technologies categorized before, in order to understand where they are exactly established on the customer experience even though they are mostly disconnected among them. In other words, the implementation of technology support for teachers is usually represented on a series of tools that are not structured on the same language of use, which means there is not an integrated analysis of the features that technology should provide according to the user desires.

From this context, the scheme illustrates the teacher journey beside the technology systems included (figure 48). Then, as a result, it is identified the missing points of other systems to be implemented, opening the opportunity of new connections between them leading to a user experience improvement.



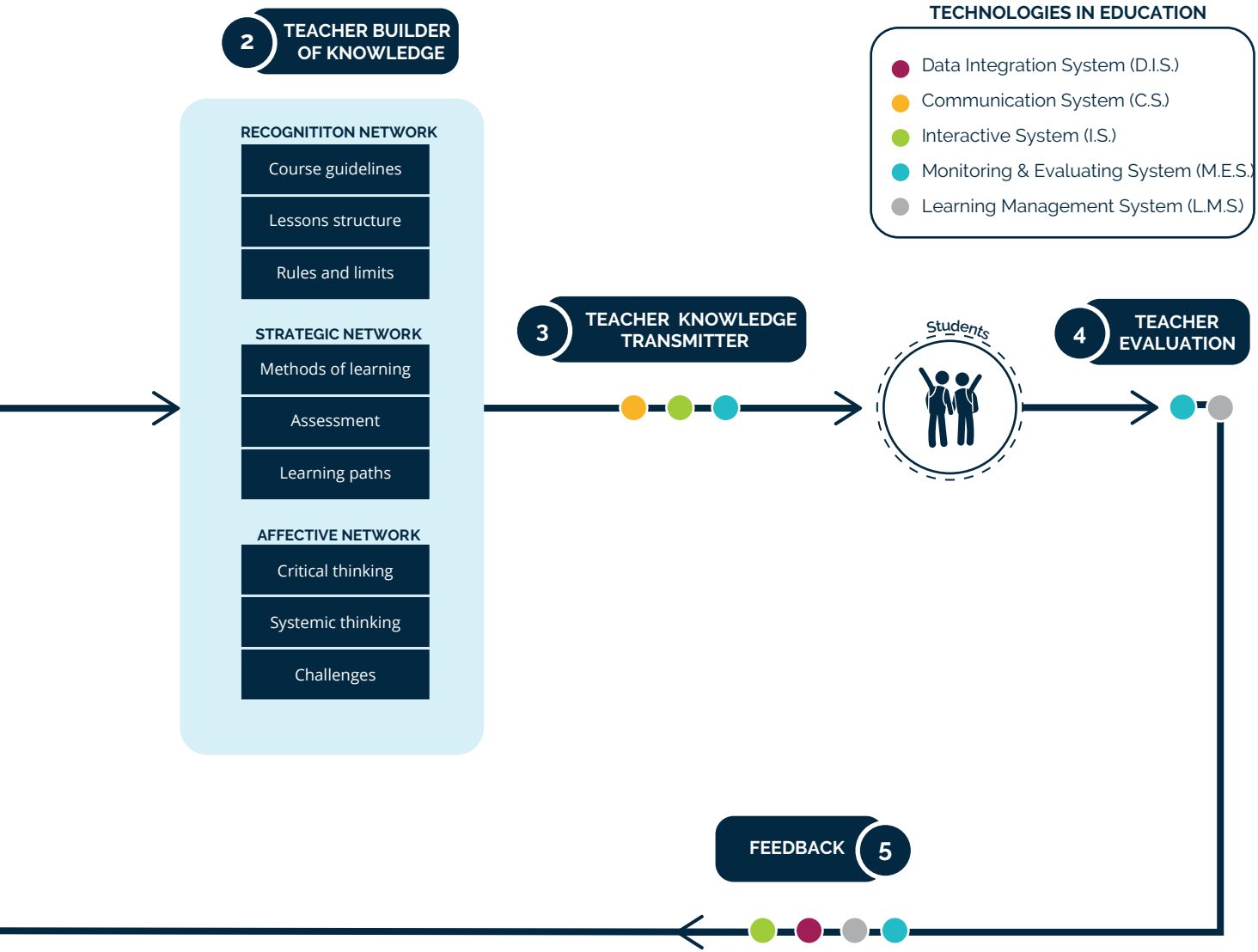


Figure 48. User experience journey based on technology systems inclusion.

Photo by Rawpixel on Unsplash

PROJECT BOUNDARIES

PROJECT OBJECTIVES

General objective

Generate an integrated tool guide for AI-based EdTech designers, driving them to implement user-centered solutions and the adequate strategies of introduction for this new technology into the education market, through the results identified by a systemic analysis.

Specific objectives

Boost the development of EdTech tools for teachers

i. Propound the design of more ethical and conscious supportive tools for teachers, based on a human-centered exploration of Artificial Intelligence technology.

ii. Promote more favorable strategies for the instruction and introduction of new technologies into the education industry, to consequently induce the user to reinforce specific skills for their enhancement.

iii. Persuade professionals from different disciplines to get involved in the study and development of AI-based technologies creating multidisciplinary teams leading to obtaining integrated multifaceted solutions.

Systemic scenario for strategic feasibility plans

i. Provide a flexible and adaptable overall scenario including the stakeholders to be targeted and the components interaction during the design process.

ii. Demonstrate the relevance of user-centered design to achieve proper results on the market and efficiency on the developed products.

iii. Contribute a user experience journey throughout each step of the teaching process and the implementation of optimal technology systems strategically arranged.

Synthesis and integration of multidisciplinary information

i. Encourage developers to implement Systemic Design Thinking methods for the establishment of a design concept for supportive tools in education.

ii. Identify the connections between the components of the system and subsystems leading to propose new connections or modify some of the currently found.

iii. Classify hierarchically the information involved in the analysis to provide potential conclusions that might become a contributing source for the decisions of design taken by the following EdTech tools for educators.

iv. Determine the inputs, outputs and the processes inside the teaching frame to transmit a general scenario to keep in mind in the intervention for the improvement of education systems.

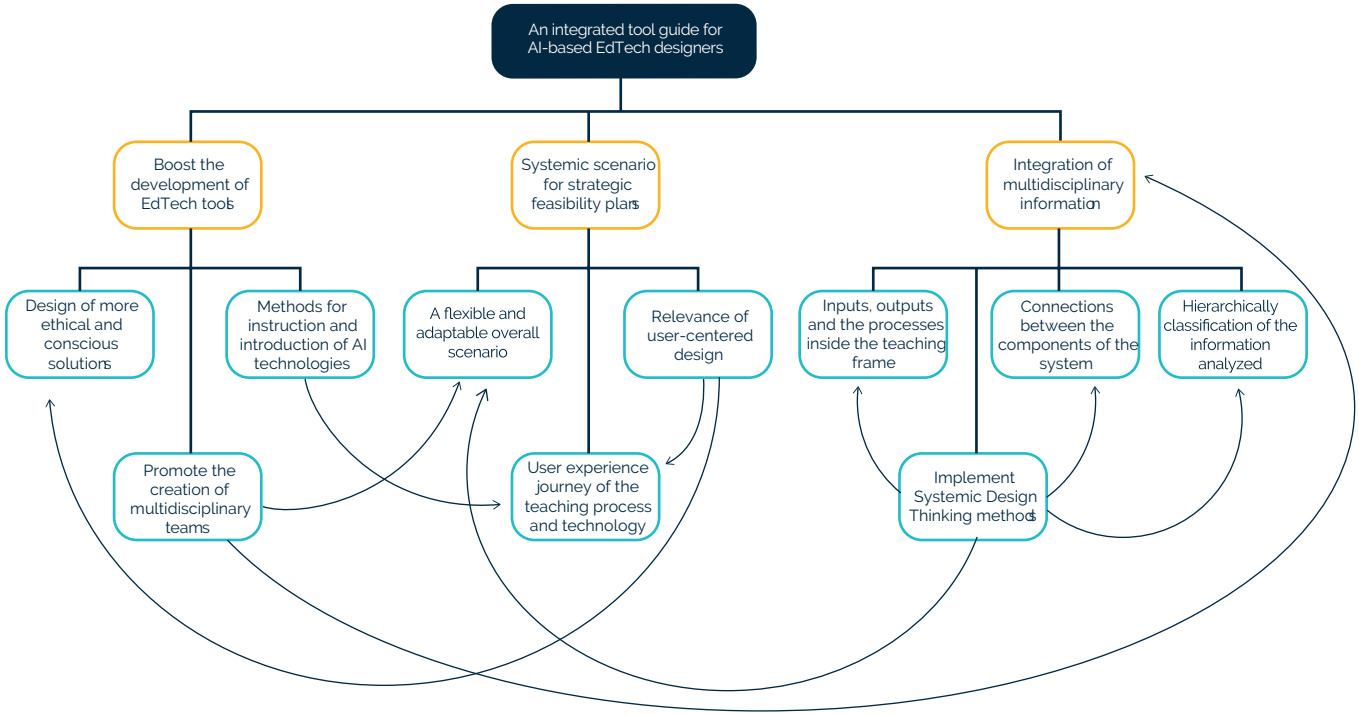


Figure 49. Objectives map of the project

PROJECT REQUIREMENTS

In respect with the aim of the project, the requirements strategy to be implemented is requested to point to the visualization of relevant information needed to be communicated for the future developers of AI-based supportive technologies. Therefore, it was pertinent to reference the methodology created by Andrew Vande Moere and Helen Purchase (2011)[62] that is based on a triad of requirements for visualization design structured to acquire the message receiver's attention. Those three key elements they refer are (figure 50): Utility (functionality, usability, effectiveness and efficiency), Soundness (reliability, versatility, feasibility), and Attractiveness (aesthetics, originality, communication channels). Evidenced on figures 51, 52 and 53.

62 *Moere, A.V., & Purchase, H.C. (2011). On the role of design in information visualization. Information Visualization, 10, 356-371. DOI: 10.1177/1473871611415996. Available at https://pdfs.semanticscholar.org/d9c8/a774a7cfd3f93ca5d1c80e192bba0ade6f77.pdf?_ga=2.26743739.725482847.1549844436-1545816123.1548633208*

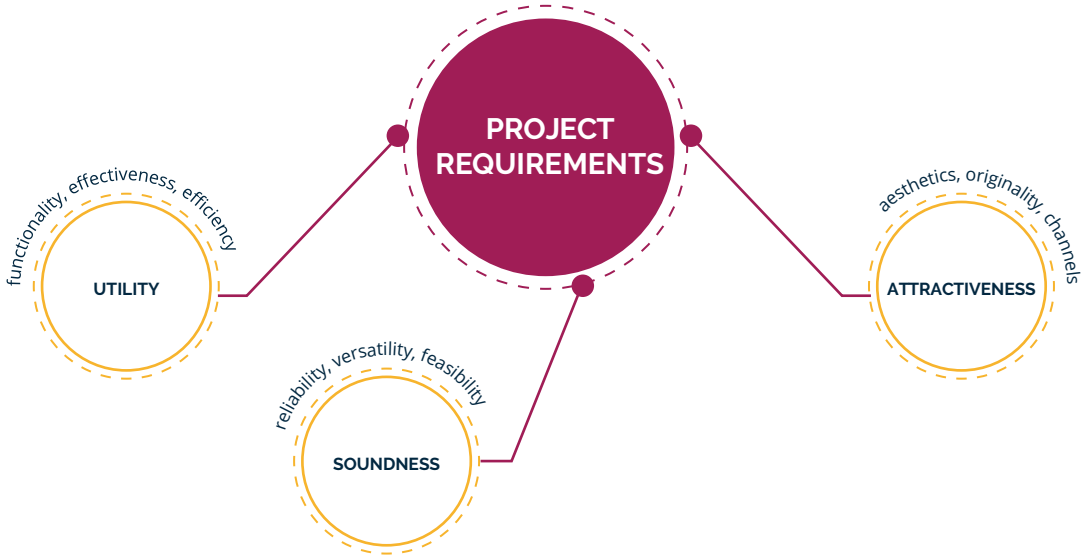


Figure 50. The Vitruvius triangle, based on typical architectural design requirements.
Source: Adapted from Moere, A.V. and Purchase, H. 2011. On the role of design in information visualization. Available at https://pdfs.semanticscholar.org/d9c8/a774a7cfd3f93ca5d-1c80e192bba0ade6f77.pdf?_ga=2.26743739.725482847.1549844436-1545816123.1548633208

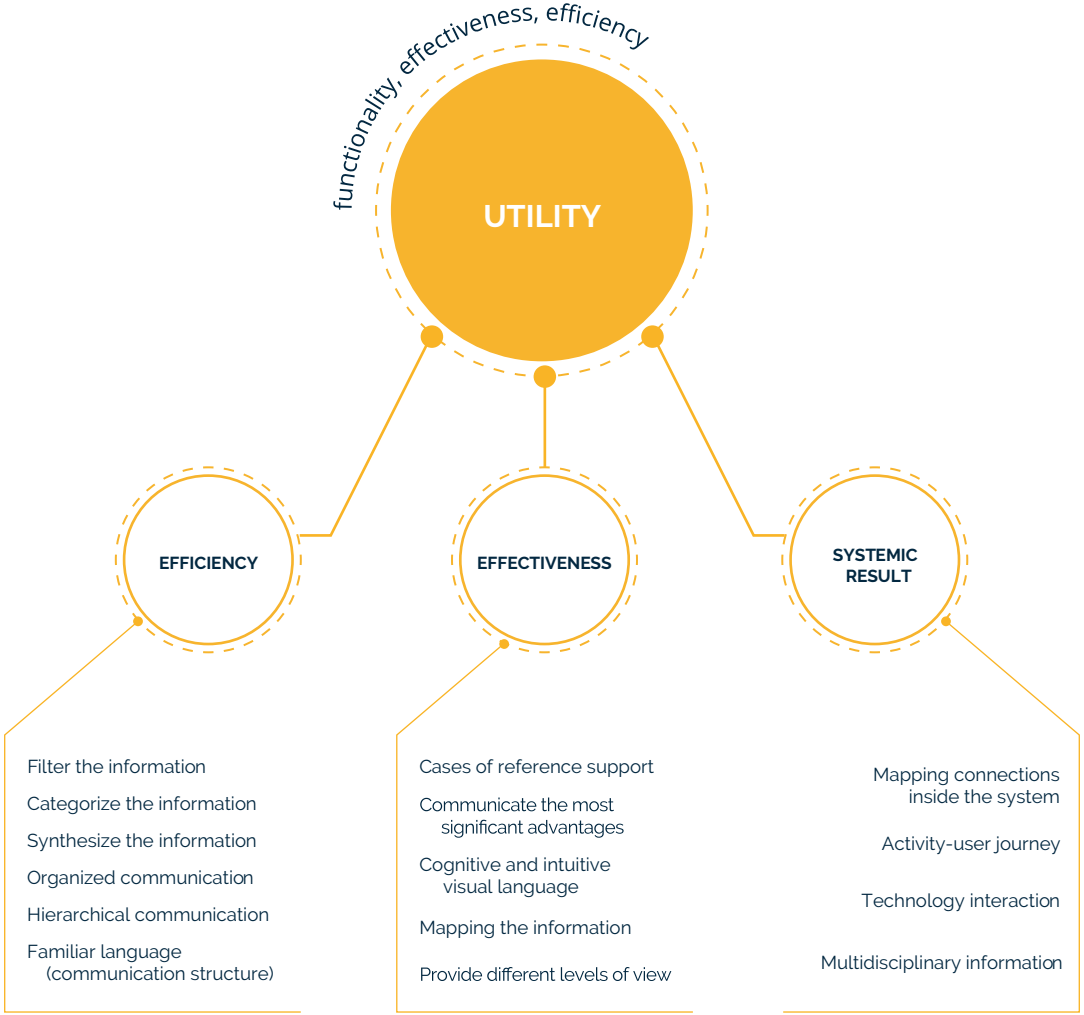


Figure 51. Requirements and methods for Utility aspect

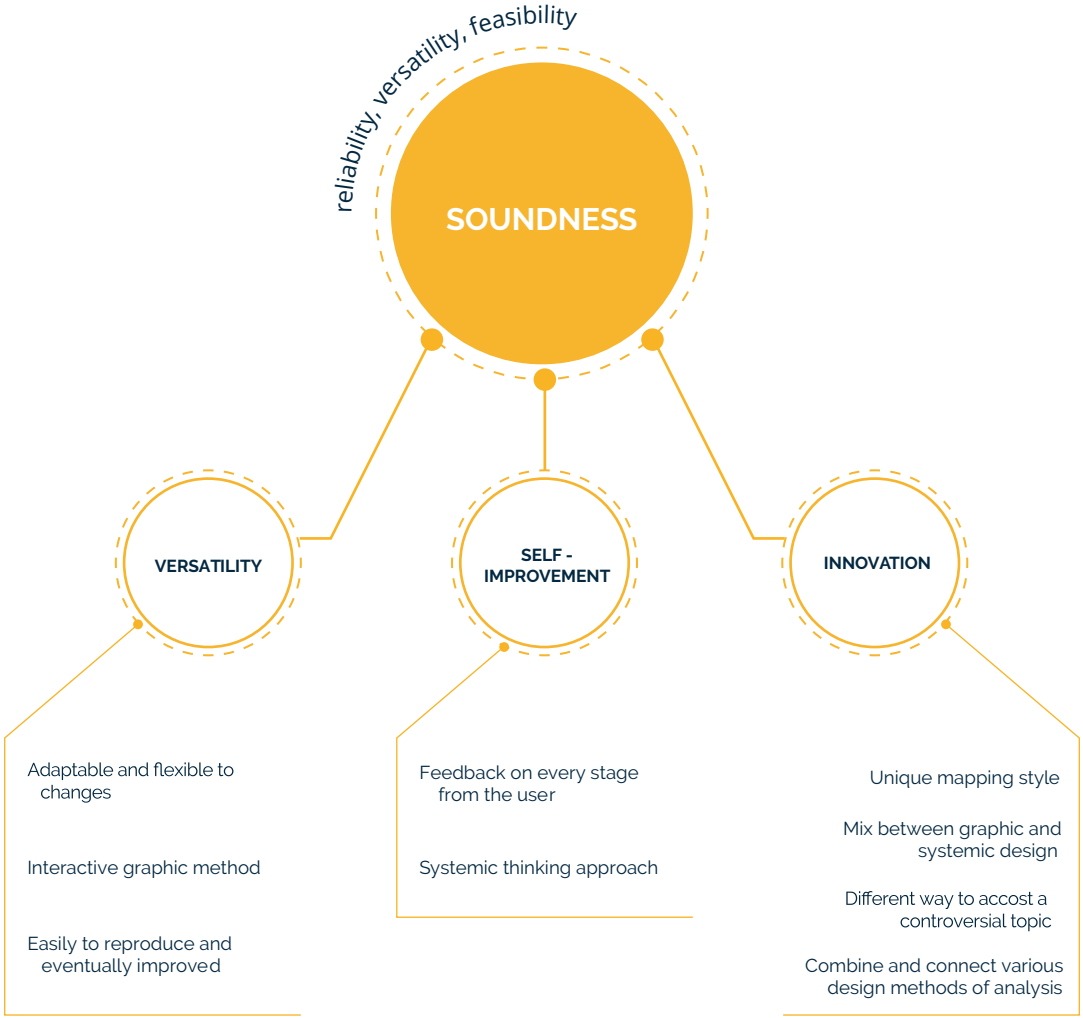


Figure 52. Requirements and methods for Soundness aspect

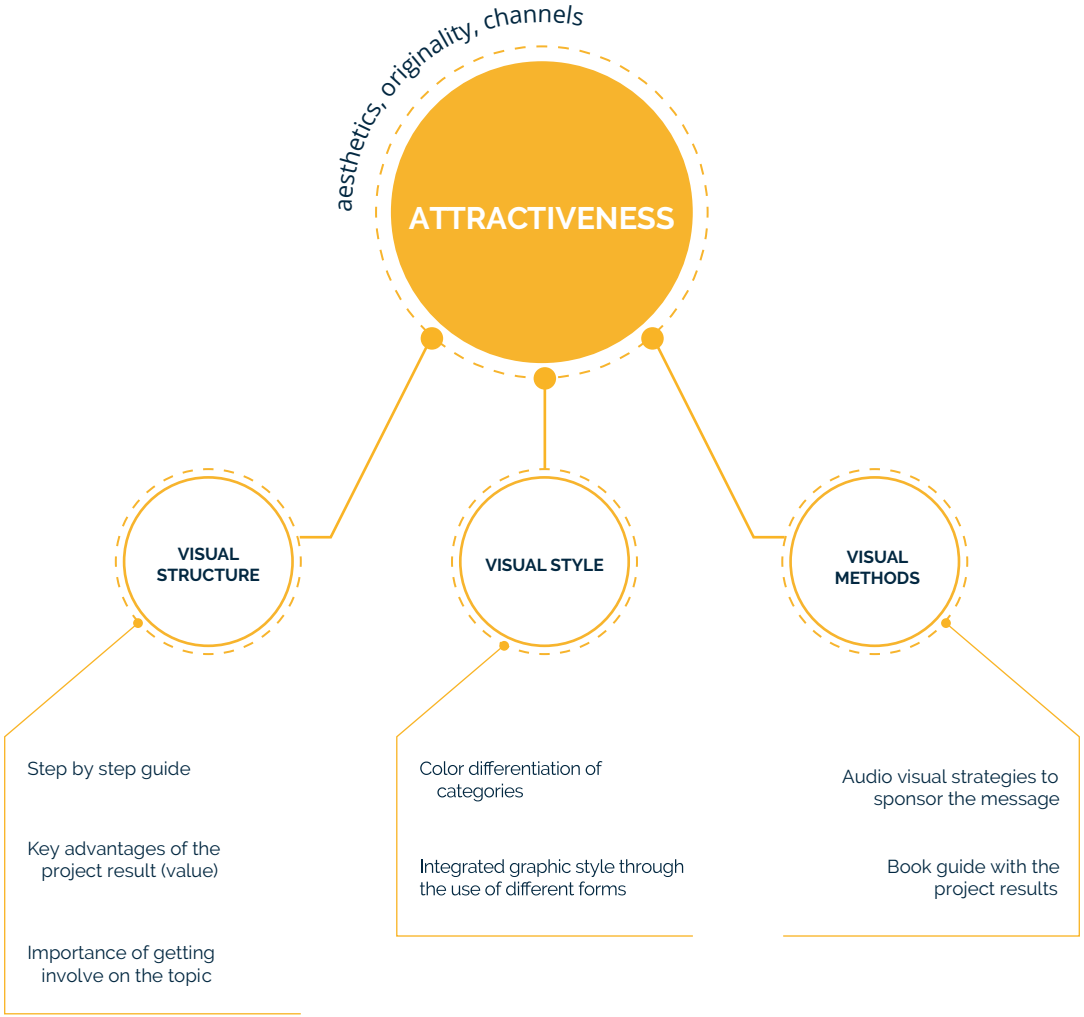


Figure 53. Requirements and methods for Attractiveness aspect

JUSTIFICATION OF THE STUDY

One of the biggest challenges that education systems have been facing along the last decade is related to the range of students that attend to learning institutions. However, according to recent data collected around the world by international organizations, there is a major problem that has been identified, the quality of education. In other words, learning environments should not be measured by the number of students they are able to offer a service but is more important the quality of the sources and strategies provided to achieve positive outcomes.

From this context, the quality of education depends on a variety of factors connected to the elements and actors involved in the system. Nevertheless, studies on the field have demonstrated that one of the main causes is the motivation of the individuals interacting on learning and teaching processes which means that part of the challenges of education is to remain motivated students and educators along the road. Hence, this research is focused on understanding and identifying teachers requirements, in order to afford supportive tools to facilitate their work but based on the appropriate implementation of new technologies such as Artificial Intelligence.

Consequently, the approach of the study is to evaluate different perspectives to create a scenario of the education systems and the subsystems inside that refer to the teaching-learning processes. As a matter of fact, the information and arguments granted along the research, demonstrate that present and future educators are challenged to reinforce some of their responsibilities and release some others that can be supported by the technology.

Nevertheless, this paradigm shift has to be adequately accompanied by solutions pointing to the same objectives, which means that the decisions taken inside the subsystems and the tools developed by the entities around are requested to impulse those purposes. The approach of this project is to impulse for the implementation of supportive tools that follow teachers desires and encourage them to improve their role as leaders of education, thereby the strategic plan might motivate the stakeholders involved in the system to invest in the creation of solutions related.

In particular, the most important contribution obtained by this investigation is the multidisciplinary exploration and the overall and singular analysis of the system. For instance, the analysis of AI technology from a theoretical and experimental perspective contrasted with studies focused on human intelligence features, open a discussion for developers to identify the importance of new technologies but giving more relevance to the role of the actors around it in order to avoid collateral effects on the society. As a result, the outcome obtained by this study is looking forward to motivating future developers of this kind of technology to inquire and evaluate the features and requirements of their products or services, leading to create useful, efficient, and desirable tools for educators.

The main impact of the study is to communicate a strategy, based on systemic analysis through a systemic visualization, to find solutions well designed and well instructed for the present and future generations to implement them. In other words, educational technologies have been significantly changing during the last years, therefore, is also valuable to understand its power from a rational perspective which means identifying and exploit its features but in a consistent manner.

Finally, the advantages brought to the system can be defined by:

i. The connections that can be created between the different actors involved, willing to align their purposes and actions to achieve the requested outcomes settled in the education system boundaries.

ii. The incentive for current and future developers of EdTech for educators to create tools well analyzed and evaluated from a user-centered perspective, to impulse industries or processes where technology works “hand by hand with the human”.

iii. A systemic perspective of the scenario in which educational technologies are immersed leading to motivate students and professionals from different disciplines for the exploration of Artificial Intelligence and new high technologies features based on diverse points of view to achieve well-designed solutions.

LIMITS OF THE PROJECT

During the research and the project development there were some inconveniences, likewise around the topic studied is possible to find uncertain information and variability of the results due to the continuous changes and technological developments.

Thus, the main limits of the project are:

From the methodology perspective

i. The availability of time of the users to obtain more specific results during the research which, for instance, confine the opportunity of applying an interview session to engage more with the teachers and allow them to participate more actively on the research.

ii. The interaction and direct relation with the stakeholders in order to verify the information reached from the literature and considering their current perspective of the situation.

iii. This type of project requires the expertise and participation of a multidisciplinary team to enrich the different aspects evaluated and included on the systemic analysis thereby enabling the veracity of the conclusive report.

From the topic perspective

i. The AI-based supportive tools in education implement technology in the phase of exploration which means is unpredictable the changes it might suffer during the next years, modifying and probably contradicting the results obtained on the research.

ii. AI technology implementation on the education industry is presenting debatable opinions and repercussions that during the research was difficult to affirm the authors with the right arguments, which makes the study subjective since it depends on the researcher ideological direction.

CHAPTER III
DESIGN CONCEPT

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PROJECT CONCEPT

AI-EdTech for educators is a communication strategy based on a systemic analysis approach to promoting the inclusion and participation of students and professionals from different disciplines to explore and evaluate consciously the advantages of Artificial Intelligence technology for education, mainly focus on the improvement of teachers performance.

It consists of a guide book that contains an instructed methodology divided into phases that current and future developers should follow, analyze and evaluate during the design of AI-based supportive tools. The research results investigated in this thesis uphold the methods and arguments defended on the communication strategies implemented.

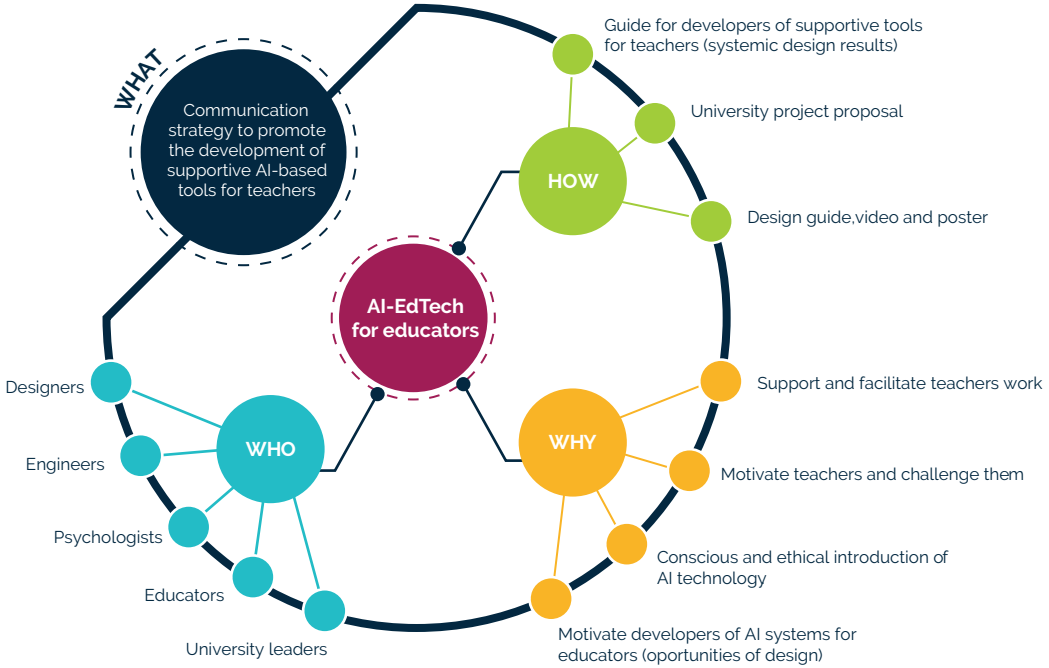

Figure 54. AI-EdTech for Educators: project concept boundaries

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STRATEGY PLAN

The project is structured into five steps that correctly connected will achieve the approval and investment by the right stakeholders to impulse the development of supportive tools for educators from an internal (institutional level) to get the attention of external actors leading them to take part on the solution from their capabilities and role on the system.

The first step is to integrate the information collected along the research and transform it into a guide book that contains flexible schemes that connect the information and provide a synthetic communication of the education system scenario and the subsystems inside of it. However, it can be modified and improved on the following steps due to the complexity and variability of the system.

Through this study, the objective is to persuade and motivate students, professionals and institution leaders to create a network and a multidisciplinary team that enrich the project aim to lately explore the technology, impulse a participative design (include teachers on the design decisions), testing prototypes developed, improve teachers performance and consequently increase education's quality of the institutions involved and the education system itself.

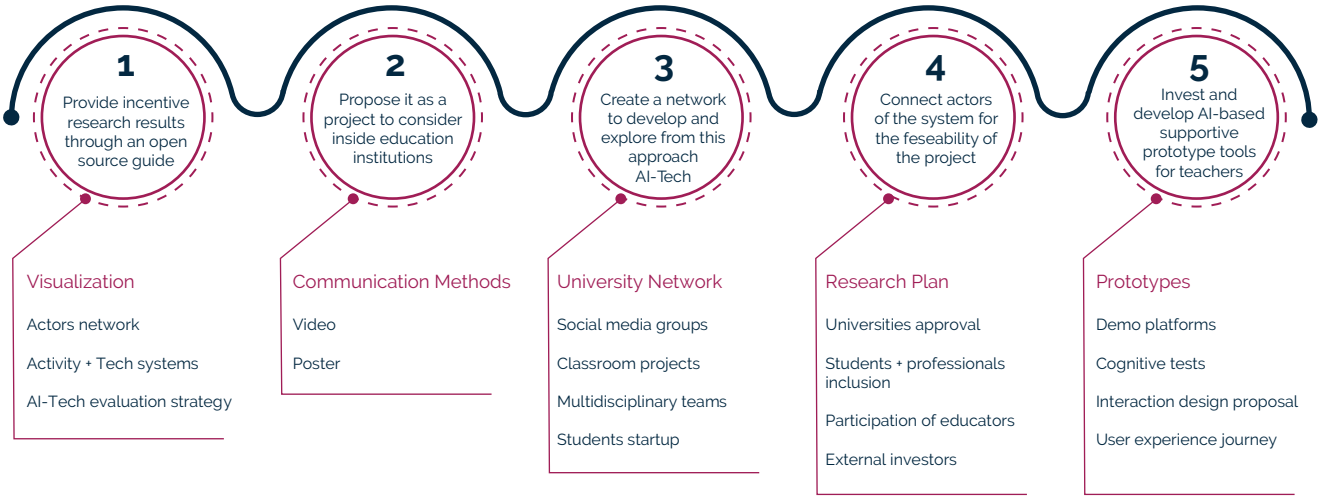

Figure 55. AI-EdTech for Educators: structure of the strategy plan and the elements to include

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PROJECT PROPOSAL

The Guide Book, AI-EdTech for educators, is a short book that presents the problems found in education systems and the implementation of new technologies in learning environments, giving a broader context of the situation and the impact of its study. Then, it provides a methodology plan where is mapped the design process and consequently divided into three main phases to keep in mind with their corresponding methods of analysis, design, and evaluation of the final solutions.

Each of the phases explained in the book are supported by concepts studied on the research and briefly explained in order to contextualize a general public that might be interested in discovering the project aim and procedure. The Guide Book is designed with interactive and flexible graphics with the purpose of lead through general boundaries, to an open and adaptable system that developers can analyze, modify and recognize easily the strategies their own teams would like to implement.

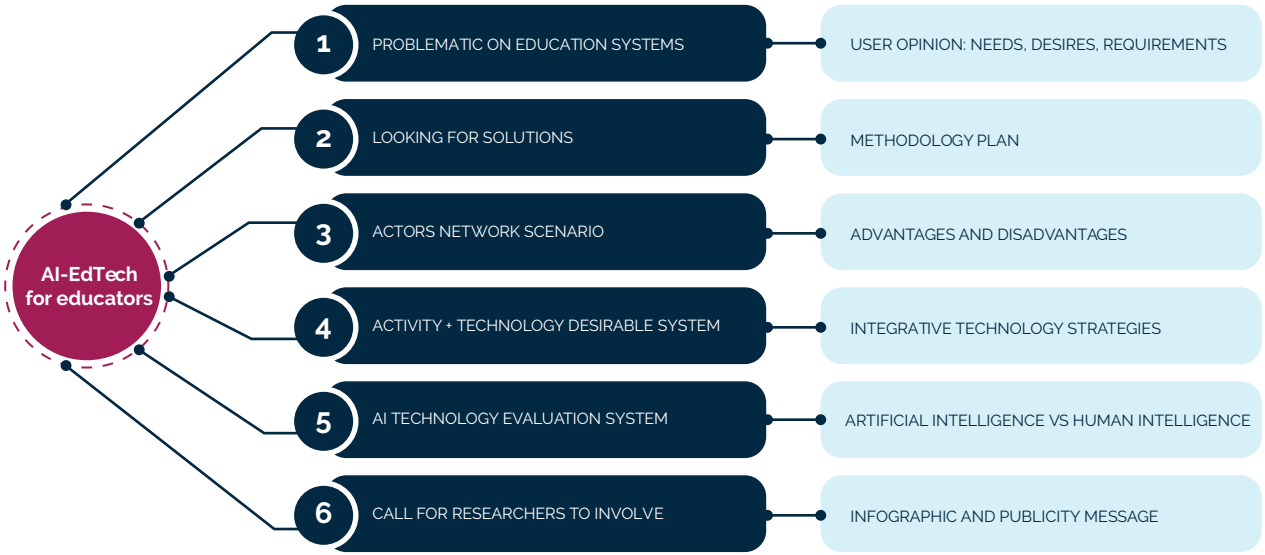


Figure 56. AI-EdTech for Educators: communication strategy components

ACTORS NETWORK

This graphic scheme integrate and communicate the role and resources mainly provided by each actor inside the system. The purpose is to illustrate to the public a general scenario of the elements a project of this kind might have in disposition, leading to organize the team ideas and take decisions of the strategies to be implemented in order to create connections with the right target.

On right side of the graphic, there is an internal level of actors (teachers, students and institution leaders) while on left side are situated the external actors of the project (government, private entities, and international organizations) and besides each of them the resources they can provide to the project (figure 58). The idea is to recognize and decide who, when, where (process) and how is going to intervene in the project (figure 57).

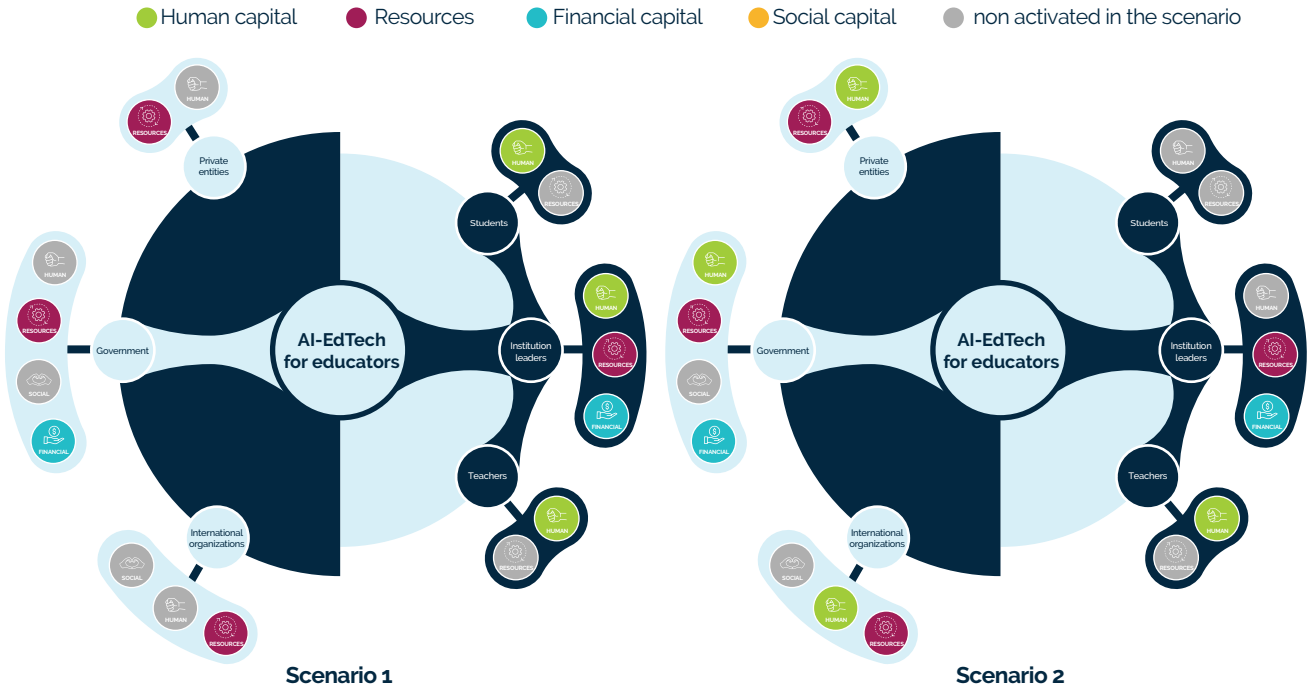


Figure 57. Possible scenarios of actors connections and role on the system

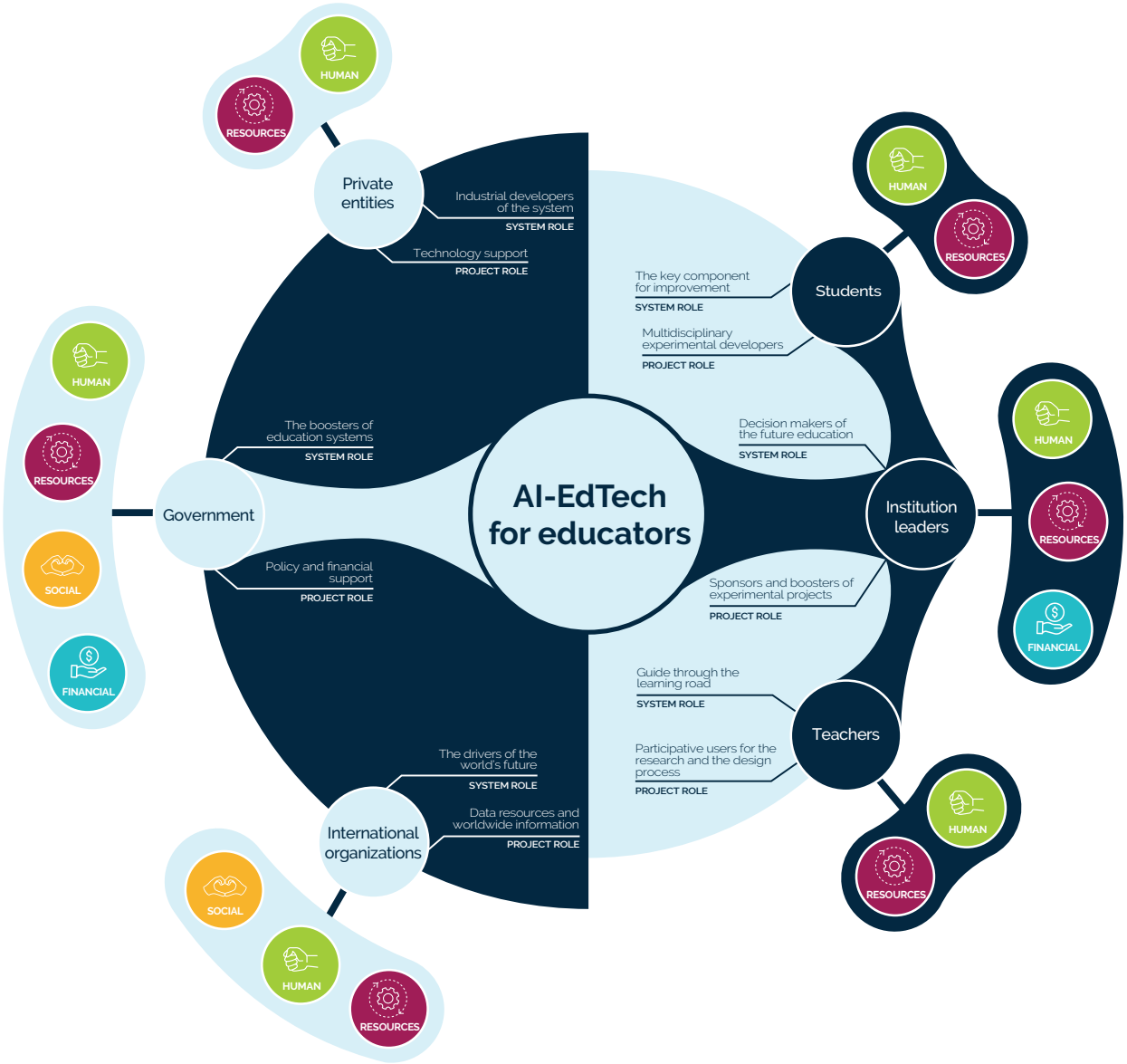
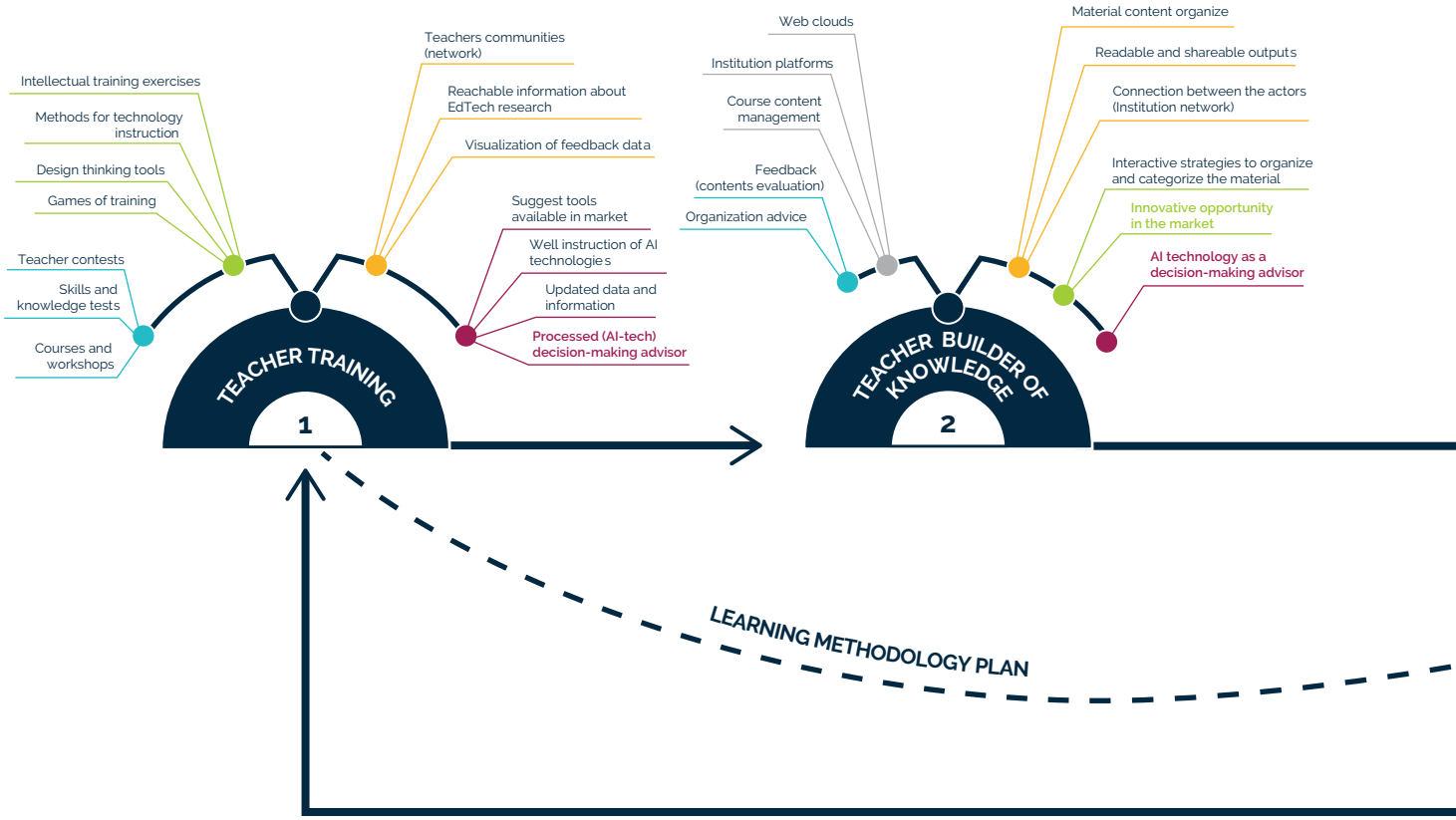


Figure 58. Graphic scheme of actors involved inside an education system and their resources



ACTIVITY AND TECHNOLOGY

In this phase is presented the process of teaching. In each step is suggested a group of technological systems that should be integrated to provide the tools required by educators and a group of characteristics or possible solutions to be included to improve teachers labor. This result is mainly based on user research results.

TECHNOLOGIES IN EDUCATION

- Data Integration System (D.I.S.)
- Communication System (C.S.)
- Interactive System (I.S.)
- Monitoring & Evaluating System (M.E.S.)
- Learning Management System (L.M.S.)

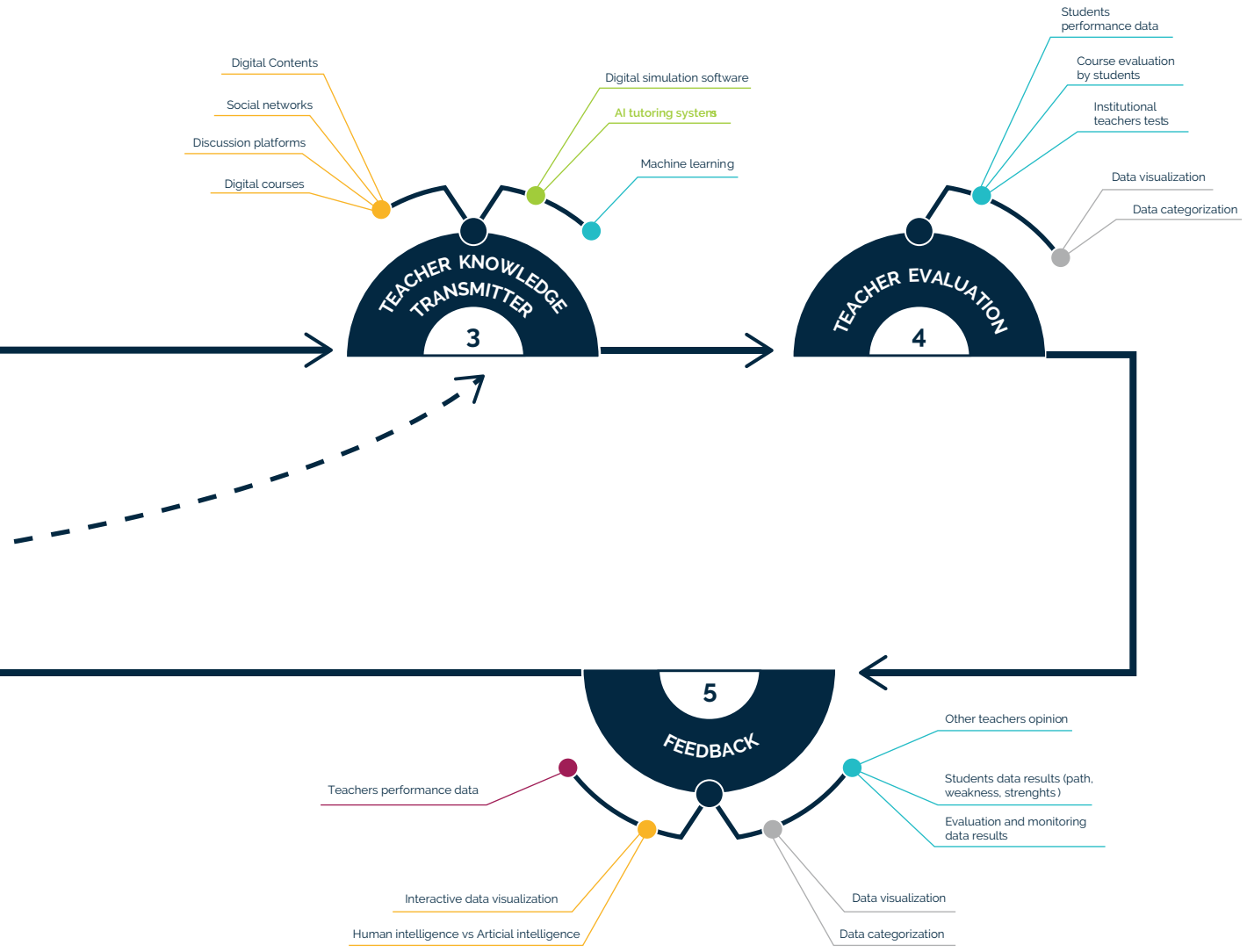
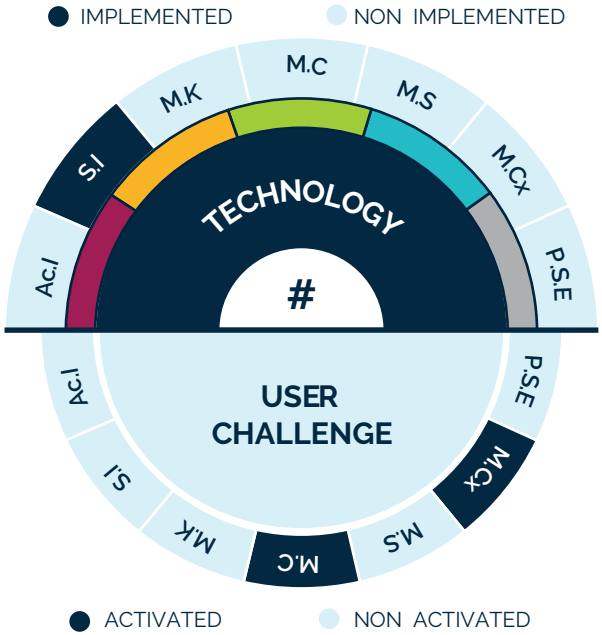
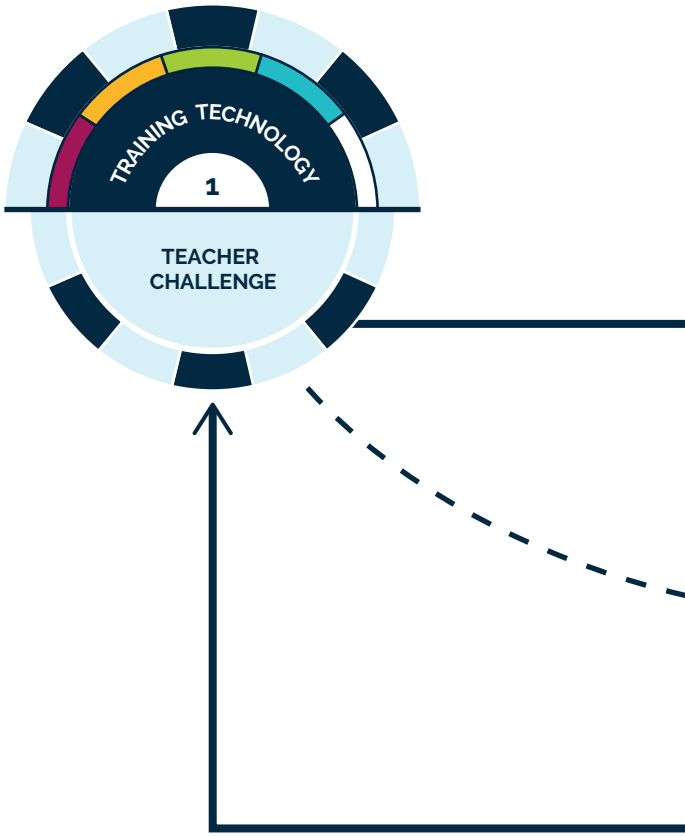


Figure 59. Activity analysis and the required integration of technology systems on each step

AI-BASED EDTECH EVALUATION

In addition, it is included a system of evaluation of the solutions design in terms of technological terms parallel to the impact on the human that will interact with the tool. Consequently, this graphic is designed to compare the systems integrated with the characteristics of an "intelligent artifact", based on the categorization of human intelligence. The aim is to recognize the elements that the technology will be in carrying on and where educators have to focus and improve their skills in order to recognize technology's advantages and challenges.





TECHNOLOGIES IN EDUCATION

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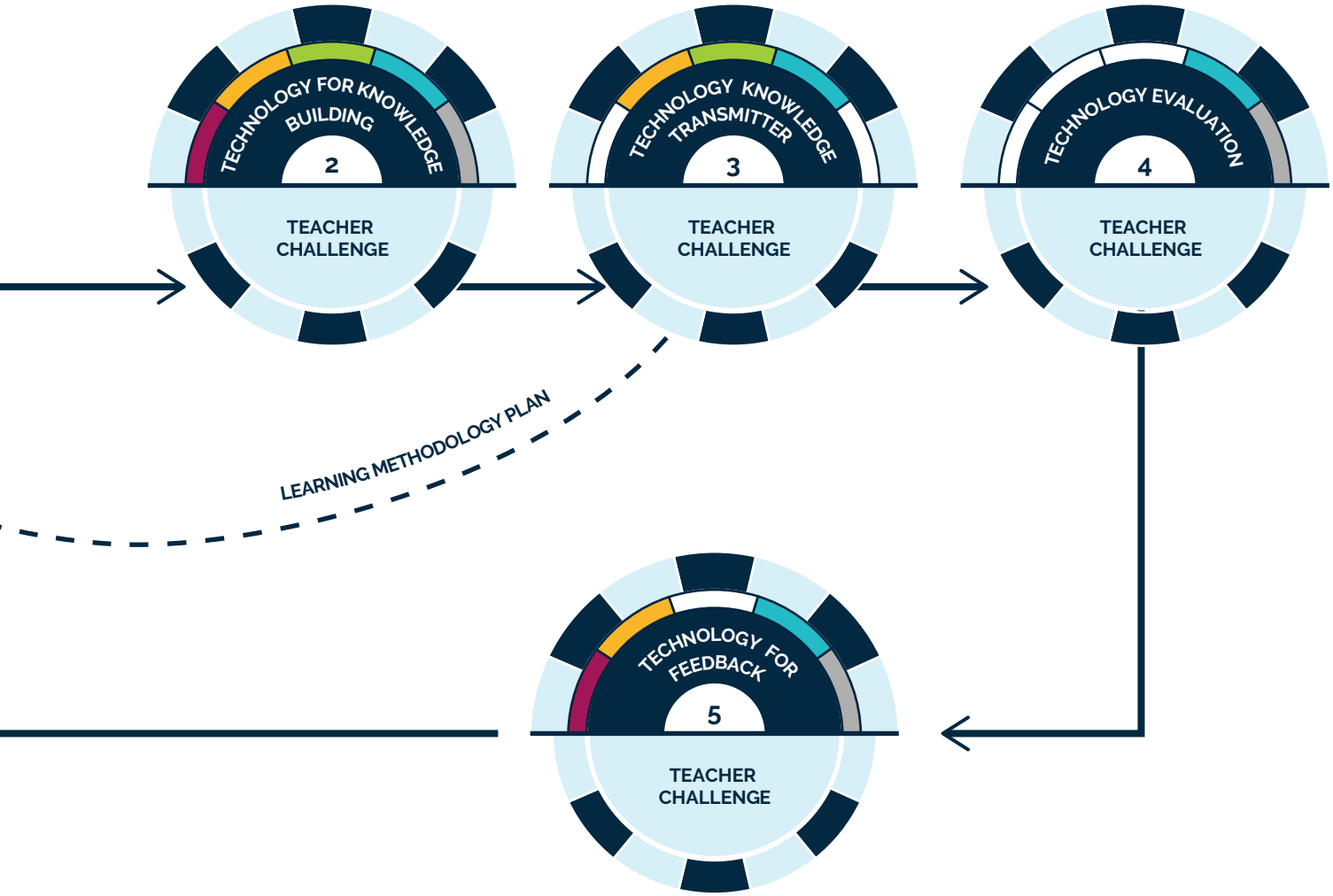

Figure 60. Evaluation system of the integrated technologies designed

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

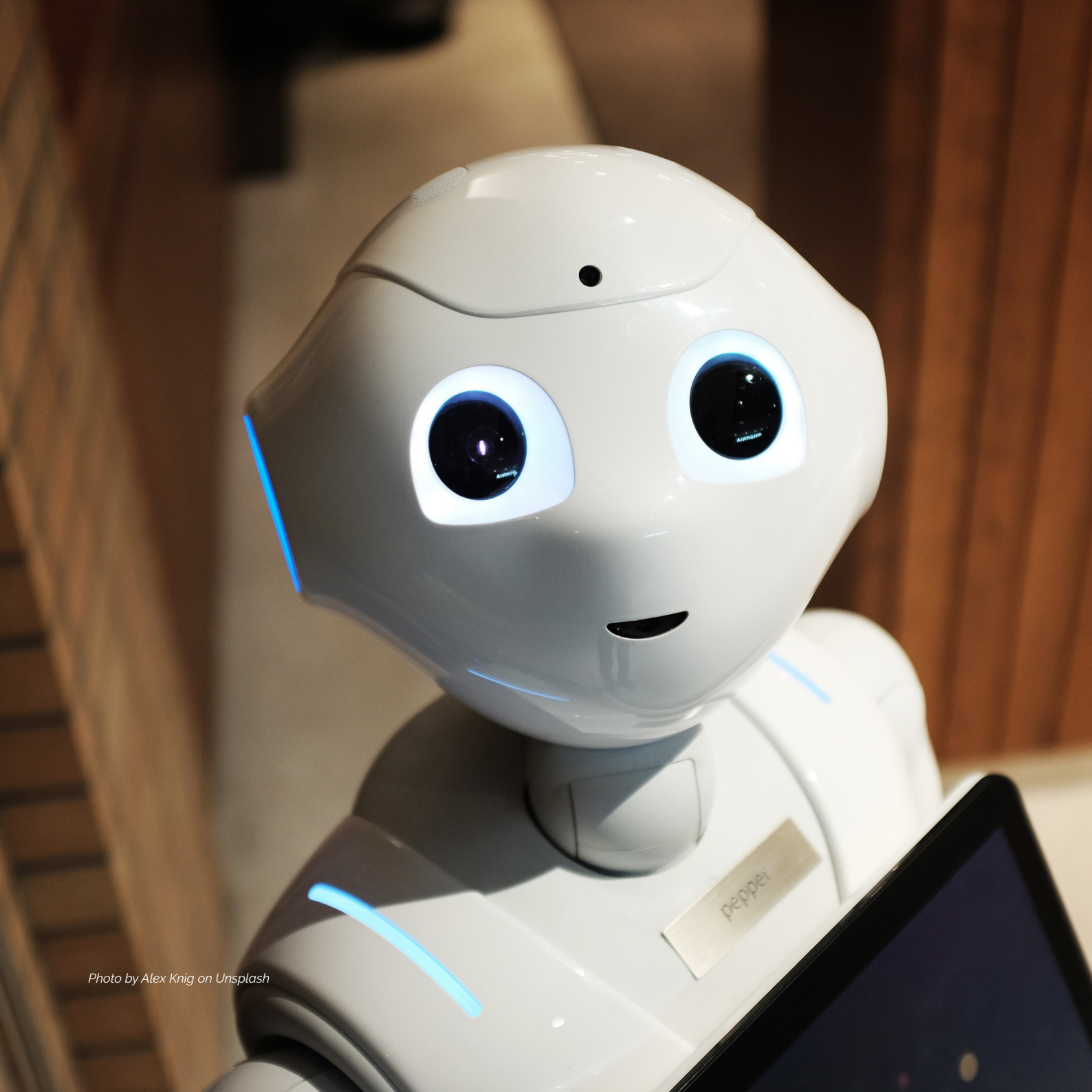

Photo by Alex Knig on Unsplash

CONCLUSIONS

The exploration that was done through this research permit to identify some key elements and conclusions from the different perspectives around education. Then, to conceptualize all the information presented on this thesis is necessary to individualize the conclusions of the research by the categories in which it was divided the study. However, an important concept related to a systemic analysis is based on the integration of the elements inside the system. In other words, is not only significant to understand the single elements but the key point is to recognize the connections between them, to identify the system behavior.

EDUCATION CONCEPTS

First, it was possible to clarify the differences between the concepts of education that cannot be misunderstood because is which usually tend to create the incorrect impression of technologies features. For instance, when is mentioned the word "intelligence" to describe Artificial Intelligence, it is directly comparing and putting at the same level the complexity that both have but that eventually human intelligence overcome. Likewise, it was possible to identify the terms of information (unprocessed data), knowledge (processed data and personal interpretation of the human behind) and skills (the capability to act and solve something).

On the other hand, the complexity of human intelligence is characterized by the interconnections between the seven different types of intelligence that humans have: academic intelligence, social intelligence, and meta-intelligence; inside the last one mentioned are situated the other five. In other words, the power of human intelligence is based on the personal experiences he/she has, the interaction with the world and the current interpretation of their combination.

From a teaching perspective, an inspiring course is measurable by the way in which it is structured. There is a large number of methodologies for learning, tools for transmitting the information to the students interactively, and communication systems working together to change the way education has been seen during the last century, due to the impact and fast development of educational technologies.

EDUCATION SYSTEM

The approach of systemic thinking allowed the construction of different levels of visualization and interpretation of the education system, evidencing the actors, resources (inputs and outputs) and the processes included for learning environments. Therefore, this characterization of the information

collected lead to identifying the connections between them that affect positive or negative the system, which lately supports the limits and problematics that according to international organizations, education systems are required to solve urgently. For instance, one of the biggest obstacles is the nonalignment of the actors because each of them is willing to obtain different goals, and even if the system implicit since the begging the main purposes around education, the stakeholders tend to change the path and defend their personal purposes.

From this perspective, quality of education is a continuous debate around the world between public and private entities but a currently common aspect that is affecting the outcomes of education systems is the low motivation of the teachers. Nevertheless, governments and decision makers of the system tend to imitate the solutions for this problem as monetary incentives which is not the only way to get their attention. As a matter of fact, teachers are being in charge of some other responsibilities that forty years ago they did not have, then, is also necessary to evaluate that the motivation can be also achieved by supporting their job and facilitating some of the tasks they are daily facing.

Likewise, the intervention on this field and accompanied by the exploration of new technologies become a cyclic process where the actors involve should be constantly evaluating the problems, designing and planning the right solutions and evaluate their performance in order to redesign solutions as many times as needed until the outcomes desired are achieved.

EDUCATION AND NEW TECHNOLOGIES

The impact of technologies in every industry has been significant during the last years, and the education industry is not getting behind. Nowadays, on the market is possible to find a big range of tools for educational purposes, however, this does not entirely represent a positive result. From the teacher's case perspective, who are currently learning and being introduced to all the features of new technologies, found extremely draining the fact of learning more than three instruments at the same time and also each one with a different language, from an interface perspective. Then, one of the most important issues identified is the non-integrated systems for supportive tools for teachers and is basically the result of not analyzing in detail the process that teachers are going through and their participation on the design of these solutions.

As a consequence, an example of failure on the introduction of new technologies is related to the way Artificial Intelligence is being immersed in the education field. This technology is eventually challenging and changing the paradigm of teaching, which means it needs to communicate and instruct educators to understand the power but especially the limits it presents. This way, they will be able to recognize where can they focus and reinforce their labor, while leaving some other task to be done by the technical support.

DESIGN APPROACH ON EDUCATION

A systemic design approach was more than necessary to understand the complexity of the system and build the context scenario where these technologies are involved leading to recognizing the impact they promote on the different elements of the system. The advantages of a systemic design is mainly the possibility to identify the situation, facilitate the phase of analysis of the information and provide an overview that permit to see the situation from an open and flexible perspective which ends on finding innovative solutions but especially strongly support by factual information, based on interpreting the knowledge obtained by experiences and the theoretical information behind.

Furthermore, the design solutions through the analysis by components of the system provide important value and responsibility for designers to give priority to the user. Along the research and mainly illustrated in the results of this thesis, is necessary to include the user on every step of the project because it is by understanding their need, requirements, way of work, thoughts, etc, that is possible to identify and build the journey of teaching and the real inconveniences around it. Consequently, this approach motivates and impulse designers to be ethical and critical on their design process and looking for solutions that respond to the industry desires but that most important do not affect negatively the people immerse on the system.

AN INTEGRATED APPROACH

Finally, last but not least, the complexity of this kind of systems need not only to be investigated from different aspects but the real power of this approach is to be able to filter the information collected and integrate the elements that coherently belong together, creating connections and supporting between the arguments the outcomes of the research and consequently the solution designed.

RECOMMENDATIONS

The research approach of this thesis project represents a starting point for a long route of exploration and innovation on educational technologies for the improvement of teaching-learning methods. It means that is necessary to continue the study and remain updated information to continue with its development, due to the level of experimentation in which AI technologies is located currently. Then, in this section are explain some recommendations based on the experience obtained along the process.

Regarding the information collected and analyzed, it is evident that the research remains limited due to the repercussion of a variety of disciplines need to be engaged in the project. An aspect that was identified as relevant for the success of the methodology, is the study and exploration of evaluation systems able to recognize the characteristics and measure of specific skills according to the way "human intelligence" is understood. In other words, to improve teachers performance is necessary to amplify the information related methods of evaluation of skills and knowledge, leading to establishing more grounded parameters to test the characteristics of the technologies besides human intelligence capabilities.

On the other hand, user research requires continuous participation of the educators to update and identify more precisely their needs and requirements. Consequently, is necessary to include a "field study", which demands a closer approach to the user, including the observation of daily habits, working environments and their behavior inside and outside the classroom.

The information obtained is important for the design decisions, to understand and follow part of the language they are more familiar with. However, it does not mean is not possible to innovate and challenge teachers skills, the ideal solution should come with the necessary problematics, which means giving possible "cognitive failures" with a precise reason to be there. In addition, in the user research should be also included an interview session with teachers allowing them to share their opinion, problems, desires, needs, fears, etc.

Finally, is recommended for future developers of the project to implement tools or methods of creative thinking. Along the process it was possible to recognize the value of sharing with experts from different areas and questioning about "impossible" solutions but that while they were connecting with the rest of the elements around, it was possible to find various paths of solutions.

FUTURE DEVELOPMENTS

The research and conclusions reached by this study illustrate a strategic plan to persuade and motivate technology curious professionals, students and institution leaders to get involved in the development of innovative supportive tools for educators. Consequently, the next step is to prototype the methodological tools proposed in order to collect feedback information from different disciplines related such as computer science, pedagogy, engineering, and humanities to prove the efficiency of the communication sources designed.

Followed by this, the next step is the implementation of the methodology proposed, which might take place through a workshop session with teams and university projects related to the topic. For instance, it should be an exercise to apply for the future multidisciplinary team working on the chat-bot project for oriented tutoring systems at the Alta Scuola Politecnica. However, the approach of this project is to stimulate the development of supportive tools for educators, which means is necessary to open the discussion inside educational institutions in order to create strategies that impulse them to invest in projects that will become resources exploited by their own teachers to facilitate their work and improve their performance.

The study has evidenced that an important element for this project is the possibility to connect different points of view. As it was mentioned before, Artificial Intelligence is a technology in process of experimentation reaching from different industries some advantages and disadvantages of its implementation. From this perspective, it is valuable to create a multidisciplinary network where the people interested or directly involve in the topic, can share their ideas, experiences, results, and issues to empower the research. Additionally, through this channel can be possible to create some events and share the results of the research, making it an open source to every person interested and familiar with it.

The most important element to keep in mind is that all these strategies need to be aligned to the same purpose of education systems. The complexity of this systems that involve a large number of actors usually tend to get lost in the route and take some decisions apart from the main goals of the system, but is part of the methodology approach to situate at the center not only the user but also the direction to the common endpoint that the system settle from the beginning.

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